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Pregledni rad

OPLEMENJIVANJE BRESKVE U SVETU

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Izvod. U ovom radu prikazani su najznačajniji ciljevi, metode i rezultati oplemenjivanja breskve [*Prunus persica* (L.) Batsch.] u svetu. Među ciljevima oplemenjivanja posebna pažnja je posvećena osobinama koje utiču na smanjenje troškova proizvodnje i raznoliki ukus potrošača. Od metoda oplemenjivanja obrađene su hibridizacija, inbriding, klonska selekcija, indukovane mutacije i nove metode biotehnologije. Po pojedinim kontinentima i državama dat je i pregled velikog broja oplemenjivačkih programa sa njihovim najznačajnijim rezultatima. Posebno su istaknuti rezultati rada na stvaranju novih sorti breskve i nektarine namenjenih za potrošnju u svežem stanju. Iako su u oplemenjivanju breskve postignuti vrlo značajni rezultati, u mnogim zemljama sveta na ovom poslu još uvek se intenzivno radi.

Ključne reči: *Prunus persica*, oplemenjivanje, sorte, hibridizacija, selekcija, mutacije.

Uvod

Breskva je veoma cenjena i rentabilna vrsta voćaka. Plod joj je vrlo atraktivnog izgleda i dobrog kvaliteta. Koristi se za stonu potrošnju, za proizvodnju sokova, kompota, džemova, marmelada, bebi kaša, kao i za sušenje i smrzavanje. Breskva se među voćkama po proizvodnji nalazi na osmom mestu u svetu, a među listopadnim voćkama na trećem mestu. Prema podacima FAOSTAT (2012) prosečna proizvodnja breskve u svetu, u periodu od 2006. do 2010. godine, iznosila je 19.552.135 t. Glavni proizvođač je Kina sa 9.555.546 t, što čini 49% od ukupne svetske proizvodnje. Za njom slede Italija (8%), Španija (6%), SAD (6%), Grčka (4%), Turska (3%), Iran (2%), Egipat (2%), Čile (2%), Francuska (2%) itd. Srbija se na ovoj listi nalazi na 26 mestu, sa prosečnom proizvodnjom od 66.657 t (ili 0,3% od ukupne svetske proizvodnje).

U svetu postoji više od 6.000 sorti breskve. Za razliku od ostalih vrsta voćaka, sortiment breskve je jedan od najdinamičnijih. Oplemenjivanje breskve, naročito u drugoj polovini XX i početkom XXI veka, omogućilo je neprekidno stvaranje novih i boljih sorti, čime je preporođeno breskvarstvo u mnogim zemljama sveta. Međutim, treba imati u vidu da je današnji sortiment breskve nastao od veoma ograničenog početnog materijala i da je kao takav dosta osetljiv na nepovoljne činioce sredine kao što su mraz, suša, prouzrokovači bolesti i štetočine (Mišić, 2002). Zato se vidan

napredak u stvaranju novih sorti breskve otpornih na abiotičke i biotičke stresne faktore može postići jedino korišćenjem nove germplazme i usavršavanjem kako klasičnih, tako i novih biotehnoloških metoda oplemenjivanja.

Klasifikacija sorti breskve može se izvršiti na različite načine. Najubičajenija je podela na sorte obične breskve (belog i žutog mesa), nektarine (belog i žutog mesa) i industrijske breskve. Bassi i Monet (2008) predložili su klasifikaciju sorti breskve na osnovu morfoloških i komercijalnih svojstava sa jedne strane i na osnovu i fenoloških svojstava sa druge strane. U okviru morfološke i komercijalne klasifikacije svrstavanje sorti vrši se u zavisnosti od upotrebne vrednosti stabla (sorte za proizvodnju plodova i ukrasne forme), tipa ploda (sorte obične breskve, nektarine i industrijske breskve), oblika ploda (sorte okruglog ili izduženog i sorte spljoštenog ploda), boji mesa (sorte belog i žutog mesa), teksturi mesa (sorte topivog, netopivog i čvrstog mesa) i kiselosti mesa (sorte kiselog i sorte slabo-kiselog mesa). U okviru fenološke klasifikacije svrstavanje sorti vrši se na osnovu potreba za relativno niskim temperaturama u periodu zimskog mirovanja, vremena cvetanja i vremena sazrevanja. Skoro u svakoj zemlji gde se breskva gaji razvijeni su i oplemenjivački programi koji prate neke od navedenih pravaca.

Cilj ovog rada bio je da se najpre prikažu osnovni pravci i metode, a potom i rezultati najznačajnijih oplemenjivačkih programa breskve u svetu.

Ciljevi oplemenjivanja breskve

Neki od prvih oplemenjivačkih ciljeva breskve, mnogih selekcionara, bili su boja, čvrstoća ploda i atraktivnost, dok je izostajalo oplemenjivanje osobina kao što su ukus, otpornost na niske temperature i adaptivnost na ekonomski isplative sisteme gajenja. Poboljšanje komercijalnih osobina je bilo neophodno jer stare sorte nisu bile atraktivne, nisu bile podobne za rukovanje i transport i nisu bile pogodne za komercijalni način gajenja. Tako su pre nekih 30-tak godina razvijeni ciljevi koji pokrivaju interese i proizvođača i potrošača breskve (Monet i Bassi, 2008).

Jedan od najinovativnijih ciljeva oplemenjivanja breskve je smanjenje troškova proizvodnje. Sorta ima male proizvodne troškove ukoliko je dobro adaptirana na ekološke uslove područja u kom se gaji. Ako nije dobro adaptirana, onda se povoljni uslovi moraju “veštački” stvoriti, što povećava troškove proizvodnje. Savremene plemenite sorte u tom pogledu treba da se odlikuju otpornošću na klimatske ekcese (mraz, sušu i tople vetrove), da im je zimski odmor odgovarajuće dužine (odnosno da traje određen broj časova na temperaturi 0-7°C), kao i da po mogućstvu budu otporne na prouzrokovače bolesti i štetočine.

Adaptacija na određene klimatske faktore je bila i trenutno je jedan od najvažnijih ciljeva u mnogim oplemenjivačkim programima. Stvaranje sorti koje pokazuju otpornost na zimske temperature u umereno-kontinentalnim klimatima, ili stvaranje sorti kratkog zimskog mirovanja tzv. “low chill” sorti (sorti kojima je potrebno 100-500 h ispod 7°C) su i dan danas aktuelni ciljevi velikog broja oplemenjivačkih programa.

Takođe su interesantni oplemenjivački programi čiji je cilj stvaranje sorti otpornih na bolesti i štetočine. Redukcija broja prskanja je jako poželjna, jer smanjuje troškove proizvodnje, a smanjuje i zagađenje životne sredine. Genetički inženjering bi u skorije vreme mogao da dâ brzo rešenje problema bolesti i štetočina breskve. Međutim, mnogi potrošači još uvek oklevaju sa konzumiranjem hrane koja je nastala od transformisanih, ili genetički modifikovanih organizama (GMO). Iako su korišćenjem klasičnih metoda, mnogi oplemenjivački progami uspeli da stvore nove sorte breskve koje su otporne na bolesti i štetočine, taj rad se i dalje nastavlja. Od novih sorti breskve u tom pogledu očekuje se visok stepen otpornosti na prouzrokovače sledećih bolesti: kovrdžavosti lišća (*Taphrina deformans*), rupičavosti lišća (*Wilsonomyces carpohilus*), pepelnici (*Sphaerotheca pannosa*), sušenju cvetova, grančica i mrkoj truleži plodova (*Monilinia laxa* i *Monilinia fructicola*), bakterijalnoj lisnoj pegavosti (*Xanthomonas pruni*), raku rana (*Leucospora cincta*), šarki (*Plum Pox Virus*) i štetočinama: lisnim vašima (*Myzus persicae* i *Hyalopterus amygdali*) i gusenicama (*Anarsia linatella* i *Grapholita molesta*) koje žive na letorastima i plodovima.

Troškovi proizvodnje mogu se smanjiti i sadnjom sorti kod kojih su veličina stabla i oblik prirodno prilagođeni sistemu gajenja. Zato se vrši oplemenjivanje u cilju stvaranja patuljastih formi koje su pogodne za gustu sadnju (Liverani i Fideghelli, 1993), formi koje će imati ‘pilar’ (columnar) tip stabla za gajenje u obliku ‘zida’ (Scorza et al., 1989), kao i pendulastih formi, sa orezivanjem centralne vođice (Monet et al., 1988).

Nove sorte breskve treba dalje da budu samooplodne, da dozrevaju u različito vreme, počev od vrlo ranih do vrlo poznih i da budu rane, visoke i redovne rodnosti. Plod treba da im bude krupan (preko 65 mm u prečniku), čvrst, da ne puca, da je loptast i ujednačen, sa privlačnom crvenom pokožicom i sa što manje malja. Meso (mezokarp) ploda treba da bude žuto (bez crvenila oko koštice) ili belo, a koštica što manja i da se od mesa lako odvaja (kalanka). Ukus ploda treba da je slatko-nakiseo i harmoničan, sličan sorti ‘Haleova pozna’. Oblik ploda treba da omogući mašinsko sortiranje. Sorte breskve za stonu upotrebu treba dobro da podnose klasiranje, pakovanje, prevoz i čuvanje, a sorte za industrijsku preradu da budu vrlo čvrste, bez izraženog vrha koštice, fine građe mezokarpa, otporne na pucanje koštice, postojane pri sečenju (da njihova boja mesa ne prelazi u mrku) i da omoguće proizvodnju kvalitetnih prerađevina (kompota, džema, marmelade, soka itd.).

Da bi dobili ovakvu raznolikost kod breskve, oplemenjivači su pošli od Mendelovih pravila genetičke varijabilnosti. Na tržištu su se ranije mogle naći samo breskve belog ili žutog mesa, dok su danas prisutne i jedne i druge. Onda su se 1960-tih godina prošlog veka pojavile nektarine. Pljosnate breskve su takođe bile cilj oplemenjivanja u nekoliko programa, kao na primer u Kini i Francuskoj (Monet et al., 1985), Italiji i SAD-u (Sherman i Lyrene, 2001). Breskve i nektarine crvenog mesa stvorene su u Francuskoj i SAD-u. Suprotno tome, nektarine bez prisustva antocijana su cilj oplemenjivačkih programa u Italiji (Bellini et al., 1994) i SAD-u.

Sve ove osobine se mogu dalje kombinovati. Tako, na primer, kod breskve “subacid” ili “medni” ukus ploda (mali sadržaj kiselina u plodovima), koji je veoma popularan u zemljama Dalekog Istoka, uveden je kao jedan od ciljeva evropskih i američkih oplemenjivačkih programa. Ova osobina dozvoljava raniju berbu plodova bez značajnijeg uticaja na ukus. Kombinacijom pljosnatih plodova sa malim sadržajem kiselina kod nektarine dobijeni su plodovi koji se zovu ‘platerine’. Na isti način, uvođenje sorti koje poseduju netopivo meso ploda za stonu upotrebu, daje mogućnost da se berba plodova obavi neposredno pred zrelost pri optimalnom kvalitetu i ukusu, ali sa većom trajnošću za rukovanje i transport do udaljenih tržišta.

Na kraju, treba istaći da ovi brojni ciljevi oplemenjivanja razvijaju inovacije u proizvodnji breskve, sa sve većom pažnjom usmerenom ka proizvođačima i potrošačima, što predstavlja promenu u odnosu na ranije programe oplemenjivanja koji su se bavili isključivo komercijalnim ciljevima.

Metode oplemenjivanja breskve

U oplemenjivanju breskve najčešće se primenjuju sledeće metode: hibridizacija, inbriding, klonska selekcija, indukovane mutacije i nove metode biotehnologije. Hibridizacija je najraširenija metoda za stvaranje novih sorti breskve. U prošlosti je većina sorti breskve stvorena spontanom hibridizacijom. I danas tako nastaje oko 10% novih sorti breskve. Međutim, mali broj današnjih privredno značajnih sorti breskve nastao je spontanom hibridizacijom. Mišić (2002) navodi da su određeni autori kao što su van Mons, Rivers i drugi stvorili dosta sorti breskve i veštačkom hibridizacijom. Ipak, najznačajniji metod za stvaranje novih, sorti breskve je planska hibridizacija. Ovom metodom stvoreno je više od 50% sorti koje se danas nalaze u proizvodnji.

U stvaranju novih sorti breskve veoma uspešno se koristi i inbriding. To je sistem oplođenja u kojem potomstvo (inbridi) postaje sjedinjavanjem gameta roditelja, koji su među sobom srodniji nego što je prosek srodnosti populacije. Samooplodnja kao najviši stepen inbridinga je moguća kod samooplodnih sorti, a tehnika ovog postupka kod breskve sastoji se od izolacije i samooprašivanja. Inbridingom su stvorene neke privredno značajne sorte breskve, a u našoj zemlji to su ‘Maja’, ‘Vesna’ i ‘Gročanka’.

Pozitivnom klonskom selekcijom odabrano je dosad oko 15% novih sorti breskve u odnosu na ukupan broj novostvorenih sorti. Najveća pažnja u radu na klonskoj selekciji posvećena je otkrivanju mutanata koji se razlikuju od matične sorte po vremenu sazrevanja, rodnosti i boji pokožice ploda. Tako su od sorte ‘Redhaven’ postali mutanti ‘Early Redhaven’, ‘Garnet Beauty’, ‘Stark Earliglo’, ‘Sunshine’ i ‘Pratt's Compact Redhaven’; od sorte ‘Coronet’ - ‘Early Coronet’ i ‘Magnolia’; od sorte ‘Rio Oso Gem’ - ‘Early Kirkman’ i ‘Kirkman Gem’; od sorte ‘Springcrest’ - ‘Maycrest’, ‘Earlycrest’ i ‘Morning Sun’; od sorte ‘Springtime’ - ‘Royal Gold’; od sorte ‘Triogem’ - ‘Early Triogem’; od sorte ‘Haleova pozna’ (‘J.H. Hale’) - ‘Honey Dew Hale’, ‘Albru’, ‘Radmilovčanka’ itd. Pri radu na

klonskoj selekciji treba, međutim, biti obazriv jer se često umesto totalnih mutanata, koji na potomstvo verno prenose izmenjenu osobinu, javljaju himere, koje se u tom pogledu različito ponašaju.

Primenom određenih fizičkih i hemijskih agenasa (mutagena) kod pojedinih sorti breskve mogu se takođe izazvati značajne nasledne promene. Hough i Weaver (1958) izlagali su jednogodišnja stabla nekoliko sorti breskve hroničnom zračenju u gama polju. Oni su otkrili pojavu mutanata ranijeg i poznijeg vremena sazrevanja kod sorti breskve ‘Fairhaven’ i ‘Elberta’, kao i odgovarajuće promene u čvrstini mesa ploda kod sorte ‘Elberta’ i izrazitije crveno obojeno meso kod sorte ‘Fairhaven’. Toyama (1974) je otkrio 24 haploida breskve vizuelnim osmatranjem sejanaca iz spontane populacije gajene u staklari. Najviše haploida poticalo je iz populacije sorte ‘Elberta’, a zatim sorti ‘Rio Oso Gem’ i ‘Suncrest’. Toyama je utvrdio da se prosečno dobija po jedan haploidni sejanac breskve od 1.250 biljaka. Mladi haploidi breskve su manje bujni, grančice su tanje, internodije kraće, listovi svetlozeleni, a liske uže nego kod odgovarajućih diploidnih sejanaca. Primenom kolhicina (0,5%) Toyama je dobio 10 dihaploida (homozigotnih diploida) breskve, koji su znatno bujniji od odgovarajućih haploida. Oni su po pravilu plodni i predstavljaju čiste homozigotne linije, kod kojih i recesivne osobine dolaze do izražaja. Capocasa et al. (2012) su mutacijom pljosnate sorte breskve ‘Stark Saturn’ dobili nektarinu spljoštenog oblika ploda pod nazivom ‘Concettina’. Ova sorta poseduje visoku rodnost i poboljšane senzorne i nutritivne osobine.

Od novih biotehnoloških metoda u oplemenjivanju breskve najviše se koriste kultura embriona, somatska organogeneza, somaklonalna varijablnost, genetičke transformacije, izoenzimi i molekularni markeri. Kultura embriona se koristi radi dobijanja sejanaca od nedovoljno razvijenih embriona vrlo ranih i ranih sorti. To je jedini način da se stvore nove, vrlo rane i rane sorte breskve. Regeneracija organa breskve somatskom organogenezom ostvarena je iz delova semena: kalusa nezrelih embriona, nezrelih kotiledona i nezrelog endosperma. Somaklonalne varijante mogu da nastanu promenama strukture molekula DNK, hromozomskim mutacijama i aktivacijom, odnosno inaktivacijom gena (Kahl, 1995). Te promene su izvor nove genetičke varijabilnosti. Genetičke transformacije breskve najčešće se ostvaruju unošenjem gena direktno (pomoću genetičkog pištolja) ili preko vektora (Ti-plazmida bakterije *Agrobacterium tumefaciens*). Tako je kod breskve posredstvom bakterije *Agrobacterium tumefaciens* ubačen *ipt* gen koji utiče na kompaktnost krune (Smigocki i Hammerschlag, 1991). Za genetičke transformacije breskve stoji na raspolaganju i gen proteinskog virusnog omotača (Beachy et al., 1990), gen za *Bt* protein koji deluje kao insekticid izolovan iz *Baccillus thuringiensis* (Fischhoff et al., 1987), kao i geni za otpornost na herbicide (Scorza i Okie, 1991). Izoenzimi i molekularni markeri (RFLP, RAPD, AFLP, SSR i dr.), mogu da se koriste za genetičko mapiranje, identifikaciju sorti, izučavanje naslednosti, filogenetska proučavanja i ranu predselekciju sejanaca breskve (Dirlewanger et al., 1998; Wünsch, 2009).

Sve nabrojane metode same, ili u kombinaciji, najčešće sa hibridizacijom, mogu sa uspehom dovesti do ostvarenja postavljenih ciljeva oplemenjivanja i poboljšanja sortimenta breskve.

Rezultati oplemenjivačkih programa breskve u svetu

Na stvaranju novih sorti breskve veoma se intenzivno radi širom sveta. U ovaj posao uključen je veliki broj kako državnih, tako i privatnih institucija. Najznačajniji programi oplemenjivanja breskve nalaze se u SAD-u, Italiji i Francuskoj, dok je znatno manja aktivnost zastupljena u drugim zemljama. Infante et al. (2006), analizirajući rad 26 oplemenjivačkih programa u svetu, došli su do zaključka da se 40% programa nalazi u SAD-u, 28% u Evropi, 28% u Južnoj Americi i 4% u Aziji. U proseku svi programi su delovali oko 26 godina i vrednovali su oko 3.500 sejanaca po godini. Obično je selekcionisano 3,7 hibrida na 10.000 sejanaca. Programi su priznavali 25 sorti godišnje ili u proseku 0,88 sorti po programu.

Najveći broj oplemenjivačkih programa breskve radi na stvaranju sorti za svežu potrošnju. Zajedno sa oplemenjivačkim programima za svežu potrošnju teku i programi oplemenjivanja sorti za preradu, zato što su genetika i metodologija ova dva pravca oplemenjivanja identični (Etienne et al., 2002). Glavna razlika između sorti za preradu i sorti za svežu potrošnju je u tome što se sorte za preradu tretiraju kao sirovina, pa je potrebna veća postojanost i uniformnost ploda, kao i veći prinosi kako bi se nadoknadila generalno niža cena sirovine. Pošto se preradom gube aromatične i mirišljave materije, oplemenjivački programi za preradu moraju da vode računa i o tim osobinama (Blanc i Arregui, 1999). Oko 83% svih prerađenih plodova breskve čine glođuše sa netopivim mesom, zato što je takav mezokarp otporniji na pojavu fizičkih oštećenja koja se javljaju pri berbi, transportu, preradi i sečenju. Industrijske sorte breskve su većinom visoke rodnosti, srednje krupnog ploda, čvrstog i žuto obojenog mesa i prijatnog ukusa i arome. Sortiment u većini zemalja sveta zasnovana je uglavnom na srednje poznim sortama poreklom iz Italije među kojima se ističu ‘Maria Serena’, ‘Romea’, ‘Adriatica’, ‘Tebana’, ‘Lamone’, ‘Tirrenia’, ‘Villa Ada’, ‘Villa Adriana’, ‘Villa Doria’ i ‘Villa Giulia’ i poznim sortama poreklom iz SAD-a kao što su ‘Shasta’, ‘Carson’, ‘Vivian’, ‘Andros’, ‘Jungerman’, ‘Babygold 6’, ‘Babygold 8’, ‘Babygold 9’ i ‘Halford’. Pored Italije i SAD-a na stvaranju industrijskih sorti breskve radi se i u Francuskoj, Rumuniji, Australiji, Brazilu, Južnoj Africi i drugim zemljama.

Određen broj oplemenjivačkih programa breskve usmeren je ka stvaranju sorti sa kratkim zimskim mirovanjem (“low chill” sorte). Trenutno postoji jedanaest državnih i dva privatna oplemenjivačka programa u sedam zemalja koje se bave stvaranjem sorti breskve i nektarine sa kratkim zimskim mirovanjem. Ovi oplemenjivački programi su locirani tamo gde je prosečna temperatura u najhladnijem mesecu od 12°-16°C. Takve lokacije imaju prosečno zimsko mirovanje od 250 do 650 CU (“chill units“-hladne jedinice), na geografskim širinama od 19° do 30°. Ovi oplemenjivački programi se izvode u predelima koji variraju od suvih

pustinja, vlažnih sub-tropa i tropskih visoravni sve do umereno-kontinentalnih klimata. Najstariji programi koji i danas postoje nalaze se u SAD-u (Gainesville), Brazilu (Pelotas i Campinas) i južnoj Africi (Stellenbosch). U poslednjih 30 godina broj ovakvih oplemenjivačkih programa je porastao usled tražnje sorti koje će biti adaptirane na lokalne klimatske uslove i lokalna tržišta do kojih ne mogu da stignu standardne sorte.

Značajan broj oplemenjivačkih programa breskve orjentisan je i na stvaranje ukrasnih formi stabla (stubast, patuljast, pendulast i dr.) (Bassi i Rizzo, 2000; Scorza et al., 2006; Dongyan i Zuoshuang, 2008), kao i na stvaranje sorti spoljoštenog oblika ploda (Jiang et al., 2002; Ma et al., 2003).

U daljem tekstu prikazaće se pregled najznačajnijih oplemenjivačkih programa iz pojedinih zemalja sveta koji se prvenstveno bave stvaranjem novih sorti breskve i nektarine namenjenih za svežu potrošnju.

Severna Amerika

SAD. Najznačajniji oplemenjivački programi breskve u SAD-u nalaze se u Kaliforniji.

USDA oplemenjivački program u Kaliforniji je počeo sa radom 1920. godine u Palo Alto, a kasnije u Davis-u, prvenstveno radi stvaranja sorti za konzervisanje i sušenje. Kasnije je ovaj program premešten na univerzitet Kalifornija u Davis-u i od strane J.H. Weinberger-a proširen je sa stvaranjem sorti za svežu potrošnju. Tokom 1980. godine Weinberger-ove nektarine (‘Fairlane’ ‘Firebrite’, ‘Flamekist’, ‘Flavortop’ i ‘Independence’) uključujući i vodeću sortu u to vreme ‘Fantasia’, zauzimale su preko 40% od ukupne proizvodnje nektarine u SAD-u. Sa druge strane Weinberger-ove sorte breskve uključujući ‘Coronet’, ‘Desert Gold’, ‘Fairtime’, ‘Fayette’, ‘Flamecrest’, ‘Flavorcrest’, ‘Redtop’,‘Regina’, ‘Summerset’ i ‘Suncrest’ čine preko 25% sorti koje se isporučuju na tržištu Kalifornije. D.W. Ramming je nastavio USDA oplemenjivački program breskve u Fresno (sada Parlier) iz 1974. godine sa naglaskom na veoma rano i veoma pozno vreme sazrevanja, kao i poboljšanje kvaliteta ploda. Njegova istraživanja kulture embriona kao sredstva da se proizvedu sejanci iz ukrštanja ranih sorti, omogućila su stvaranje ultra ranih sorti kao što su ‘Spring Baby’ i ‘Spring Gem’ kod breskve i ‘Mayfire’ i ‘Crimson Baby’ kod nektarine. ‘Spring Baby’ je bila jedna od prvih sorti breskve sa netopivim mesom koja je plasirana na tržište. Značajna rana sorta breskve iz ovog programa je i ‘Goldcrest’ i pozna sorta nektarine ‘Fairlane’. Sorta ‘Autumn Red’, koja je dalje priznata, obezbedila je visok kvalitet, dobru obojenost i pozno sazrevanje breskve, a ‘September Free’ je bila visoko kvalitetna i poznosazrevajuća nektarina. Nedavno je stvorena i sorta krupnog spljoštenog ploda ‘Galaxy’ kao dodatak sorti ‘Saturn’.

Osim u državnim institucijama, u Kaliforniji se značajan oplemenjivački rad odvija i kod privatnih oplemenjivača. Od starih privatnih programa posebno se ističu Grant Merill koji je bio aktivan do 1973. godine i Fred Anderson koji je bio aktivan do 1982. godine.

Merrill (1899-1973) je uglavnom radio sa breskvama priznavajući i uvodeći u proizvodnju značajne sorte kao što su ‘O’Henry’, ‘Early O’Henry’, ‘Elegant Lady’, ‘Spring Lady’, ‘Angelus’, i dr. od kojih se mnoge još uvek gaje širom sveta. Tokom 1970-tih i 1980-tih godina 40% od svih sorti u Kaliforniji bile su Merrill sorte (Zaiger, 1988). Sa druge strane F. Anderson (1883-1982) je najviše radio na stvaranju novih sorti nektarine. On je uveo u proizvodnju mnoge značajne sorte uključujući ‘Le Grand, ‘Sun Grand’, ‘May Grand’, ‘Early Sun Grand’, ‘Stark Redgold‘, ‘Red June’, ‘Red Diamond’, ‘Spring Red’ i mnoge druge. Andersonove nektarine dominirale su tržištima širom sveta mnogo godina. Sa Andersonom su na stvaranju novih sorti dosta radili C.F. Zaiger i N.G. Bradford koji su kasnije uspostavili sopstvene oplemenjivačke programe (Zaiger Genetics, Inc. i Bradford Genetics, Inc.), koji su i danas aktivni.

Zaiger Genetics, Inc. je porodična oplemenjivačka organizacija osnovana u Modesto 1958. godine. Zaiger je patentirao prvu sortu breskve ‘Royal Gold’ i nektarine ‘Crimson Gold’ 60-tih godina prošlog veka. Veoma rano Zaiger je počeo sa stvaranjem sorti belo obojenog mesa ploda za evropsko i azijsko tržište. U Americi je dosta radio sa Dave Wilson rasadnikom koji je testirao njegove nove sorte. Selekcionisane sorte breskve i nektarine sa niskim sadržajem kiselina i dobrim ukusom su označene kao članovi ‘Zee Sweet®’ grupacije i licencirane su širom sveta. Okie et al. (2008) navode da su zasadima Kalifornije od Zaiger sorti breskve ranog vremena sazrevanja najraširenije ‘Super Rich’ (1997), ‘Brittney Lane’ (1998) i ‘Spring Snow’ (1997), kao i srednje pozna sorta ‘Country Sweet’ (1999). Od sorti nektarine najviše se gaje ‘Honey Blaze’ (1998), ‘Arctic Snow’ (1992), ‘Arctic Mist’ (1999) i ‘Red Roy’ (2001). Iz ovog oplemenjivačkog programa proistekle su i rane sorte breskve ‘Rich Lady’ (1990), ‘Rich May’ (1991) i ‘Earlirich’ (1994), srednje pozne sorte ‘Zee Lady’ (1986), ‘Royal Glory’ (1987), ‘Summer Sweet’ (1992), ‘Vista’ (1996) i ‘Sweet Dream’ (1998) i pozne sorte ‘September Snow’ (1992), ‘Autumn Snow’ (1997), ‘Sweet September’ (1997) i ‘Snowfall’ (2000). Od ranih sorti nektarine mogu se još istaći ‘Royal Glo’ (1993), ‘Arctic Star’ (1995) i ‘Arctic Sweet’ (1996), od srednje poznih ‘Honey Kist’ (1995) i ‘Arctic Jay’ (1997) i od poznih ‘Arctic Pride’ (1993). Značajne sorte breskve iz ovog programa su i ‘Summer Rich’, ‘Sweet Fire’ i ‘Royal Moon’, a od nektarina se ističu sorte ‘Supercrimson’, ‘Big Top’, ‘Fire Top’ i ‘Queen Ruby’. Oplemenjivački program Zaiger Genetics, Inc. je do sada stvorio i veliki broj sorti breskve sa kratkim zimskim mirovanjem.

Bradford Genetics, Inc. je takođe porodična oplemenjivačka organizacija u Le Grand-u. Ovaj program je počeo sa srednje sazrevajućim, nektarinama žutog mesa, uobičajene kiselosti i visokim potrebama za zimskim mirovanjem. Za prvih 10 godina Bradford program je izgrađen na uspesima Anderson-a, potpomognut superiornim roditeljima kao što je nektarina ‘Red Diamond’, koja je uspostavila novi standard za čvrstoću i boju, kada je priznata 1972. godine. Tokom 1990-tih godina Bradford je napravio veliki pomak u razvoju bresaka i nektarina belog mesa. Početni akcenat bio je stvaranje kisele sorte belog mesa tražene od strane odgajivača u Francuskoj. Međutim, u Aziji je davana prednost tipovima sa niskim sadržajem

kiselina. Stvaranjem ‘Pearl’ serije, nektarine sa belim mesom i niskim sadržajem kiselina su postale popularne u Kaliforniji i na južnoj hemisferi. Breskve sa belim mesom kao što su sorte ‘Ivory Princess’, ‘Ice Princess’ i ‘Snow Princess’ su takođe bile popularne širom sveta. Da bi ostao konkurentan Bradford je napravio pomak ka stvaranju sorti ranijeg sazrevanja i “low chill” sorti. Najraširenije Bradford sorte nektarine u zasadima Kalifornije su ‘Diamond Bright’ (1996), ‘Kay Sweet’ (1999), ‘August Pearl’ (1999), ‘Grand Pearl’ (1997) i ‘Ruby Sweet’ (1997). ‘Od sorti breskve najviše se gaje ‘Ivory Princess’ (2000) i‘Crimson Lady’ (1992). Kao interesantne srednje pozne sorte nektarine iz ovog programa mogu se izdvojiti i ‘Spring Bright’ (1991), ‘Diamond Ray’ (1994), ‘June Pearl’ (1995), ‘Fire Sweet’ (1997) i ‘Kay Pearl’ (1999), a kao pozne sorte ‘September Red’ (1986), ‘August Red’ (1988), ‘Regal Pearl’ (2000) i ‘September Bright’ (2003). Značajna sorta breskve iz ovog programa je i ‘Diamond Princess’, a od nektarina se ističu sorte ‘Rita Star’, ‘May Star’, ‘Early Star’, ‘Spring Star’, ‘Summer Star’, ‘August Snow’, ‘Bright Pearl’, ‘Fire Pearl’ i ‘Stark Crimson Snow’.

Burchell Nursery, Inc. je oplemenjivački program porodičnog rasadnika u Oakdale i Fowler-u, osnovan 1942. godine. Nove patentirane sorte (>40) iz ovog programa uknjižene su sa imenom sorte i prefiksom ‘Burpeach’ za breskve i prefiksom ‘Burnect’ za nektarine. U zasadima Kalifornije od Burchell sorti breskve najviše se gaje ‘Burpeachone’ (2001), ‘Burpeachfourteen’ (2003) i ‘Burpeachfive’ (2002), a od sorti nektarine ‘Burnecten’ (2003) i Burnectfour’(2003). Od značajnijih sorti breskve iz ovog programa mogu se pomenuti i ‘Burpeachthree’, ‘Burpeachfour’ i ‘Burpeachsix’ stvorene 2002. godine.

Sun World International, Inc. je oplemenjivački program iz Kalifornije koji je fokusiran na stvaranje sorti ranog vremena sazrevanja prvenstveno za područje Bakersfield-a. On je takođe jedan od najmoćnijih oplemenjivačkih programa u svetu za stvaranje sorti sa kratkim zimskim mirovanjem. U stvaranju ovih sorti program aktivno učestvuje od 1987. godine. Nove patentirane sorte uknjižene su sa imenom sorte i prefiksom ‘Supech’ za breskve i prefiksom ‘Sunect’ za nektarine. Sun World grupa sorti breskve za tržište sreće se i pod brendom po imenu AMBER CREST®. Iz ove serije ističu se sorte kratkog zimskog mirovanja ‘Supechthirteen’ i ‘Supechfifteen’, koje se beru tokom prve polovine aprila, dok ‘Supechsix’, ‘Supechsixteen’ i druge sorte sazrevaju u maju. Sun World je vrednovao i nekoliko sorti nektarine sa kratkim zimskim mirovanjem koje sazrevaju tokom aprila, a takođe je promovisao i sortu ‘Sunectwentyone’, koja sazreva u prvoj nedelji maja.

Osim Kalifornije, značajni programi oplemenjivanja breskve se odvijaju još u dva regiona SAD-a: severoistočnom i jugoistočnom. Od programa u severoistočnom delu SAD-a najznačajniji su oni koji se odvijaju u državama Nju Džersi, Mičigen i Zapadna Virdžinija.

Oplemenjivanje u New Jersey počelo je 1914. godine na Rutgers univerzitetu. Ovaj oplemenjivački program je bio jedan od najraznovrsnijih u zemlji, ne samo u pogledu stvaranja sorti za svežu potrošnju već i u pogledu stvaranja novih sorti nektarina i industrijske breskve. Vrlo rodna sorta ‘Collins’ proistekla iz ovog

programa priznata je 1959. godine, a pozna sorta ‘Autumn Glo’ 1977. godine. Kasnijih godina u program je uključeno stvaranje sorti breskve belog i žutog mesa, spljoštenog oblika ploda, niskog sadržaja kiselina i sorti otpornih na bolesti. ‘Saturn’ (NJF-2) je verovatno bila prva sorta spljoštenog ploda imenovana od strane Starks rasadnika 1985. godine. Na Rutgers univerzitetu stvorena je i sorta ‘Jerseypink’ koja se odlikuje otpornošću na mraz i poznim cvetanjem. Najnovije sorte breskve iz ovog programa su ‘NJ350’, ‘NJ351’, ‘NJ352’ (Messina^{TM}), ‘NJ353’ (Vitoria^{TM}), ‘NJF15’, ‘NJF16’, ‘NJF17’, ‘NJF18’, a najnovija sorte nektarine ‘NJN100’.

Na selekciji novih sorti breskve u Michigan-u najviše je radio Stanley Johnston. Prve selekcije koje su rezultirale priznavanjem bile su ‘Halehaven’ (1932) i ‘Kalhaven’ (1938). Ukrštanjem sorti ‘Halehaven’ i ‘Kalhaven’nastala je 1940. godine sorta ‘Redhaven’ (Iezzoni, 1987), koja je i danas široko rasprostranjena u svetu. Kasnije su iz populacije od 21.000 sejanaca priznate sorte ‘Fairhaven’, ‘Sunhaven’, ‘Richhaven’, ‘Glohaven’ i ‘Cresthaven’ (Kessler, 1969). Michigan State University oplemenjivački program breskve od 1992. godine vodi W. Shane. Program je fokusiran na stvaranje sorti žutog, belog i sočnog mesa, koje će sazrevati posle sorte ‘Redhaven’, sa boljom bojom pokožice ploda, veličinom, čvrstoćom, produktivnošću i većom otpornošću na bolesti. Ranih 1990-tih godina Iezzoni i dr. pokrenuli su projekat za stvaranje sorti tolerantnih na rak rana. Program koji je imao 2.000-3.000 sejanaca godišnje rezultirao je 2004. godine sortom po imenu ‘Beaumont’. Nedostatak novih sorti prilagođenih severoistočnom delu SAD-a inicirao je i dva privatna oplemenjivačka programa u Michigan-u. ‘Fruit Acres’ prvi privatni program lociran u Coloma, komercijalizovao je ‘Stellar’ seriju breskve. U više država na severu SAD-a gaje se sorte iz ovog programa kao što su ‘Coralstar’, ‘Glowingstar’ i ‘Redstar’. Drugi privatni Michigan oplemenjivački program ‘Flamin Fury’ lociran takođe u Coloma je razvio ‘Flamin Fury’ ili ‘PF-’seriju breskve. Ove sorte obezbedile su potreban set crvenila i otpornost na bakterijalnu lisnu pegavost. Neke sorte kao što su ‘PF12A’, ‘PF23’ i ‘PF17’ dobro su prihvaćene za komercijalno gajenje, pre svega na severu Amerike.

Oplemenjivanje na univerzitetu Maryland počelo je sa radom 1929. godine i prva priznata sorta bila je ‘Redskin’ 1944. godine. Program je 1980. godine premešten u Kearneysville, West Virginia. Pod rukovodstvom R. Scorza priznate su sorte ‘Bounty’ i ‘Sentry’ koje su postale veoma važne sorte za severo-istočni deo SAD. ‘Earliscarlet’ je takođe poznata jarko obojena nektarina namenjena za istočni deo SAD-a. Dva novo priznata ‘columnar’ tipa ovog programa su ‘Crimson Rocket’ i ‘Sweet-N-Up’.

Od programa u jugoistočnom delu SAD-a najznačajniji su oni koji se odvijaju u državama Džordžija, Severna Karolina, Arkanzas i Florida.

USDA oplemenjivački program u Georgia počeo je 1937. godine u Hortikulturnoj voćarskoj laboratoriji u Fort Valley, tj. u centru glavnog područja proizvodnje breskve (Okie et al., 1985). J.H. Weinberger je bio prvi oplemenjivač do 1954. godine, kada je program preseljen u Fresno, California. On je stvorio sorte kao što su ‘Cardinal’ i ‘Dixired’. V.E. Prince je nastavio oplemenjivanje od 1954. godine.

Program je zatim preseljen 1964. godine 20 milja istočno u novootvorenu voćarsku laboratoriju u Byron-u. Prince je takođe stvorio mnogo važnih sorti, posebno ‘Springcrest’ koja se počela široko gajiti uz sortu ‘Redhaven’. Prince i Weinberger stvorili su zajedno 21 sortu breskve, jednu sortu nektarine i podlogu ‘Nemaguard’. Weinberger je kasnije stvorio i podlogu ‘Nemared’. Novostvorene sorte iz ovog programa pod rukovodstvom V.E. Prince su i ‘Scarletprince’, ‘Julyprince’, ‘Early Augustprince’ i ‘Augustprince’. Od 1980. godine sve sorte sa žuto obojenim mesom ploda imaju u svom nazivu ‘prince’ kao deo imena u čast V.E. Prince. Tako su najuspešnije nove sorte za proizvođače bile ‘Juneprince’, ‘Goldprince’, ‘Sunprince’, ‘Fireprince’, ‘Flameprince’, ‘Rubyprince’ i ‘Summerprince’ (Okie, 1997). Veoma interesantne sorte iz ovog programa ‘Springprince’ i ‘Autumnprince’ priznate su 1998. godine. Sorte breskve sa belim mesom ‘Scarletpearl’ i ‘Southern Pearl’, kao i i sorta nektarine sa belim mesom ‘Roseprincess’, bile su takođe vrlo korisne za lokalna tržišta.

Oplemenjivački program breskve North Carolina započet je 1955. godine. Iz ovog programa proistekla je serija otpornih sorti na bakterijalnu lisnu pegavost, a najotpornije su bile sorte ‘Clayton’ i ‘Candor’. Druge popularne sorte bile su ‘Norman’, ‘Winblo’ i ‘Biscoe’ (Werner i Ritchie, 1982). Pod rukovodstvom D.J. Werner-a iz ovog programa proistekle su i sorte ‘Contender’, ‘Intrepid’ i ‘Challenger’ koje kasno cvetaju i imaju otpornost na pozni prolećni mraz. Werner je stvorio i seriju kolumnar tipova ‘Corinthian Pink’, ‘Corinthian Rose’ i ‘Corinthian White’, zajedno sa ‘White Glory’. Druge značajne sorte iz ovog programa su ‘Carolina Gold’, žutog topivog mesa i poznog vremena sazrevanja, ‘Galactica’, krupnog i slabo kiselog ploda i ‘China Pearl’ belog mesa i slabo kiselog ploda.

Na univerzitetu Arkansas oplemenjivački program je startovao sredinom 1960-tih. Glavni cilj programa bio je stvaranje industrijskih sorti breskve namenjenih za ishranu beba. U kasnim 1990-tim godinama pod rukovodstvom J.R. Clark-a, program je svoj cilj usmerio na stvaranje sorti za svežu potrošnju i sorti nektarine. ‘White River’ (2002) bila je prva priznata sorta breskve iz ovog programa, a onda je 2004. godine usledilo priznavanje sorti ‘White County’ i ‘White Rock’ sa niskim sadržajem kiselina (Clark et al., 2005). Nektarine proizašle iz ovog programa su ‘Westbrook’, ‘Arrington’ i ‘Bradley’ (sve priznate 2000. godine). Poslednje dve nektarine su sa netopivim tipom mesa. Ciljevi ovog programa, pored ostalog, uključuju stalno poboljšanje nektarina sa belim, žutim, topivim i netopivim mesom. Kod sorti za svežu potrošnju obraća se pažnja na belo obojeno, netopivo meso. Poseban pravac predstavlja poboljšanje sorti spljoštenog oblika ploda i otpornost na bakterijalnu lisnu pegavost. Iz ovog programa 1994. godine proizašla je i serija od četiri ukrasna tipa stabla, dva patuljasta (‘Bonfire’i ‘Leprechaun’) i dva pendulasta (‘Crimson Cascade’ i ‘Pink Cascade’). Od novijih sorti iz ovog programa ističu se ‘White Cloud’ i ‘White Diamond’.

Oplemenjivački program Univerziteta Florida (UF) počeo je sa radom 1953. godine. Početni ciljevi ovog programa bili su stvaranje velikog broja sorti breskve i nektarine koje su adaptirane na ekološke uslove Floride, dobrog kvaliteta, topivog

mesa i kratkog perioda od cvetanja do sazrevanja (manje do 100 dana). ‘Florida’ serija breskvi i ‘Sun’ serija nektarina čine ovu grupu sorti. Od nedavno, UF program se delimično promenio i stvaraju se sorte breskve i nektarine sa netopivim mesom u cilju poboljšanja ukusa ploda. Sorte breskve i nektarine sa netopivim mesom imaju prefiks UF (‘UFSun’, ‘UFQueen’, itd.). Pored ovoga UF, univerzitet u Džoržiji i USDA program sarađuju na programu u Attapulgus-u, Georgia kako bi stvorili sorte sa srednje dugim zimskim mirovanjem (400-650 CU), a kod nekih (250-400 CU). Sorte stvorene iz ovog programa imaju prefiks ‘Gulf’, kao na primer ‘Gulfking’, ‘Gulfprince’, ‘Gulfcrest’ i ‘Gulfcrimson’. Na univerzitetu Florida su stvorene sledeće sorte breskve za stonu potrošnju ‘Diamante Especial’, ‘FlordaRio’, ‘Forestgold’, ‘UF2000’, ‘UFBeauty’, ‘UFBlaze’, ‘UFCharm’, ‘UFGold’, ‘UFO’, ‘UFSun’, ‘White Opal’ i ‘White Satin’. Od priznatih sorti nektarine značajne su ‘Carolina’, ‘SunBest’, ‘Suncoast’, ‘Sunmist’, ‘Sunraycer’, ‘Sunsnow’, ‘Sunsplash’, ‘SunWright’, ‘UFQueen’ i ‘UFRoyal’.

Kanada. U Kanadi je oplemenjivanje breskve počelo 1911. godine u Ontariju, Odeljenju za poljoprivredu u Vineland-u, sa ciljem da se stvore sorte koje će produžiti sezonu sorte ‘Elberta’, kao i sorte za industrijsku preradu. Do 1964. godine priznato je 14 sorti, a najvažnije od njih bile su ‘Veteran’, ‘Valiant’ i ‘Vedette’. Kasnije je ovaj program spojen sa stanicom univerziteta Guelph. Od novijih sorti breskve iz ovog programa ističu se ‘Vitall’ i ‘Vollie’. U međuvremenu startovao je i drugi kanadski oplemenjivački program u istraživačkom centru Harrow-u, u provinciji Ontario (Agriculture and Agri-Food Canada). U njemu su stvorene otporne sorte breskve i nektarine na mraz. Mnoge od njih još uvek se široko gaje u Ontariu i severnoj Americi. Od sorti breskve posebno se ističu ‘Canadian Harmony’, ‘Harbrite’, ‘Harson’, ‘Harrow Diamond’, ‘Harrow Beauty’ i ‘Harrow Dawn’, a od sorti nektarine ‘Hardired’ i ‘Harblaze’. Nažalost zbog budžetske krize ovaj program je prestao sa radom 1996. godine.

Evropa

Italija je jedna od vodećih zemalja po proizvodnji breskve u svetu. U centralnoj i južnoj Italiji najviše se gaje sorte sa netopivim i žutim mesom, a u severnoj Italiji sorte sa belim mesom i kalanke. Moderni oplemenjivački programi u Italiji počeli su kasnih 1920-tih, najpre sa nekoliko oplemenjivača amatera, a potom i naučno istraživačkih radnika kao što su C. Cappucci, P. Martinis, A. Pieri, A. Pirovano, A. Ragionieri i dr. Na univerzitetu u Firenci A. Morettini je započeo veliki oplemenjivački program koji je trajao 30 godina sve do 1970-tih. Zanemarivši italijansku germplazmu, a koristivši samo introdukovane sorte iz SAD-a za oplemenjivački rad, naročito sortu ‘J.H. Hale’ (ideotip u to vreme) Morettini je stvorio oko 20 sorti belog i žutog mesa koje su sazrevale od sredine juna do avgusta meseca. Krajem 1960-tih skoro istovremeno počela su sa radom tri državna oplemenjivačka programa i to institut za voćarstvo Ministarstva poljoprivrede (u Rimu i Forliju, severna Italija) i univerziteti u Bolonji i Firenci. Ovi programi su

uglavnom imali za cilj stvaranje sorti adaptiranih na italijanske uslove sredine, uz bolji prinos. Mnogo truda je posvećeno i otpornosti na bolesti i štetočine, a roditelji za ovu svrhu uzimani su uglavnom iz strane germplazme. Kvalitet ploda poboljšavan je takođe u različitim pravcima (veličina, izgled, tekstura mesa, ukus) (Giovannini et al., 2004). Interesantne osobina za oplemenjivački rad bile su i nizak sadržaj kiselina, veća čvrstina mesa, pogodnost nektarina za konzervisanje (bez antocijana) i povećan sadržaj vitamina C (Liverani et al., 2002). Postignuti su i rezultati na stvarnju patuljastih, stubastih i pendulastih tipova stabla. Bellini et al. (1990) navode da je u velikim italijanskim kolekcijama (oko 2400 aksešna) više od 20% sorti italijanskog porekla. Ipak, pedigrei više od 200 italijanskih sorti priznatih poslednjih 30 godina pokazuju dominaciju američkih sorti, posebno iz Kalifornije. Najnovije i najinteresantnije sorte belog mesa su ‘Aliblanca’ i ‘Alirosada’ (iz Forlija), ‘Maria Bianca’ (iz Firence) i ‘Rubia’ i ‘Rubisco’ (iz Bolonje). Poznate sorte breskve iz Forlija su i ‘Springbelle’ (1985), ‘Alba’ (1993) i ‘Bea’ (1993), iz Firence ‘Maria Rosa’ (1984), ‘Maria Delizia’ (1984), ‘Maria Grazia’ (1984), ‘Maria Cristina’ (1985) i ‘Maria Marta’ (1990) i iz Bolonje ‘Rosired 1’ (1981) i ‘Rosired 3’ (1983). U Rimu su stvorene značajne sorte nektarine ‘Cassiopea’ (1978), ‘Weinberger’ (1979), ‘Anderson’ (1979), ‘Nectaross’ (1983), ‘Andromeda’ (1983), ‘Croce del Sud’ (1983), ‘Pegaso’ (1983), ‘Sirio’ (1987), ‘Vega’ (1987) i ‘Antares’ (1989), u Bolonji ‘Nectagrand 1’ (1983), ‘Nectagrand 2’ (1981), ‘Nectagrand 4’ (1981) i ‘Fantalate’ (1987) i u Firenci ‘Maria Laura’ (1982), ‘Maria Aurelia’ (1983), ‘Maria Emilia’ (1983) i ‘Maria Carla’ (1985) (Conte et al., 1994). Oplemenjivački program univerziteta u Palermu (Sicilija) startovao je sa ciljem stvaranja sorti sa kratkim zimskim mirovanjem. Željene osobine bile su i kasno ili veoma kasno vreme sazrevanja (oktobar), netopivo meso za svežu potrošnju sa poboljšanim ukusom, kao i različit oblik stabla (stubast, patuljast, itd.). Roditelji su birani iz bogate Sicilijanske germplazme za pozno sazrevanje, netopivo meso i visok kvalitet ploda i iz Floride za stvaranje sorti sa kratkim zimskim mirovanjem.

U Italiji su na stvaranju novih sorti breskve uključeni i privatni oplemenjivački programi. Skoro sav raniji rad je izgubljen, sem nekoliko izuzetaka. Tako se breskva belo obojenog mesa ‘Iris Rosso’, dobijena od strane P. Martinis-a, 1950-tih, danas još uvek gaji u mnogim zasadima. Današnji aktivni privatni oplemenjivački programi u Italiji su Bubani, CIV rasadnici, Minguzzi, Morsiani, Montanari i Ossani. Oni se nalaze u severnoj Italiji (region Emilia-Romagna). Njihovi ciljevi su strogo komercijalni, a zasnivaju se na korišćenju američkih sorti posebno nektarina za slobodno oprašivanje, samooprašivanje ili ukrštanje sa drugim sortama kao što su ‘Elegant Lady’, ‘Fantasia’, ‘Big Top’ i dr. U poslednjih 30 godina privatni oplemenjivači su učestvovali sa 50% u stvaranju novih sorti breskve u Italiji. Sorta ‘Stark Redgold’ pored toga što je najviše gajena nektarina u Italiji postala je i najviše korišćeni roditelj u oplemenjivačkim programima nektarine. Iz njenog potomstva među najznačajnijim sortama mogu se izdvojiti ‘Ambra’, ‘Caldesi 2000’, ‘Caldesi 2010’, ‘Caldesi 2020’ (serija belog mesa), ‘Orion’, ‘Maria Aurelia’ i ‘Venus’ kod nektarine i sorta ‘Rome Star’ kod breskve. Od značajnijih sorti nektarine belog mesa

stvorenih u Italiji ističu se i ‘Maria Anna’, ‘Maria Lucia’, ‘Maria Linda’, ‘Maria Teresa’, ‘Sweet Silver’, ‘Anna Bassi’, ‘Laura Bassi’, ‘Early Silver’, ‘Morsiani 19’, ‘Silver Bright’, ‘Silver Giant’, ‘Silver Moon’, ‘Silver Ray’, ‘Silver Rome’, ‘Silver Star’, ‘Silver Splendid’ i ‘Vania’, a od sorti nektarine žutog mesa ‘Guerriera’, ‘Maeba Top’, ‘Alitop’, ‘Anthony’, ‘Maria Elisa’, ‘Amiga’, ‘Maria Camilla’, ‘Maria Dolce’, ‘Maria Dorota, ‘Alma’, ‘Sweet Red’, ‘Sweet Lady’, ‘Morsiani 90’ i ‘Max 7’. Značajne sorte breskve u Italiji su i ‘White Crest’, ‘Greta’, ‘Maria Angela’, ‘Regina Bianca’, ‘Regina d’ Ottobre’, ‘Flaminia’, ‘Padana’ i ‘Alired’.

Francuska. Savremeni oplemenjivački program breskve u Francuskoj počeo je ranih 1960-tih u institutu National pour la Recherche Agronomique (INRA) u Bordeaux-u. Pod rukovodstvom R. Monet-a stvorena je spljoštena sorta breskve ‘Platina’ i spljoštena sorta nektarine ‘Mesembrine’. Krajem 1990-tih program je premešten iz Bordeaux-a u stanicu u Avignon-u. Ciljevi ovog novog programa bili su poboljšanje kvaliteta ploda, kao i otpornosti na pepelnicu, kovrdžavost lišća, lisne vaši, Plum Pox Virus-u (PPV) i nematode. Jedan od ciljeva ovog programa bio je i dobijanje različitog oblika stabla (Kervella et al., 1998). Partnerstvo sa privatnim oplemenjivačima (Pascal i Monteux-Caillet, 1998) dovelo je do razvoja belih (‘Caprice’, ‘Surprise’ i‘Elise’) i žutih (‘Conquise’) sorti breskve. Od nedavno i nekoliko privatnih preduzeća kao što su Meynaud, Valla, a naročito Maillard uključena su na uvođenju sorti ‘Big Bang®’ (nektarina) i ‘Sweetcap®’ (spljoštena breskva) koje su se počele široko gajiti u Francuskoj, Španiji i Italiji. Neki privatni proizvođači iz Francuske kao što su Buffat, Dumont i Monteux-Caillet su takođe uključeni u oplemenjivanje breskve i rade sa INRA. ‘Zephir®’, ‘Emeraude®’, ‘Jade®’ i ‘Topaze®’ su najpoznatije sorte iz ove kooperacije koje zauzimaju više 5% površina pod belim nektarinama u Francuskoj. Takođe i neke belo obojene breskve kao što su ‘Opale®’ i ‘Melina®’ se često sade u svim regionima gde se breskva u Francuskoj gaji. Glavni cilj ovih privatnih oplemenjivačkih programa je stvaranje novih sorti poboljšane veličine ploda, čvrstoće, rodnosti i dobrog ukusa, sa naglaskom i na neke posebne osobine kao što su spljošten oblik ploda (naročito za bele breskve) i nektarine crveno obojenog mesa ploda (Zambujo, 2004). Danas francuske sorte breskve zauzimaju oko 30% površina u proizvodnim zasadima. Novostvorene INRA sorte distribuiraju se uglavnom prekio udruženja rasadničara ‘CEP Innovations’. Među najpoznatijim sortama breskve belog mesa iz Francuske ističu se ‘Azurina’, ‘Bellina’, ‘Golo’, ‘Rubiette’, ‘Benedicte’ i ‘Tendresse’, a od sorti žutog mesa ‘Starcrest’, ‘Grenat’ i ‘Symphonie’. Značajne sorte nektarine žutog mesa su ‘Fireking’ i ‘Fuzador’, a od sorti nektarina belog nesa mogu se istaći ‘Jaquotte’, ‘Olympio’, ‘Rolina’, ‘Audrey’, ‘Big Ball’, ‘Corail’, ‘Cristalrose’, ‘Dellys’, ‘Dina’, ‘Fanny’, ‘Festina’, ‘Icalana’, ‘Isabelle’, ‘Mallassa’, ‘Malican’, ‘Marilyn’, ‘Modina’, ‘Nectagenais’, ‘Pascaline’, ‘Peggy’, ‘Roseline’, ‘Silver King’ i ‘Snowred’. Najnovije sorte breskve stvorene u Francuskoj su ‘Crispdelice Sun’, ‘Crispregal’ i ‘Julienice’, a najnovije sorte nektarine ‘Nectagala’, ‘Nectalady’, ‘Nectaperle’, ‘Nectapink’, ‘Nectaroyal’ i druge (Finn i Clark, 2008; Clark i Finn, 2010).

Španija je poznata širom sveta po bogatstvu svoje lokalne germplazme, posebno sortama sa žuto obojenim netopivim mesom. Breskve sa netopivim mesom su najpogodnije za špansko tržište i mnogo je radova urađeno na vrednovanju i klonskoj selekciji najboljih tipova (Badenes et al., 1998). Trenutno u Španiji postoji nekoliko oplemenjivačkih programa, tri u državnim institucijama (od 1993, u Saragoza i Valencia) i najmanje sedam u privatnim preduzećima. Značajniji ciljevi nekih od ovih programa usmereni su ka poboljšanju žutih breskvi (glođuša), u pogledu boljeg ukusa ploda, otpornosti na bolesti i proširenju sezone sazrevanja, dok je manje značajan cilj poboljšanje breskvi spljoštenog oblika ploda, pogodnih za pojedina tržišta. Neki od španskih privatnih programa fokusirani su na stvaranje veoma ranih sorti breskve i nektarine topivog mesa koje bi bile pogodne za gajenje u južnim regionima zemlje.

Rumunija. Oplemenjivački program breskve u Rumuniji počeo je krajem 1950-tih (Ivascu i Balan, 1998). On se bazirao na korišćenju stranih sorti, uglavnom iz SAD-a, Kanade, Francuske, Italije i Kine. Jedan od prvih ciljeva oplemenjivanja bio je stvaranje otpornih sorti prilagođenih oštrim klimatskim uslovima u zemlji. Posle 1985. godine više pažnje je posvećeno otpornosti na bolesti (monilija, pepelnica, kovrdžavost lista, rak rana, PPV). Poboljšanje kvaliteta ploda, proširenje sezone sazrevanja i dobijanje različite arhitekture stabla bili su prioritetni ciljevi posle 1990. godine. Veliki napredak je ostvaren u voćarskim istraživačkim stanicama Baneasa i Constanca stvaranjem otpornih sorti breskve na mraz (‘Splendid’, ‘Superba de Toamna’, ‘Triumf’ i ‘Victoria’), poboljšanim nektarinama (‘Cora’, ‘Delta’, ‘Mihaela’, ‘Romamer 2’ i ‘Tina’), patuljastim breskvama (‘Cecilia’ i ‘Puiu’), patuljastim nektarinama (‘Livia’ i ‘Melania’), ukrasnim formama breskve (‘Paul’) i nektarine (‘Dan’) i veoma otpornim sortama breskve na pepelnicu i kovrdžavost lista (‘Victoria’ i ‘Flacara’). U poslednjih 10 godina u Rumuniji su stvorene i sorte breskve ‘Alexia’, ‘Amalia’, ‘Antonia’, ‘Dida’ i ‘Eugen’, nektarine ‘Tina Mihaela’ i spljoštene breskve ‘Alex’ i ‘Herastrau’ (Ivascu et al., 2007). Trenutno oko dve trećine najraširenijih sorti koje se gaje vode poreklo iz rumunskih oplemenjivačkih programa.

Bugarska. Vodeća institucija u oplemenjivanju breskve u Bugarskoj je Institut za voćarstvo u Plovdivu, zajedno sa eksperimentalnim stanicama u Sliven-u, Pomorie i Petrich-u. Kao rezultat brojnih ukrštanja nastale su sorte za svežu potrošnju ‘Bulgarska Ranna’, ‘Yulska Edra’, ‘Petrichka’, Zlatna Krichimka’, ‘Chervena Kurtovka’, ‘Elinpelinska’ i ‘Zlatka’, a kasnije i sorte za preradu ‘Tundzha 1’ i ‘Tundzha 2’. Korišćenjem veštačkih mutacija stvorene su sorte ‘Plovdiv 1’, ‘Plovdiv 2’, ‘Plovdiv 6’ i ‘Yoneta’. Posebno značajan rezultat bio je S. D’bov-a koji je ukrštao breskvu sa *Prunus ferganensis* i nakon tri decenije stvorio sorte otporne na pepelnicu kao što su ‘Aheloy’ i ‘Remil’ za svežu potrošnju i ‘Malo Konare’ i ‘Stoyka’ za preradu. Oplemenjivački program u Plovdivu ponovo je startovao 1989. godine od strane A. Zhivondov-a i njegove grupe. Glavni ciljevi ovog oplemenjivačkog programa bili su stvaranje sorti otpornih na pepelnicu, kovrdžavost lista, proširenje sezone sazrevanja i stvaranje sorti različitog oblika stabla (stubast, patuljast,

pendulast). Neke od novijih sorti breskve proisteklih iz ovog programa su ‘Flavia’ i ‘Puldin’ (Zhivondov, 2012a, b) i sorta nektarine ‘Gergana’ (Zhivondov, 2009).

Ukrajina ima najpovoljniju klimu za gajenje breskve od većine bivših republika Sovjetskog Saveza u kojima je vreme vrlo često hladno. Ivan N. Ryabov u Nikita botaničkoj bašti blizu Yalta-e, počeo je oplemenjivački program pre 50 godina prikupljajući veliki deo germplazme breskve iz centralne Azije i Transkavkazja. Tokom vremena stvorene su određene sorte breskve i nektarine otporne na bolesti (pepelnica i kovrdžavost lista), otporne na mraz i prinosne u svojim klimatima (Yezhov et al., 2005). Najvažnije sorte breskve nastale iz ovog programa su ‘Krymsky Feyerverk’, ‘Sagdiets’, ‘Startovy’, ‘Dostoyny’, ‘Otlichnik’ i ‘Posol Mira’, a od značajnijih sorti nektarine mogu se pomenuti ‘Ametist’, ‘Pintola’, ‘Evpatoriysky’, ‘Ishunsky’ i ‘Rubinovy 8’. Od novijih sorti breskve stvorenih i patentiranih u Ukrajini u poslednjih pet godina ističu se i ‘Vavilovskyi’, ‘Diemierdzhynskyi’, ‘Etiudnyi’, ‘Kandydatskyi’, ‘Krymskyi Sonet’, ‘Kniazhehradskyi’, ‘Krymskyi Diamant’, ‘Karnavalnyi’, ‘Krymskyi Shedevr’, ‘Merkurii’, ‘Mirianin’, ‘Ozhydaniie’, ‘Osvizhaiuchyi’, ‘Podarok Like’, ‘Pivdenna Fantaziia’, ‘Pontiiskyi’, ‘Persei’, ‘Rodzynka’, ‘Rumianyi Nikitskyi’, ‘Soprano’, ‘Strieliets’, ‘Serdolik’, ‘Sonata Tavrydy’, ‘Temisovskyi’, ‘Yubileinyi Rannii’ i ‘Yuzhna Harmoniia’, a značajne sorte nektarine stvorene 2008. godine su ‘Kiparh’, ‘Maremi’ i ‘Starho’ (Anonymous, 2012).

Srbija. Oplemenjivanje breskve u Srbiji počelo je ranih 1950-tih u institutu za voćarstvo u Čačku (Ogašanović, 1998), a zatim i programima u Beogradu i Novom Sadu. Sve nove sorte koje su do sada priznate u Srbiji (8), selekcionisane su iz potomstava dobijenih iz strane germplazme: ‘Maja’, ‘Vesna’ i ‘Gročanka’ dobijene su samooprašivanjem sorte ‘Glohaven’, a ‘Dora’,‘Čačak’, ‘Goca’ i ‘Julija’ ukrštanjem ostalih sorti. Sorta ‘Radmilovčanka’ nastala je mutacijom sorte ‘J.H. Hale’. Jedna od osobenosti regiona Srbije je i veliko bogatstvo sa lokalnim populacijama vinogradske breskve koja se tradicionalno razmnožava semenom i najčešće koristi za proizvodnju generativnih podloga (Nikolić et al., 2010). Ove breskve pokazuju širok opseg korisnih osobina kao što su otpornost na mraz, tolerantnost na sušu, otpornost na pepelnicu i kovrdžavost lista, pa se u novije vreme koriste u programima oplemenjivanja.

Azija

Kina. Iako je Kina centar porekla breskve, oplemenjivački programi u ovoj zemlji su novijeg datuma. Od kasnih 1950-tih do 1990-tih u nekoliko mesta postojali su oplemenjivački programi za stvaranje industrijskih sorti breskve. Stvaranje sorti za svežu potrošnju počelo je 1970-tih i 1980-tih, ali od 20-setak započetih, danas su ovi oplemenjivački programi svedeni na svega nekoliko aktivnih, koji uglavnom stvaraju sorte breskve sa belim mesom i niskim sadržajem kiselina. U principu, programi uključuju ukrštanja kineskih i japanskih sorti sa američkim sortama. Oplemenjivanje u Dalian institutu za poljoprivredna istraživanja započeto je sa

stvaranjem žuto obojenih sorti obične breskve namenjenih za preradu. Sorte ‘Fenghuang’ i ‘Lianhuang’ nastale su na osnovu potreba kineske prerađivačke industrije. Odnedavno se u Kini stvaraju i nove sorte nektarine, kao i pozno sazrevajuće sorte breskve (kalanke). Pekinška akademija poljoprivrede i šumarstva je jedan od najstarijih programa koji je počeo da radi na ovom polju 1960-tih godina. ‘Qingfeng’ i ‘Maixiang’ su poznate sorte nastale iz ovog programa. Od značajnijih sorti breskve spljoštenog oblika ploda mogu se pomenuti ‘Ruipan 1’, ‘Ruipan 2’ ‘Ruipan 3’, ‘Ruipan 4’, ‘Ruipan 5’ i ‘Ruipan 8’. Trenutni napori usmereni su ka stvaranju novih sorti nektarine i pozno sazrevajućih sorti breskve spljoštenog oblika ploda. U pekinškom institutu šumarstva razvijen je program za stvaranje ukrasnih “low chill”sorti. Program hortikulturnog odeljenja Jiangshu akademije poljoprivrednih nauka u Nanjing-u stvorio je rano sazrevajuću sortu ‘Yuhualu’, kao i niz drugih sorti breskve ranog vremena sazrevanja. Trenutni ciljevi su stvaranje pozno sazrevajućih sorti breskve (kalanke) otpornih na gljivične bolesti. Stvaraju se i sorte nektarine otporne na kišne klimate. Zhengzhou voćarski institut u Henan-u radi na stvaranju novih sorti breskve i nektarine sa kratkim zimskim mirovanjem, kao i novih sorti spljoštene nektarine, a Hortikulturno odeljenje Šangajske akademije poljoprivrednih nauka radi na stvaranju ranih sorti breskve i nektarine. Poznate sorte iz ovih programa su ‘Chunlei’ i ‘Chunhua’ (Wang i Lu, 1992) i ‘Shuguang’ (Wang et al., 2002). Među novijim kineskim sortama nektarine belog mesa ističu se i ‘Hongshanhu’, ‘Qinguang’, ‘Xiangshanhu’, ‘Yanguang’, ‘Zaohongzhu’ i ‘Zaohongxia’.

Japan. Najvažniji oplemenjivački program breskve u Japanu odvija se u nacionalnom voćarskom institutu u Tsukuba, u kome je priznata je serija sorti breskve među kojima se ističu ‘Chiyohime’, ‘Akatsuki’, ‘Natsuotome’, ‘Yuzora’ i ‘Akizora’. Lokalne istraživačke stanice koje se nalaze u glavnim centrima gajenja breskve su takođe aktivne u oplemenjivanju, uključujući Yamanashi (sa priznatom sortom koja ima veoma krupan plod ‘Yumeshizuku’), Nagano (sa priznatom sortom ‘Natsuki’), Fukushima (sa priznatim, veoma ranim sortama ‘Fukuotome’ i ‘Hatsuotome’) i Okayama. Priznate sorte ‘Sweet Nectarine Reimei’ i‘Sweet Nectarine Reiou’ iz Yamanashi voćarske eksperimentalne stanice su sa žutim mesom, dok su sorte ‘Sweet Nectarine Shoku’ i ‘Sweet Nectarine Shogyoku’ sa belim mesom.

Južna Koreja. Iako je prvi oplemenjivački rad u Koreji, u nacionalnom hortikulturnom istraživačkom institutu u Suwon-u, započet 1957. godine, veća aktivnost na ovom polju usledila je sredinom 1980-tih. Ciljevi oplemenjivanja bili su stvaranje sorti breskve belo obojenog mesa, dobrog kvaliteta ploda sa malo kiselina i visokom otpornošću na bolesti. Najpoznatije sorte iz ovog oplemenjivačkog programa su ‘Cheonhong’ nektarina i ‘Yumyeong’ krupna bela breskva za stonu potrošnju (Chung et al., 1998). ‘Yumyeong’ je sorta koja je korišćena kao roditelj i u drugim zemljama, kao što su Italija i Novi Zeland, prvenstveno zbog veličine i čvrstoće ploda. Od ostalih korejskih sorti breskve treba pomenuti ‘Baekmi Josaeng’, ‘Hwando’, ‘Saeboksunga’, ‘Sangdo’, ‘Mihong’ i ‘Soomee’.

Okeanija

Novi Zeland. Oplemenjivanje breskve u hortikulturnom istraživačkom institutu u Havelock North-u, na Novom Zelandu počelo je sa poboljšanjem sorti za konzervnu industriju. Sredinom 1980-tih rad je proširen sa stvaranjem sorti breskve pogodnih za izvoz, naročito na Azijsko tržište koje preferira sorte sa belo obojenim mesom i niskim sadržajem kiselina. Sorte moraju biti prilagođene i suvljim klimatima, sa otpornošću na bolesti, tolerantnošću na mraz i visokim kvalitetom ploda. Iz ovog programa proistekao je niz poznatih sorti među kojima se ističu ‘Coconut Ice’, ‘Scarlet O’Hara’ i ‘Havelock Pearl’. Oplemenjivanje na Novom Zelandu je takođe i put ka stvaranju novih belih sorti nektarine sa niskim sadržajem kiselina.

Australija. Univerzitet Western Sydney u Australiji, započeo je program stvaranja sorti breskve sa kratkim i srednjim zimskim mirovanjem početkom 1990-tih. Program se nalazi u Richmond-u, New South Wales. Jedna od strategije selekcionara je da se stvore sorte sa visokim kvalitetom kojima je potrebno do 120 dana za razvoj ploda. Sorte nektarine stvorene 2003. godine za svežu potrošnju su ‘Dawn Gold’, ‘December Ice’, ‘Hail’, ‘Honey Ice’ i ‘Pale Ice’. Oplemenjivački program Queensland odeljenja primarne industrije i ribarstva koji je smešten u Maroochy istraživačkoj stanici u Nambour-u počeo je takođe stvaranje sorti kratkog zimskog mirovanja sredinom 1990-tih. Cilj je bio da se stvore visoko kvalitetne sorte breskve i nektarine sa izuzetno kratkim zimskim mirovanjem (100–150 CU).

Južna Amerika

Brazil. Jedan od dva oplemenjivačka programa u Brazilu, Brazilian Agricultural Research Enterprise (Embrapa Clima Temperado) je smešten u Agriculture Research Centre of Temperate Crops (CPACT) u Pelotas, Rio Grande do Sul. On je počeo sa radom 1953. godine i do sada je stvorio veliki broj sorti breskve čije je zimsko mirovanje 150-500 CU. Oplemenjivački program u Instituto Agronomico (IAC) u Sao Paulo je drugi brazilski program koji je počeo sa radom 1950. godine. I iz ovog programa proistekao je veliki broj sorti breskve i nektarine za stonu potrošnju i preradu koje imaju izuzetno kratko zimsko mirovanje (50-150 CU).

Meksiko. Program oplemenjivanja Centra za voćarstvo Colegio de Postgraduidos u Chapingo-u, Mexico, počeo je sam radom 1985. godine sa ciljem stvaranja sorti breskve kratkog zimskog mirovanja, različitog vremena sazrevanja i otpornošću na pepelnicu. Oplemenjivači sa Univerziteta u Floridi i Chapingo su imali zajednički program i međusobno su testirali dobijenu germplazmu. Kao rezultat ovog zajedničkog rada stvorena je sorta breskve ‘Oro A’, potpuno žuto obojenog ploda sa netopivim mesom. Posle 1993. godine ovaj program je počeo raditi na stvaranju novih sorti kojima je potrebno 500-700 CU. U oplemenjivačkom programu na ‘Instituto Nacional de Investigaciones Forestales y Agropecuarias’ (INIFAP)

stvoreno je takođe nekoliko sorti sa akcentom na one koje su pokazale otpornost na pepelnicu i netopivo meso, kojima je uz to potrebno 50-450 CU zimskog mirovanja.

Afrika

Južna Afrika. Oplemenjivački program u JAR, Stellenbosch-u, Agricultural Research Council (ARC) Infruitec-Nietvoorbij je počeo sa radom 1937. godine sa ciljem stvaranja sorti za konzervisanje, sušenje i sorti za svežu potrošnju, kako za domaće tako i za inostrano tržište. Neadekvatno zimsko mirovanje u regionima Južne Afrike gde breskva rano sazreva postalo je problem, pa je tako počelo oplemenjivanje i u cilju stvaranja sorti sa kratkim zimskim mirovanjem (<400 CU). Specifični ciljevi oplemenjivanja su i prisustvo crvene dopunske boje >80%, okrugao oblik ploda bez vrha i suture, visoka čvrstoća ploda, visok odnos ukupnih šećera i kiselina, fina tekstura mesa, zadržavanje dobrog kvaliteta ploda nakon nekoliko nedelja provedenih u transportu itd. Svake godine se proizvede oko 3.000 sejanaca za vrednovanje, a od tog broja su 2/3 sejanci sa kratkim zimskim mirovanjem. Rana desertna sorta nektarine ‘Alpine’ stvorena 1997. godine u Infruitec-Nietvoorbij istraživačkom centru, pokazala se izuzetno dobrom prođom na evropskim tržištima. Iz ovog oplemenjivačkog programa proistekle su i mnoge druge poznate sorte nektarine (‘Nectar’, ‘Flavorine, ‘Crimson Giant’, ‘Donnarine’, ‘Olympia’, ‘Unico’ i ‘Summearly’) i breskve (‘Excellence’, ‘Elandia’, ‘Bonnigold’, ‘Classic’, ‘Novadonna’, ‘Transvalia’, ‘Keisie’, ‘Oribi’, ‘Snowhite’, ‘Summersun’, ‘Western Cling’ i ‘Western Sun’). Od najnovijih sorti breskve ističu se ‘Cederberg’, ‘Scarlet’, ‘Summertime’ i ‘Sundry’, a od najnovijih sorti nektarine ‘ARC NE-1’, ‘ARC NE-2’, ‘ARC NE-8’ (Colorburst^{TM}) i ‘Early Glo’.

Zaključak

Rad na stvaranju novih, boljih sorti breskve u svetu je vrlo intenzivan, pogotovu u Americi i Evropi.

Glavni cilj najvećeg broja programa oplemenjivanja je poboljšanje kvaliteta ploda, povećanje otpornosti na bolesti i štetočine i adaptacija biljaka na uslove spoljne sredine.

Najznačajniji metod za stvaranje novih sorti je planska hibridizacija, a u znatno manjoj meri klonska selekcija i indukovanje mutacija.

Novostvorene sorte breskve i njihove pogodne kombinacije sa podlogama, pri gajenju u gustim zasadima mogu znatno da pomognu da se obezbede veći i redovniji prinosi. Posebnu pažnju treba obratiti izboru sorte za date uslove sredine , namenu i tržišne zahteve.

Iako je rad na stvaranju sorti breskve veoma intenzivan, ovaj posao treba dalje nastaviti u cilju dobijanja novih sorti koje bi trebale da unaprede ukupnu proizvodnju, kvalitet i ravnomernost ponude plodova za svežu potrošnju i preradu.

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PEACH BREEDING IN THE WORLD

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Summary

The most important objectives, methods and results of peach [*Prunus persica* (L.) Batsch.] breeding worldwide are presented in this paper. Among the goals of breeding, special attention is paid to features that affect the reduction of production costs and diversification for the consumer. The methods discussed are the hybridization, inbreeding, clonal selection, induced mutation and new methods in biotechnology. An overview of a large number of breeding programs and their most important results are introduced by individual countries and continents. Results of work on creation of new peach and nectarine cultivars intended for fresh consumption are especially emphasized. Although the peach improvement achieved very significant results in many countries of the world its breeding is still working intensively.

Key words: *Prunus persica*, breeding, cultivars, hybridization, selection, mutation.

Pregledni rad

DOSTIGNUĆA U OPLEMENJIVANJU KAJSIJE U SVETU

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Izvod. U radu su prikazani ciljevi i metode oplemenjivanja kajsije (*Prunus armeniaca* L.), kao i najznačajniji rezultati na stvaranju novih sorti u poslednjih 20 godina. U navedenom periodu u svetu je stvoreno oko 500 novih sorti kajsije. Najveći broj novih sorti kajsije je stvoren u SAD, a zatim slede Francuska, Italija, Rusija, Španija, Rumunija, Ukrajina i Češka. U stvaranju sorti kajsije dominira javni sektor (državne institucije), dok je privatni sektor manje zastupljen. Privatni programi oplemenjivanja zastupljeni su u SAD, Francuskoj, Italiji, Španiji, Nemačkoj, Izraelu i Australiji.

Ključne reči:*Prunus armeniaca*, oplemenjivanje, sorte, hibridizacija, klonska selekcija.

Uvod

Kajsija je jedna od najcenjenih voćaka koje se gaje u uslovima umerene klimatske zone. Njeni plodovi imaju veliku upotrebnu vrednost i koriste se za potrošnju u svežem stanju, kao i za smrzavanje, sušenje ili preradu u različite proizvode, kao što su: sok, kompot, džem, pekmez, marmelada, bebi kaše, žele, slatko, sirup, voćni jogurt, voćne salate. Takođe se prerađuju i u rakiju, koja se zbog specifične arome smatra jednom od najkvalitetnijih voćnih rakija.

Plodovi kajsije predstavljaju bogat izvor biološki aktivnih materija, koje blagotvorno deluju na zdravlje ljudi. Najveći značaj među njima imaju karotenoidi, mineralne materije, vitamini, dijetetska vlakna i fenolna jedinjenja (Milatović, 2013).

Kajsija se po proizvodnji nalazi na petom mestu u svetu među kontinentalnim voćkama, iza jabuke, kruške, breskve i šljive. Prosečna proizvodnja kajsije u svetu u periodu 2008-2010. godine iznosila je 3,6 miliona t (FAOSTAT, 2012). Od toga, najveći deo se proizvede u Aziji (56%), zatim u Evropi (26%) i Africi (14%). Glavno proizvodno područje je rejon Mediterana, gde se proizvede više od 50% svetske proizvodnje kajsije. Drugo značajno proizvodno područje je Centralna Azija, gde se proizvede više od 30% od ukupne svetske proizvodnje. Vodeća zemlja po proizvodnji kajsije u svetu je Turska sa prosečnom proizvodnjom od 640.690 t. Njeno učešće u ukupnoj svetskoj proizvodnji iznosi 17,7%. Slede Iran sa učešćem od 11,6%, Uzbekistan sa 8,1%, Italija sa 6,2%, Pakistan sa 5,8%, Alžir sa 5,7% i Francuska sa 3,9%.

U svetu postoji više od 2.000 sorti kajsije. Sortiment kajsije nije tako dinamičan kao što je to slučaj kod drugih vrsta voćaka, naročito jagode i breskve. Međutim, tokom poslednje dve decenije stvorene su mnogobrojne nove sorte kajsije.

Cilj ovog rada je da prikaže ciljeve i metode oplemenjivanja kajsije, najznačajnije oplemenjivačke programe i novostvorene sorte u svetu u periodu nakon 1990. godine.

Ciljevi oplemenjivanja kajsije

Adaptivnost na različite klimatske uslove. Glavni faktor koji ograničava proširenje areala gajenja kajsije je slaba adaptivnost sorti van klimatskog područja u kom su one stvorene.

Jedan od najznačajnijih ciljeva u oplemenjivanju kajsije je stvaranje sorti koje imaju dug period biološkog (dubokog) zimskog mirovanja, odnosno velike potrebe za relativno niskim temperaturama u toku zime („chilling requirements“). To im omogućava da bolje podnesu kolebanja temperature u toku zime. Takođe je poželjno da nove sorte zahtevaju veću količinu toplote („heat requirements“) za početak cvetanja nakon što je završeno njihovo biološko zimsko mirovanje. Kombinacija ove dve osobine ima za posledicu kasnije cvetanje, što novim sortama može omogućiti izbegavanje poznih prolećnih mrazeva (Layne et al., 1996).

Otpornost na zimske mrazeve je ograničavajući faktor gajenja kajsije u mnogim područjima sa hladnijom klimom, kao što su severnija područja Rusije, Kanade i SAD. Zato je u oplemenjivačkim programima ovih zemalja jedan od primarnih ciljeva stvaranja novih sorti povećana otpornost na zimske mrazeve.

Ograničavajući faktor gajenja kajsije u područjima sa toplijom klimom je nedovoljna suma relativno niskih temperatura (ispod 7°C) u toku zime. Zbog toga se nastoji da se stvore sorte pogodne za gajenje u ovim područjima, koje će imati male potrebe za niskim temperaturama u toku zimskog mirovanja (150-400 h).

Samooplodnost. U poslednjih 20 godina značajno je povećan broj novostvorenih samobesplodnih sorti kajsije. To se može objasniti korišćenjem samobesplodnih azijskih ili severno-američkih sorti u oplemenjivačkim programima u cilju dobijanja potomstva sa osobinama kao što su: otpornost na virus šarke šljive (Badenes i Llácer, 2006; Karayiannis, 2006; Krška et al., 2011), otpornost na mraz (Benediková, 2006; Krška et al., 2006), povećanje sadržaja šećera (Ledbetter et al., 2006), produžetak vremena zrenja (Topor et al., 2010).

U cilju obezbeđenja redove rodnosti teži se da se stvore samooplodne sorte. One se mogu gajiti u jednosortnim zasadima, bez potrebe za gajenjem oprašivača.

Rodnost. Poželjno je da nove sorte kajsije što ranije stupaju u rod i da daju visoke i redovne prinose. Sa ekonomskog aspekta, sorta koja redovno rađa i ima osrednji kvalitet ploda je generalno profitabilnija za gajenje od visokokvalitetne sorte koja rađa neredovno. Na rodnost kajsije utiče više faktora, kao što su: adaptivnost na klimatske uslove, pre svega otpornost na zimske i pozne prolećne mrazeve, udeo normalno diferenciranih cvetova, samooplodnost, zametanje plodova i dr.

Otpornost na prouzrokovače bolesti. Kajsiju napada relativno mali broj patogena, ali neki od njih mogu prouzrokovati veoma značajne štete. Zbog toga je veoma važan cilj oplemenjivanja kajsije otpornost na prouzrokovače bolesti, od kojih su najznačajniji: virus šarke šljive (*Plum Pox Virus*), sušenje cvetova i grančica i trulež plodova (*Monilinia* spp.), bakteriozni rak (*Pseudomonas syringae*) i fitoplazma ESFY (*European Stone Fruit Yellows*).

Produžetak raspona sazrevanja. Raspon sazrevanja sorti kajsije evropske ekološko-geografske grupe je relativno kratak i iznosi oko mesec i po dana. Oplemenjivanjem se nastoji da se period sazrevanja produži. U tu svrhu se koriste sorte iransko-kavkaske i srednjeazijske grupe koje imaju duži raspon sazrevanja.

Kvalitet ploda. Važan cilj pri stvaranju novih sorti kajsije, naročito onih koje se koriste za stonu potrošnju, je atraktivan izgled ploda. Poželjno je da nove sorte imaju krupan plod, čija je masa veća od 60 g, pravilan oblik i privlačnu boju pokožice. U nekim programima oplemenjivanja cilj je dobijanje sorti koje imaju dopunsku crvenu boju na najvećem delu površine ploda.

Jedan od značajnih zahteva pri stvaranju novih sorti kajsije je da one imaju čvrsto meso. Takve sorte su bolje prihvaćene od strane potrošača i bolje podnose klasiranje, pakovanje i transport. Za kvalitet mesa je važno da ukus bude slatko-nakiseo, harmoničan, sa skladnim odnosom šećera i kiselina, kao i da plodovi imaju prijatnu aromu. Sve veći značaj se daje i nutritivnim svojstvima ploda, pre svega visokom sadržaju karotenoida i polifenola. Koštica treba da bude relativno sitna, sa što manjim udelom u masi ploda, i da se lako odvaja od mesa.

Sorte koje su namenjene za preradu treba da imaju plodove koji su ujednačene i srednje krupnoće, pravilnog oblika i narandžaste boje pokožice i mesa, koja se ne menja pri sečenju. Meso treba da ima dobru teksturu, bez vlakana i provodnih snopića i da nije sklono posmeđivanju oko koštice („pit burn“). Koštice treba da su sitne i da nemaju izražen vrh koji se lako lomi pri preradi. Takođe je poželjan visok sadržaj rastvorljive suve materije, dobar odnos šećera i kiselina i izražena aroma. Kod sorti namenjenih za sušenje važno je da imaju visok sadržaj šećera.

Metode oplemenjivanja kajsije

U oplemenjivanju kajsije najčešće se primenjuju sledeće metode: selekcija iz prirodnih populacija, hibridizacija i klonska selekcija.

Selekcija iz prirodnih populacija. Genetička varijabilnost postojećih sorti kajsije u svetu je dosta ograničena, naročito kada su u pitanju sorte evropske ekološko-geografske grupe. Znatno veća varijabilnost je izražena kod sorti srednjeazijske i iransko-kavkaske grupe, kao i kod kineskih sorti.

Kina, kao centar porekla kajsije, se odlikuje velikom varijabilnošću germplazme. Poznato je više od 2.000 lokalnih sorti, koje su nastale selekcijom iz prirodne populacije. Većina ovih sorti je samobesplodna, a kod mnogih su u velikoj meri izražene i anomalije tučka. One uglavnom imaju dobar ukus i jako izraženu

aromu, ali je često spoljašnji izgled manje privlačan, a meso nedovoljno čvrsto. Neke od sorti imaju veoma krupan plod, čija masa može biti i do 180 g (Liu et al., 2010).

Turska se odlikuje bogatom germplazmom kajsije, koja pripada iransko-kavkaskoj grupi i u okviru koje postoji velika varijabilnost u pogledu vremena zrenja, krupnoće i hemijskog sastava ploda (Balta et al., 2002; Asma et al., 2007). Kod selekcionisanih tipova sadržaj rastvorljive suve materije je bio 11-26%, a sadržaj kiselina 0,2-2,9%.

U južnoj Italiji, naročito u području planine Vezuv postoji bogata germplazma kajsije. Selekcionisano je više sorti koje se odlikuju dobrim kvalitetom za preradu (visok sadržaj šećera, dobra tekstura, izražena aroma). Od toga, 11 sorti ima zaštićeno geografsko poreklo pod nazivom “Albicocca vesuviana”. To su sorte: Barracca, Boccuccia Liscia, Boccuccia Spinosa, Ceccona, Fracasso, Monaco Bello, Palummella, Pellecchiella, Portici, San Castrese i Vitillo (Rao et al., 2009).

U Srbiji se kajsija u prošlosti često razmnožavala generativno, tako da postoji brojna populacija sejanaca iz koje se mogu izdvojiti genotipovi koji se odlikuju pozitivnim osobinama, kao što su visoka rodnost, dobar kvalitet ploda, dobro zdravstveno stanje, otpornost na nepovoljne ekološke činioce. Od devet sorti kajsije koje su do sada stvorene u našoj zemlji sedam je stvoreno selekcijom iz prirodne populacije (Paunović, 1996; Đurić et al., 2005).

Hibridizacija. Planska hibridizacija je najznačajnija metoda za stvaranje novih, boljih sorti kajsije, jer omogućava rekombinaciju gena. Iako je rad na planskoj hibridizaciji započeo Mičurin još početkom XX veka, ovaj metod oplemenjivanja dobija veći značaj tek u poslednje tri-četiri decenije.

Postupak pri hibridizaciji zavisi od toga da li su sorte samooplodne ili samobesplodne. Kod samooplodnih sorti je neophodna emaskulacija (kastracija), dok je kod samobesplodnih sorti potrebno obaviti izolaciju grančica sa cvetnim pupoljcima. Pošto kajsija rano cveta, emaskulacija i oprašivanje se često obavljaju na nižim temperaturama nego kod drugih voćaka, što otežava rad selekcionara i utiče na slabije zametanje plodova.

Pored ukrštanja u okviru vrste *Prunus armeniaca*, kod kajsije se primenjuje i međuvrsna hibridizacija. Obična kajsija se lako ukršta sa drugim vrstama kajsije, kao što su: sibirska kajsija (*P. sibirica*), mandžurska kajsija (*P. mandshurica*) i japanska kajsija (*P. mume*). Pri tome je moguće i recipročno ukrštanje, a dobijeni sejanci su vitalni i fertilni. Sibirska i mandžurska kajsija se koriste kao donori otpornosti na zimske mrazeve, a japanska kajsija kao donor adaptivnosti na uslove humidne klime.

Kajsija se može ukrštati i sa raznim vrstama šljive. Pri tome je ukrštanje uspešnije ako se šljive koriste kao ženski roditelji. Najbolji rezultati se dobijaju pri ukrštanju sa džanarikom (*P. cerasifera*). Dobijeni hibridi podsećaju na crnu kajsiju (*P. dasycarpa*) koja je prirodni hibrid ove dve vrste. Odlikuju se nešto kasnijim cvetanjem i većom otpornošću na gljivične bolesti. Njihova fertilnost je varijabilna, ali generalno mala.

Hibridi kajsije sa japanskom šljivom (*P. salicina*) se relativno lako dobijaju, ali su uglavnom samobesplodni. Ovi hibridi su poznati pod nazivom „plumcot“ i

odlikuje ih velika sočnost ploda. Prve hibride je stvorio američki selekcionar Luter Berbank još krajem XIX veka. Ovi hibridi se mogu povratno ukrštati sa oba roditelja. Povratnim ukrštanjem sa šljivom dobijeni su hibridi poznati kao „pluot“, a povratnim ukrštanjem sa kajsijom hibridi poznati kao „aprium“.

Klonska selekcija nema tako veliki značaj kod kajsije kao kod nekih drugih voćaka. Veći broj klonova selekcionisan je u Mađarskoj kod sorte Mađarska najbolja (Magyar kajszi), u Češkoj kod sorte Velkopavlovicka, a u Ukrajini kod sorte Krasnošćekij. U SAD su otkriveni mutanti sorti Blenheim, Royal, Moorpark i Tilton.

U Turskoj su Akça i Askin (1995) selekcionisali 17 klonova sorte Hacihaliloglu, koja se u ovoj zemlji najviše gaji i čiji se plodovi koriste za sušenje. Oni se odlikuju krupnijim plodom (40-54 g) i visokim sadržajem rastvorljive suve materije (20-25%). Akça i Asma (1997) su selekcionisali 13 klonova sorte Kabasi, kod kojih je krupnoća ploda bila 32-61 g, a sadržaj suve materije 22-30%.

Programi oplemenjivanja kajsije u svetu

Na stvaranju novih sorti kajsije se intenzivno radi širom sveta. Fideghelli i Della Strada (2010) navode da je u periodu 1980-2007. godine u svetu stvoreno 545 sorti obične kajsije. Najveći broj sorti nastao je u SAD (78), zatim u Francuskoj (74), Italiji (63), Rumuniji (43), Kini (42), Republici Češkoj (35), Španiji (31) i na Novom Zelandu (20).

U stvaranju sorti kajsije dominantno mesto zauzima javni sektor (više od 60%), dok je udeo privatnog sektora manji. Privatni programi oplemenjivanja se nalaze uglavnom u SAD, Francuskoj, Italiji, Španiji, Nemačkoj, Izraelu i Australiji.

SAD. Najveći broj novih sorti kajsije je nastao u SAD. Od 1990-2009. godine je patentirano 36 novih sorti (U.S. Plant Patents, 2012). Najveći deo američke proizvodnje kajsije (oko 86%) skoncentrisan je u Kaliforniji, a u njoj se nalazi i najveći broj programa oplemenjivanja. Od sredine devedesetih godina privatni programi oplemenjivanja postaju dominantni u odnosu na državne. Trenutno su aktivna samo dva državna programa, jedan u Kaliforniji, a drugi u Nju Džersiju.

Program oplemenjivanja u ARS (Agricultural Research Service) u mestu Parlier u Kaliforniji je počeo 1955. godine i u početku ga je vodio John Weinberger, a danas ga vodi Craig Ledbetter. Osnovni cilj ovog programa je bio stvaranje sorti pogodnih za uslove vrele i suve klime u dolini San Joaquin, koja je glavno proizvodno područje kajsije u Kaliforniji. Kao roditelj je u početku najviše korišćena sorta Perfection zbog krupnog ploda i čvrstog mesa. Kasnije, glavni cilj programa postaje stvaranje sorti visokog kvaliteta ploda. Za stvaranje sorti sa većim sadržajem šećera je korišćena i germplazma iz Azije (Ledbetter i Peterson, 2004; Ledbetter et al., 2006). Ostali ciljevi oplemenjivanja obuhvataju produžetak perioda sazrevanja i uvođenje novih osobina, kao što su bela boja mesa i glatka pokožica (bez malja).

Nove sorte stvorene u okviru ovog programa su Helena (1994), Robada (1997), Lorna (1998), Apache (2002), Nicole (2003), Kettleman (2005), Bolaroja i Primarosa (2009)(Okie, 1997, 1999, 2004; Ledbetter i Peterson, 2005; Ledbetter,

2010a). Sve nove sorte su namenjene za stonu potrošnju, sa izuzetkom sorte Nicole, koja je namenjena za preradu. Od ovih sorti u Evropi je najviše raširena Robada. Sazreva srednje rano, ima krupan plod, privlačnog izgleda i dobrog kvaliteta.

U Kaliforniji postoji i veliki broj privatnih programa oplemenjivanja kajsije. Najproduktivniji program je “Zaiger’s Genetics”, koji se nalazi u Modestu. Ovaj porodični program vodi Floyd Zaiger od kraja pedesetih godina XX veka. U okviru njega je patentirano u SAD više od 100 sorti koštičavih voćaka. U periodu 1990-2003. godine patentirano je deset sorti kajsije: Earlicot, Junecot, Jordanne, Gold Brink, Poppy, Earlisunrise, Autumn Glow, Early-Autumn, Bonny i Brittany Gold (Finn i Clark, 2008; US plant patents, 2012).

Ciljevi oplemenjivanja kajsije su bili: stvaranje “low chill” sorti (sa malim potrebama za niskim temperaturama u toku zime), manja bujnost stabla, produžetak raspona zrenja, atraktivan izgled i dobar kvalitet ploda, pogodnost za preradu i sušenje. Najznačajnije sorte iz programa Zaiger’s Genetics su Poppy i Earlicot, koje imaju rano vreme zrenja i najviše su gajene stone sorte kajsije u Kaliforniji.

Program “Zaiger’s Genetics” je poznat i po međuvrsnim hibridima između kajsije i šljive (plumcot, pluot i aprium), kao i kajsije, šljive i breskve (peacotum). Do sada je patentirano više od 60 ovih hibrida, od čega je najveći broj tipa pluot. Naziv “pluot” je registrovana trgovačka marka firme “Zaiger’s Genetics”.

Drugi značajan privatni program oplemenjivanja kajsije u Kaliforniji je u okviru firme “Sun World” u mestu Bakersfield. U periodu od 1991-2006. godine patentirano je sedam sorti kajsije. Četiri sorte iz ove serije (Suapriseven, Suaprieight, Suaprinine i Suapriten) su zaštićene kao brend “Honeycot”. Ove sorte se odlikuju time što imaju vrlo krupan plod, atraktivnog izgleda, tamno narandžaste boje mesa, odličnog ukusa i arome i veoma dobre transportabilnosti. Pored toga, one su samooplodne i imaju manje potrebe za niskim temperaturama u toku zime (Okie, 1997, 1999; Clark i Finn, 2006).

Treći značajan privatni program oplemenjivanja kajsije u Kaliforniji je u okviru Bradford Farms u mestu Le Grand. Program je vodio Norman Bradford. Stvorene su tri nove sorte kajsije, koje su patentirane: Goldensweet (1994), pozna sorta kombinovanih svojstava; Goldenblush (2004) i Golden May (2009), rane stone sorte. U okviru ovog programa radi se i na stvaranju međuvrsnih hibrida kajsije i japanske šljive.

U SAD van Kalifornije je značajan još jedan javni program oplemenjivanja kajsije, koji se odvija u Poljoprivrednoj eksperimentalnoj stanici Nju Džersi koja pripada Univerzitetu Rutgers. Ovaj program oplemenjivanja je počeo 1950. godine. Osnovi cilj je bio da se stvore sorte prilagođene uslovima lokalne klime, koja je drugačija u odnosu na Kaliforniju (hladnija i vlažnija). Specifični ciljevi su bili: poboljšanje zdravstvenog stanja debla (otpornost na pruzrokovače raka – gljivica *Leucostoma* spp. i bakterija *Pseudomonas syringae*), poboljšanje kvaliteta ploda, redovna rodnost (otpornost na zimske mrazeve i nepovoljne vremenske prilike u fazi cvetanja) i otpornost na prouzrokovače bolesti koje napadaju list i plod, kao što su *Xanthomonas campestris* pv. *pruni* i *Monilinia fructicola* (Mehlenbacher i Hough,

1985). U cilju poboljšanja varijabilnosti korišćena je germplazma poreklom iz srednje Azije, kao što su npr. sorte Samarkandska najranija kao donor ranog vremena zrenja i Zard kao donor kasnog cvetanja i visokog sadržaja šećera. U okviru ovog programa stvoren je veliki broj selekcija. Pored starijih sorti Orangered i Jerseycot, stvorene su tri nove sorte: vrlo rana sorta Early Blush (NJA 53), rana sorta Sun Gem (NJA 54) i srednje kasna sorta Sugar Pearls (NJA 150) (Goffreda et al., 1995a, 1995b; Ledbetter, 2010b).

Francuska. Od evropskih zemalja najveći broj novih sorti kajsije je stvoren u u Francuskoj. U ovoj zemlji postoji jedan značajan državni program oplemenjivanja kajsije, kao i nekoliko privatnih programa.

Oplemenjivanje kajsije u INRA (Institut National de la Recherche Agronomique) se obavlja u mestu Avinjon u pokrajini Provansa na jugu Francuske i počelo je 1960. godine. Program vodi Jean-Marc Audergon. Osnovni ciljevi oplemenjivanja su: visoka i redovna rodnost, samooplodnost, dobar kvalitet ploda (krupnoća, boja, čvrstoća i ukus), produžetak raspona zrenja, otpornost na prouzrokovače bolesti (šarka šljive, fitoplazma ESFY, bakterijski rak i sušenje grančica). Kao rezultat prve faze oplemenjivanja stvoreno je jedanaest novih sorti kajsije To su: Ivresse (Avikloe), Mariem (Avignel), Malice (Avicot), Sortilège (Avilara), Comédie (Avilor), Avikaline, Gâterie (Avikandi), Frenesie, Royal Roussillon, Fantasme (Avikour) i Héléna du Roussillon (Aviera). Sve navedene sorte su srednje poznog vremena zrenja, sa izuzetkom dve poslednje, koje su poznog sazrevanja (Audergon et al., 1995). Kasnije su priznate još tri sorte: Solédane, koja je ranog vremena zrenja, kao i dve srednje pozne sorte: Bergarouge (Avirine) i Florilége (Audergon et al., 2006). Značajno dostignuće u oplemenjivanju kajsije predstavljaju tri nove sorte iz ovog programa: Ravicille, Ravilong i Ravival. One se odlikuju time što imaju pretežno crvenu boju, odnosno dopunska crvena boja prekriva oko 80% površine ploda. Ove sorte predstavljaju posebnu liniju sorti koja je zaštićena pod zajedničkim trgovačkim nazivom “Rubisco” (Audergon et al., 2010). Novije sorte iz ovog programa su Solimar (Torraviun), Bergeval (Aviclo), Aramis (Shamade), Anegat, Bangat i Congat. Sorta Aramis (Shamade) je značajna zbog toga što je otporna na virus šarke šljive i to sojeve M i D (Audergon et al., 2012). Nove sorte stvorene u INRA se distribuiraju preko udruženja rasadnika “CEP Innovations”.

Veliki privatni program oplemenjivanja kajsije vodi firma “International Plant Selection” u mestu Montelimar, koje se nalazi u departmanu Drom na jugoistoku Francuske. On se odvija u okviru rasadnika Darnaud, a selekcioner je Marie-France Bois. Osnovni ciljevi oplemenjivanja su: produžetak raspona sazrevanja, visoka i redovna rodnost, samooplodnost i dobar kvalitet ploda (posebno krupnoća, boja i čvrstoća). Stvoreno je više od 20 novih sorti kajsije, poznatih kao “Carmingo” serija. Glavno dostignuće ovog programa je produžetak raspona zrenja kajsije. Stvorene su vrlo rane sorte Primando, Pricia i Primarel, koje sazrevaju 3-5 dana pre sorte Early Blush. Po vremenu zrenja slede rane sorte Primaya, Primius, Primaris, Rubista, Primarina i Priabel, srednje rane sorte Mediabel i Medaga i kasna sorta Faralia. Posebno je značajno stvaranje sorti vrlo kasnog vremena zrenja, koje sazrevaju 20-50

dana posle sorte Bergeron, kao što su: Farely, Fartoli, Farbaly, Farfia, Farhial, Farius, Farlis, Fardao i Farclo. Time je sezona berbe kajsije produžena na četiri meseca. U uslovima jugoistočne Francuske berba se odvija od sredine maja do sredine septembra.

U Francuskoj postoji još nekoliko privatnih programa oplemenjivanja kajsije, koji se uglavnom nalaze u okviru rasadnika, kao što su Escande, Cot International, Star Fruits i dr. U rasadniku Escande su stvorene vrlo rane sorte Tsunami, Spring Blush i Sweet Red (Red Silver), srednje rane sorte Pinkcot (Cotpy), Sylred i Big Red, kao i srednje kasne sorte Kioto i Silvercot (Cotsy, Versyl). U okviru firme Cot International patentirane su vrlo rana sorta Wonder Cot, rane sorte Magic Cot i Lilly Cot, srednje rane sorte Sweet Cot, Perle Cot i Flavor Cot, kao i srednje kasne sorte Sunny Cot, Vanilla Cot i Lady Cot. Mnoge od novih francuskih sorti se ističu po atraktivnom izgledu ploda, velikoj krupnoći i dobroj obojenosti. Međutim, pretežno su samobesplodne, pa ih treba gajiti sa odgovarajućim oprašivačima.

Italija. Najznačajniji programi oplemenjivanja kajsije su locirani u Pizi i Bolonji. Pored toga, manji broj sorti stvoren je u Firenci, Palermu i Kazerti.

Najveći broj sorti stvoren je na Univerzitetu u Pizi (Dipartimento di Coltivazione e Diffesa delle Specie Legnose). Oplemenjivanje kajsije je počelo početkom 80-ih godina, a program vodi Rolando Guerriero. Ciljevi ovog programa su poboljšanje kvaliteta ploda (kombinacija organoleptičkih i komercijalnih karakteristika sa povećanom otpornošću na rukovanje i transport), produžetak vremena zrenja, adaptivnost na ekološke uslove (posebno kasnije cvetanje i manja osetljivost na pozne prolećne mrazeve), visoka rodnost i otpornost na prouzrokovače bolesti (*Monilinia laxa*, *Monilinia fructigena, Pseudomonas* spp. i *Plum Pox Virus*). Kao roditelji u ukrštanjima su najviše korišćene sorte: Reale d’ Imola, Goldrich, Rival, Harcot, Portici i dr. U ovom programu stvorene su rane sorte Salambo, Cabiria i Angela; srednje rane sorte Ardenza, Claudia, Kinzica, Bona, Gheriana, Maharani, Sillari i Ammiraglia; kao i pozne sorte: Pisana, Dulcinea, Marietta (Milady), Piera i Silvana (Bassi et al., 1995; Guerriero et al., 2006a, 2006b). Od ovih sorti u Italiji se najviše gaji Pisana, koja se ističe po krupnoći i kvalitetu ploda.

Drugi značajan program oplemenjivanja kajsije u Italiji se nalazi na Univerzitetu u Bolonji. On je počeo početkom 80-ih godina, a vodi ga Daniele Bassi, koji sada radi na Univerzitetu u Milanu. Ciljevi oplemenjivanja obuhvataju: adaptivnost na klimatske uslove severne Italije (naročito na kolebanje temperature krajem zime i početkom proleća), dobar kvalitet ploda (izgled, čvrstoća, ukus, sporije dozrevanje ploda), samooplodnost, otpornost na prouzrokovače bolesti (virus šarke šljive, *Monilinia* spp.), produžetak raspona sazrevanja, otpornost na pucanje pokožice usled kiše. U ovom programu su stvorene sledeće sorte: Cora, Ninfa, Boreale, Bora, Ardore, Pieve, Maia, Petra i Pieve Tardiva (Bassi et al., 1995; Bassi i Rizzo, 2004; Missere, 2008; Bassi et al., 2010). Od sorti stvorenih u ovom programu najznačajnije su Ninfa i Bora. Ninfa je jedna od najranijih sorti kajsije, samooplodna je i vrlo rodna. Pored Italije, ova sorta se dosta gaji i u Grčkoj, Španiji i Turskoj.

Bora je interesantna zbog otpornosti na šarku šljive, ima krupan plod, privlačan izgled i čvrsto meso.

Oplemenjivanje kajsije na Univerzitetu u Firenci vodi Elvio Bellini. Ciljevi stvaranja novih sorti su: rano sazrevanje, visoka rodnost, dobar kvalitet ploda i izražena dopunska crvena boja pokožice. Stvorene su dve sorte srednje ranog vremena zrenja: Giada i Perla. Od 2000. godine počela je nova serija ukrštanja i izdvojen je veći broj perspektivnih selekcija (Bellini et al., 2010).

U novije vreme u južnoj Italiji su započela dva nova programa oplemenjivanja kajsije. Prvi je na Univerzitetu u Palermu, na Siciliji, gde su 2003. godine stvorene dve nove sorte: Nella i Dora. Obe su nastale ukrštanjem sorti Titynthos i Ouardi, ranog su vremena zrenja, samooplodne, imaju srednje krupan plod i čvrsto meso (Calabrese et al., 2010). Drugi program se odvija u Centru za voćarstvo u mestu Kazerta u regionu Kampanija. On je počeo 1986. godine, a 2007. godine realizovane su prve dve sorte: Ischia i Procida. Obe su nastale ukrštanjem sorti Sabelle x Ouardi i odlikuju se ranim zrenjem (Pennone et al., 2010).

Španija. U Španiji se oplemenjivanjem kajsije bave dva državna programa (u Mursiji i Valensiji) i jedan privatni program (u Mursiji).

Oplemenjivanje kajsije u CEBAS-CSIC (Centro de Edafologia y Biologia Aplicada del Segura, Consejo Superior de Investigaciones Científicas) u Mursiji je počelo 1991. godine. Rukovodilac programa je Jose Egea. Osnovni ciljevi olemenjivanja su: rano zrenje, samooplodnost, otpornost na virus šarke šljive, visoka rodnost, dobar kvalitet ploda (atraktivan izgled, čvrstoća, pogodnost za čuvanje i preradu), otpornost na pucanje pokožice i smanjenje troškova proizvodnje, kao što je proređivanje plodova. U ukrštanjima su korišćeni različiti roditelji, uključujući tradicionalne sorte koje se odlikuju visokim kvalitetom (Moniqui, Pepito del Rubio) ili ranim zrenjem (Currot), kao i strane sorte kao donore atraktivnog izgleda ploda i otpornosti na virus šarke šljive (Goldrich, Orangered). Do sada je stvoreno 13 novih sorti: Rojo Pasion, Selene, Murciana, Dorada, Toñi, Sublime, Estrella, Rosa, Maravilla, Valorange, Mirlo Blanco, Mirlo Anaranjado i Mirlo Rojo (Egea et al., 2004a, 2004b, 2005a, 2005b, 2010, 2012).

Ove sorte karakterišu se malim do srednjim potrebama za niskim temperaturama u toku zime (Ruiz et al., 2007). Ranog su vremena zrenja (sa izuzetkom sorte Dorada), imaju visoku rodnost, privlačan izgled ploda, dobru transportabilnost i pogodne su za preradu (Egea et al., 2010). Sorte Mirlo Blanco, Mirlo Anaranjado i Mirlo Rojo su otporne na *Plum Pox Virus*.

Drugi javni program oplemenjivanja kajsije u Španiji nalazi se u IVIA (Instituto Valenciano de Investigaciones Agrarias) u Valensiji. On je počeo 1993. godine sa prvenstvenim ciljem stvaranja sorti otpornih na virus šarke šljive. Ostali ciljevi su obuhvatali dobru adaptivnost na klimatske uslove južne Evrope, rano zrenje i dobar kvalitet ploda. Kao roditelji su uglavnom korišćene sorte Goldrich, Sunglo, Harcot i Lito. Do sada su realizovane tri sorte otporne na *Plum Pox Virus*: Moixent, Rafel i Belgida (Martínez-Calvo et al., 2010, 2011).

Privatni program oplemenjivanja kajsije odvija se u okviru „P.S.B. Produccion Vegetal S.L.” koja se nalazi u Mursiji. To je firma porodice Buffat, specijalizovana za oplemenjivanje breskve i kajsije. Ciljevi oplemenjivanja obuhvataju: poboljšanje osobina ploda (veličina, okrugao oblik, atraktivna dopunska boja, čvrstoća i ukus), dobru transportabilnost i sposobnost čuvanja plodova, redovnu rodnost, kao i stvaranje “low chill” sorti. Do sada je stvoreno više novih sorti, kao što su: vrlo rane sorte Mogador, Colorado i Madison, rane sorte Mambo, Mirandela, Megatea, Maravita, Flodea, Margotina i Marvinka, srednje rane sorte Flopria i Latica, kasna sorta Milord i vrlo kasna sorta Sherpa. Većina ovih sorti je patentirana ili su u postupku dobijanja patenta. Njihov raspon zrenja iznosi oko tri meseca, u uslovima južne Španije od početka maja do kraja jula. Dominiraju sorte ranijeg vremena sazrevanja, a najpoznija sorta (Sherpa) sazreva oko mesec dana posle sorte Bergeron.

Grčka. Oplemenjivanje kajsije se odvija u Institutu za pomologiju u mestu Naoussa na severu Grčke. Program vodi Irene Karayiannis. Prvi kriterijum selekcije je otpornost na virus šarke šljive. Pored toga, ostali ciljevi su: samooplodnost, visoka i redovna rodnost, dobar kvalitet ploda, pogodnost za preradu (kompot), rano vreme zrenja, adaptivnost na lokalne klimatske uslove. Kao donori otpornosti na *Plum Pox Virus* su korišćene severnoameričke sorte kajsije: Stark Early Orange, Stella, NJA 2, Veecot, Sunglo, Harlayne, Orangered, Goldrich i Early Blush. One su ukrštane sa lokalnim grčkim sortama koje se odlikuju dobrim kvalitetom ploda (Bebecou) ili ranim zrenjem (Tirynthos). Prve dve sorte – Lito i Pandora priznate su 1991. godine i nastale su ukrštanjem sorti Stark Early Orange i Tirynthos. Sledeća serija od devet sorti priznata je 2001. godine. Nju čine sledeće sorte: Neraida, Niobe, Nastasia, Nina i Nereis, koje su pogodne za stonu potrošnju i sorte Nausika, Nomia, Nostos i Nefele, koje su pogodne za preradu (Karayiannis et al., 2006).

Češka. Najznačajniji program oplemenjivanja kajsije nalazi se u mestu Lednice, a na stvaranju sorti se radi i u mestima Valtice, Holovousy i Šakvice.

Na Fakultetu za hortikulturu iz Lednica (koji pripada Mendelovom univerzitetu za poljoprivredu i šumarstvo iz Brna) rad na oplemenjivanju kajsije je počeo 1960. godine sakupljanjem i proučavanjem germplazme. U narednom periodu je rađena klonska selekcija sorte Velkopavlovicka. U prvom ciklusu selekcije je izdvojeno pet klonova, a u drugom ciklusu je kao najbolji odabran klon Velkopavlovicka LE-12/2 (Vachůn et al., 1999). Rad na stvaranju sorti putem hibridizacije je počeo 1981. godine, a njega je vodio Zdenek Vachůn. Osnovni ciljevi prve faze ovog programa su bili produžetak raspona sazrevanja i povećanje otpornosti cvetnih pupoljaka na mrazeve. Mnogi hibridi koji su korišćeni za ukrštanje u tom periodu potiču iz programa oplemenjivanja koji je vodio F.L. Hough na Rutgers univerzitetu u Nju Džersiju u SAD. Kao rezultat ove faze, u periodu 1999-2005. godine su nastale sorte: Ledana, Lejuna, Leskora, Leala, Lebela, Lerosa, Legolda i Lenova (Vachůn, 1999; Vachůn et al., 1999). Glavni ciljevi druge faze oplemenjivanja su bili otpornost na virus šarke šljive i povećanje krupnoće ploda. U toku 2005. godine priznato je pet novih sorti: Lemeda, Marlen, Minaret, Palava i Svatava (Krška et al., 2006). Ciljevi treće faze oplemenjivanja, koja je u toku, su

usmereni na izgled ploda, čvrstoću mesa i otpornost na šarku. U ovoj fazi izdvojen je veći broj selekcija otpornih na šarku šljive, od kojih se po otpornosti posebno ističe LE-3276 (Betinka) (Krška et al., 2000; Polak et al., 2008).

U oplemenjivačkoj stanici u mestu Valtice (sada firma “Seva Flora”) stvorene su nove sorte Jitka, Radka i Nora. Jitka (2003) je srednje rana sorta, krupnog ploda i kombinovanih svojstava. Radka (2005) je rana stona sorta (sazreva oko 20 dana pre Mađarske najbolje). Nora (Vestar x Harlayne) je priznata 2011. godine i otporna je na virus šarke šljive.

U Institutu za voćarstvo i oplemenjivanje Holovousy stvorene su dve sorte kajsije: Darina i Kompakta, koje su priznate 1999. godine. Obe su srednje kasnog vremena zrenja i kombinovanih svojstava. Sorta Kompakta se odlikuje slabijom bujnošću (kompaktni habitus strabla).

U privatnoj firmi “Lyvana” u mestu Šakvice stvoreno je pet novih sorti kajsije. To su srednje kasne sorte Alfons, Beta i Gama i srednje rane sorte Delta i Zetka.

Slovačka. Oplemenjivanje kajsije u Slovačkoj se odvija u istraživačko-oplemenjivačkoj stanici Veselé – Pieštany. Program je počeo 1964. godine, a vodi ga Daniela Benediková. Ciljevi oplemenjivanja su: otpornost na mraz, kasno cvetanje, redovna rodnost, visok kvalitet ploda, velika čvrstoća mesa, pogodnost za preradu, produžetak raspona zrenja i otpornost na prouzrokovače bolesti (*Monilinia*, *Gnomonia*, PPV). Kao roditelji su korišćene sorte različitih ekološko-geografskih grupa (evropske, srednjeazijske i kineske). Kao rezultat ovog programa do sada je registrovano deset sorti kajsije: Vesna, Vegama, Veharda, Velbora, Vesprima, Barbora, Vestar, Veselka, Vemina i Velita (Benediková, 2006).

Nove slovačke sorte kajsije odlikuju se produženim rasponom sazrevanja, kasnijim vremenom cvetanja i dobrim kvalitetom ploda. Otpornost na mraz je ostvarena kasnim početkom cvetanja (Veharda) ili dužim trajanjem cvetanja i postepenim otvaranjem cvetova (Vegama). Sorte Veharda i Vemina odlikuju se otpornošću na virus šarke šljive (soj M). Po visokom kvalitetu ploda ističu se Vesna, Vestar i Veselka, a po velikoj čvrstoći ploda Veharda i Vemina.

Mađarska. Oplemenjivanje kajsije u Mađarskoj je počelo posle drugog svetskog rata. Prva faza obuhvatala je selekciju iz prirodne populacije, kao i klonsku selekciju unutar sorti Mađarska najbolja i Kečkemetska ruža. Programi bazirani na hibridizaciji su počeli krajem 60-ih godina u institutima za voćarstvo u Cegledu i Budimpešti, kao i na Univerzitetu za hortikulturu u Budimpešti.

U Institutu za voćarstvo u Cegledu međusobnim ukrštanjem mađarskih sorti dobijeno je pet novih sorti kajsije. Sorte Ceglédi Piroska i Ceglédi napsugár su namenjene za stonu potrošnju, Ceglédi kedves je pretežno namenjena za preradu, a sorte Ceglédi arany i Nyujtó Ferenc emléke su kombinovanih svojstava (Pedryc i Kerek, 1999; Szalay et al., 2005).

Na Fakultetu za hortikulturu Korvinus Univerziteta u Budimpešti u oplemenjivanju su korišćene sorte iransko-kavkaske i srednjeazijske ekološko-geografske grupe, sa ciljem povećanja diverziteta u potomstvu, naročito vremena zrenja. Stvorene su dve sorte ranog sazrevanja: Harmat i Korai zamatos. Tri nove

sorte: Corred, Corfirm i Corlate su prijavljene za priznavanje. Sorta Corred je srednje kasna i dobro obojena, Corfirm je kasna i ima veoma čvrsto meso, a Corlate je veoma kasna (sazreva u prvoj polovini septembra) i ima krupan plod, spljoštenog oblika (Pedryc i Herman, 2012).

U Istraživačkom institutu za voćarstvo i ukrasne biljke u mestu Érd u blizini Budimpešte stvorena je sorta Pannónia. Ona je srednje poznog vremena zrenja, male bujnosti, visoke rodnosti i kombinovanih svojstava (pogodna za potrošnju u svežem stanju i preradu).

Rumunija. Oplemenjivanje kajsije u Rumuniji ima dugu tradiciju i do sada je stvoreno više od 40 novih sorti. Trenutno su aktivna tri programa oplemenjivanja, koja se nalaze u mestima Baneasa, Konstanca i Oradea.

Istraživačka stanica Baneasa, koja se nalazi u jugoistočnom delu Rumunije, počela je sa oplemenjivanjem kajsije 1967. godine, a program je vodila Viorica Balan. Ciljevi su bili produžetak raspona zrenja (pre svega stvaranje ranih sorti), dobra adaptivnost na klimatske uslove, visoka rodnost, dobar kvalitet ploda i otpornost na prouzrokovače bolesti. U periodu 2002-2006. godine stvoreno je osam novih sorti: Rares, Carmela, Viorica, Valeria, Nicosur, Adina, Andrei i Alexandru. Po velikoj krupnoći ploda (oko 100 g) ističu se sorte Viorica i Carmela (Branişte et al., 2007; Bălan et al., 2010).

Oplemenjivanje kajsije u Konstanci je počelo 1971. godine sakupljanjem germplazme, koja sada ima više od 630 genotipova. Rukovodilac programa je Elena Topor. Osnovni ciljevi oplemenjivanja su: produžetak sezone sazrevanja, povećanje kvaliteta ploda (krupnoća, boja, čvrstoća, veći sadržaj šećera, ukus i aroma), visoka rodnost i otpornost na bolesti, kao što je šarka šljive. Kao rezultat oplemenjivačkog rada stvoreno je 14 novih sorti: Traian, Tudor, Auras, Cristal, Danubiu, Fortuna, Amiral, Orizont, Augustin, Ceres, Euxin, Histria, Elmar i Ovidius (Topor et al., 2008, 2010).

Najmlađi program oplemenjivanja kajsije u Rumuniji odvija se u Istraživačkoj stanici Oradea, koja se nalazi na severozapadu ove zemlje. U toku 2006. godine priznate su četiri nove sorte stvorene u ovoj stanici: Monica, Bihoreana, Iona i Iulia. Sve ove sorte su srednje kasnog vremena zrenja. Ioana se preporučuje za stonu potrošnju, Bihoreana i Monica za preradu, dok je Iulia sorta kombinovanih svojstava (Gîtea et al., 2008).

Rusija. Najveći deo Rusije nema pogodne klimatske uslove za gajenje kajsije. I pored toga, u većem broju naučnih instituta i oglednih stanica se odvija značajan rad na oplemenjivanju ove voćke. U Državni registar selekcionih dostignuća Rusije nakon 1990. godine upisano je 35 novih sorti, a pet od njih je patentirano (Anonymous, 2012a).

Najpogodniji klimatski uslovi za gajenje kajsije su na području severnog Kavkaza. U Dagestanskoj selekciono-oglednoj stanici u Bujraksku stvorene su sorte Uncukuljskij pozdnij, Uzdenj, Dženguta jevskij, Tamaša i Esdelik, a u Stavropoljskoj oglednoj stanici sorte Orlik Stavropolja, Reklamnij i Stavropoljskij molodežnij. Ove sorte imaju srednje krupan plod (30-50 g). U Krimskoj selekciono-oglednoj stanici u

gradu Krimsku stvorene su dve sorte: Černij barhat i Kubanskij černij, koje su nastale kao sejanci crne (purpurne) kajsije (*Prunus dasycarpa*). Ove sorte su srednje kasnog vremena zrenja, samobesplodne su i imaju sitan plod (oko 25 g).

Relativno povoljni uslovi za uspevanje kajsije su i u donjem toku reke Volge. U Institutu za voćarstvo i lekovito bilje u gradu Samara stvorene su četiri sorte kajsije koje su patentirane. To su: Kujbiševskij jubilejnij, Pervenec Samari, Samarskij i Jantar Povoložja. Ove sorte odlikuju se otpornošću na mrazeve i dobrom rodnošću, ali imaju sitan plod (20-25 g).

U glavnoj botaničkoj bašti u Moskvi stvoreno je osam novih sorti kajsije: Ajsberg, Aleša, Vodolej, Grafinja, Lelj, Monastirskij, Favorit i Carskij. Ove sorte karakteriše povećana otpornost na mraz, dobra rodnost i sitan plod (15-20 g). One su pogodne za preradu i preporučuju se za gajenje na okućnici (Kramarenko, 2006).

U Južnouralskom institutu u Čeljabinsku, koji se nalazi istočno od Urala radi se na stvaranju sorti za uslove veoma hladne klime. Kao donor otpornosti na niske temperature se koristi mandžurska kajsija. Nove sorte Snežinskij, Pikantnij, Kičiginskij i Čeljabinskij ranij karakteriše velika otpornost na mrazeve, ali i vrlo sitan plod (10-20 g).

Ukrajina. U Državni registar sorti biljaka Ukrajine od 1990. godine upisane su 23 nove sorte kajsije, od kojih je 14 sorti zaštićeno (Anonymous, 2012b). Najznačajniji programi oplemenjivanja se nalaze u mestima Jalta i Melitopolj.

Jedan od najstarijih programa oplemenjivanja kajsije u svetu nalazi se u Nikitskoj botaničkoj bašti, u gradu Jalta na Krimu. Program je počeo još 1925. godine, a vodila ga je K.F. Kostina. Od velikog broja stvorenih sorti, 16 je upisano u državni registar, a od toga 14 je patentirano. U cilju povećanja adaptivnosti u stvaranju sorti je korišćena germpazma različitog geografskog porekla. Zaštićene sorte kajsije su: Krimskij amur, Aviator, Autok, Aljans, Aljtair, Hamlet, Divnij, Krokus, Kostinskij, Naslaždenije, Pamjat Ahejevoj, Južanin, Jaltinec i Iskorka Tavridi. Ove sorte su različitog vremena zrenja i krupnoće ploda (30-60 g).

Drugi značajan program oplemenjivanja kajsije u Ukrajini se nalazi u Institutu za navodnjavanje u voćarstvu (Institut orošaemogo sadovodstva) u Melitopolju. U Državni registar sorti Ukrajine upisane su nove sorte stvorene u ovom institutu: Melitopoljskij lučistij, Dar Melitopolja, Zorjanij, Kumir, Sadovij i Tašćenakskij.

Nemačka. Na Univerzitetu Halle-Wittenberg selekcionisane su tri sorte kajsije otporne na virus šarke šljive. Sorte Brevira i Virosia ispoljavaju kvantitativnu otpornost, dok je sorta Kuresia imuna (Fuchs et al., 2001). Firma „Artevos“ je patentirala sortu Kuresia 2007. godine. Pored toga u toku je postupak zaštite još tri sorte kajsije: Clarina, Hilde i Mino. Ove sorte su veoma tolerantne na mrazeve, imaju visoku i redovnu rodnost i krupne do vrlo krupne plodove.

U Nemačkoj je stvoren i hibrid između kajsije i trešnje pod nazivom Aprikyra. On je samooplodan, cveta rano, ali posle kajsije. Plod je okruglog oblika, tamnocrvene boje, po veličini između šljive i kajsije. Da bi se dobio dobar ukus potrebno je proređivanje plodova.

Kanada. Značajan program oplemenjivanja kajsije nalazio se u istraživačkom centru Harou u provinciji Ontario u Kanadi (Agriculture and Agri-Food Canada, Harrow). Ovaj program je počeo 1964. godine, a selekcioner je bio R.E.C. Layne. Najznačajniji ciljevi oplemenjivanja su bili: otpornost na zimske mrazeve, otpornost na prouzrokovače bolesti (*Leucostoma* spp., *Xanthomonas campestris* pv. *pruni*, *Monilinia fructicola*), dobar kvalitet ploda (krupnoća, izgled, čvrstoća mesa, tekstura, ukus i odvajanje od koštice), visoka i redovna rodnost, produžetak vremena zrenja, uniformno zrenje, otpornost na opadanje plodova pred berbu i pucanje pokožice.

U periodu 1974-2000. godine realizovano je 11 sorti kajsije (Hunter i Layne, 1998). Novije sorte iz ove serije su: Harojoy, Haroblush i Harostar, koje su srednje kasnog vremena zrenja i odlikuju se vrlo privlačnim izgledom ploda (Layne i Hunter, 2003a, 2003b, 2003c). Ovaj program je 1995. godine premešten u istraživački centar Vineland. Evaluacija perspektivnih sejanaca je nastavljena u drugim područjima (SAD i Evropa). Zastupnik ovih sorti za Evropu je francuska firma Star Fruits. Dve sorte - Harobig i Harrow Red su zaštićene i introdukovane za komercijalnu proizvodnju u Evropi (Hunter i Layne, 2004).

Novi Zeland. Najznačajniji program oplemenjivanja kajsije na južnoj hemisferi nalazi se u institutu HortResearch (sada Plant and Food Research) u mestu Havelock North. Osnovni ciljevi oplemenjivanja su produžetak sezone zrenja, visoka rodnost, dobar kvalitet ploda i dobra sposobnost čuvanja (Hofstee et al., 1999). U periodu 1988-1993. godine realizovano je šest sorti tzv. “Clutha” serije: CluthaGold, CluthaStar, CluthaLate, CluthaSun, CluthaGem i CluthaEarly. One su nastale ukrštanjem sorti Moorpark i Sundrop. Od ovih sorti je najznačajnija CluthaGold koja se dosta komercijalno gaji na Novom Zelandu. U periodu 1997-1998. realizovano je sedam novih sorti. Serija sorti “Riwaka” je nastala slobodnim oprašivanjem sorte Cluthagold i čine je sorte: Alex, Benmore, Dunstan, Gabriel, Vulcan i Cluthafire. Mascot je srednje rana sorta, nastala ukrštanjem Valleygold x Earliril.

Australija. U Australiji postoje dva značajna programa oplemenjivanja kajsije. Jedan je u okviru instituta SARDI, a drugi u okviru kompanije ANFIC.

SARDI (South Australian Research and Development Institute) se nalazi u mestu Loxton u Južnoj Australiji. Osnovni cilj oplemenjivanja kajsije u ovom institutu je stvaranje sorti pogodnih za sušenje. One treba da imaju visok sadržaj suve materije, poželjno iznad 20%. Važne osobine su i randman sušenja, koji predstavlja odnos sveže i suve mase mesa ploda, kao i dužina čuvanja. Pored toga, cilj oplemenjivanja je da nove sorte imaju dobru krupnoću, boju i čvrstoću, kao i visoku i redovnu rodnost. Prva sorta iz ovog programa realizovana je 1998. godine i to je Rivergem. U toku 2005. godine realizovane su još tri sorte: Riverbrite, River Ruby i Rivergold (Graetz, 2006). Nove sorte odlikuju se visokim sadržajem suve materije (18-25%). One takođe imaju povoljniji randman sušenja (5,1 : 1 do 4,2 : 1) u odnosu na standardnu sortu Moorpark (6 : 1).

Kompanija ANFIC (Australian Nurseryman’s Fruit Improvement Company) je patentirala seriju sorti kajsije “Solar”. Oplemenjivač je Henry Franklin. Ovu seriju čine sorte: Solar Glow, Solar Fire, Solar Nugget, Solar Flair, Solar Blaze, Solar Gem,

Solar Sweet i Solar Mate. Ove sorte karakterišu se time što imaju narandžasto-žutu do tamno narandžastu boju ploda, bez dopuske crvene boje. Njihov plod je uglavnom krupan i ima vrlo dobar ukus i aromu. To su sorte ranog ili srednje ranog vremena zrenja, sa izuzetkom sorte Solar Mate, koja sazreva kasno.

Tunis. Program oplemenjivanja kajsije je počeo 1954. godine u INRAT (Institut National de Recherche Agronomique de Tunisie) u mestu Ariana na severu Tunisa. Ukrštanja su obavljana između lokalnih sorti, koje imaju dobru adaptivnost i rano sazrevanje sa introdukovanim sortama kao donorima samooplodnosti, redovne rodnosti i pogodnosti za preradu.

Nova serija ukrštanja je počela 1974. godine i od dobijenih sejanaca odabrano je šest novih sorti, koje su registrovane 1995. godine. To su srednje rane sorte Asli i Raki, i srednje kasne sorte Atef, Meziane, Ouafir i Fakher. Ove sorte su samooplodne, imaju visoku rodnost i dobar kvalitet ploda (Lachkar i Mlika, 2006).

Turska. Poslednjih godina u Turskoj je intenziviran rad na oplemenjivanju kajsije. U ranijem periodu se uglavnom radilo na selekciji kajsije iz prirodne populacije, dok se kasnije počelo i sa hibridizacijom.

Program oplemenjivanja kajsije putem hibridizacije je počeo 1989. godine na Alata hortikulturnom istraživačkom institutu u gradu Mersin, koji se nalazi u severoistočnom delu Turske, na obali Sredozemnog mora. Ukrštane su lokalne turske selekcije (Alyanak, Sakit-1, Sakit-2, Sakit-6, 07K11) sa stranim sortama (Cafona, Canino, Fracasso, Jaubert Foulon, Precoce de Colomer). Cilj je bio da se dobiju nove stone sorte ranog vremena zrenja i dobrog kvaliteta ploda. Stvoreno je pet novih sorti: Dr Kaşka, Çağataybey, Çağribey, Şahinbey i Alatayıldırzı. Kod ovih sorti masa ploda je bila od 42-58 g, a sadržaj suve materije 12,4-14,8% (Bircan et al., 2010).

Izrael. Poljoprivredna istraživačka organizacija u mestu Beit Dagan, koja radi u okviru Ministarstva poljoprivrede Izraela, realizovala je dve sorte kajsije Tarog i Daniel. Sorta Daniel je patentirana i u SAD. Ona je ranog vremena zrenja, samooplodna, dobre rodnosti i kvaliteta ploda.

Privatni program oplemenjivanja kajsije postoji u okviru firme „Ben Dor Fruits and Nurseries“. Oni rade na kreiranju nekoliko novih linija sorti kajsije. Linija „Aromacot“ se karakteriše jako izraženom aromom, narandžastom bojom mesa i visokim sadržajem suve materije (15-20%). Liniju „obojene kajsije“ čine sorte koje imaju ljubičasto crvenu ili crnu boju pokožice i crvenu ili žutu boju mesa (Blackot, Tiger, Vaiolet, Emesh-peachcot). Takođe se radi na stvaranju sorti bele boje pokožice i mesa, kao i sorti kasnog vremena zrenja.

Srbija. U poslednjih 20 godina priznato je sedam novih sorti kajsije, koje su uglavnom nastale putem selekcije iz prirodne populacije. Na Agronomskom fakultetu u Čačku stvorene su tri sorte: Biljana, Vera i Aleksandar (Paunović, 1996). Na Poljoprivrednom fakultetu u Novom Sadu stvorene su četiri sorte: NS-4, NS-6, Novosadska rodna i Novosadska kasnocvetna (Đurić et al., 2005).

Zaključak

Tokom poslednje dve decenije u svetu je stvoreno oko 500 novih sorti kajsije. Najviše sorti je nastalo u SAD, Francuskoj, Italiji, Rusiji, Španiji, Rumuniji, Ukrajini i Češkoj. Najveći broj novih sorti nastao je metodom planske hibridizacije, a znatno manji broj putem klonske selekcije i selekcije iz prirodnih populacija.

Najznačajnija dostignuća u oplemenjivanju kajsije su: produžetak raspona sazrevanja (više od tri meseca), otpornost na virus šarke šljive, otpornost na zimske mrazeve, povećanje krupnoće ploda, privlačniji izgled ploda (naročito prisustvo dopunske crvene boje na većem delu površine ploda), poboljšanje kvaliteta ploda (veća čvrstoća mesa, veći sadržaj šećera).

Mnoge nove sorte kajsije ističu se dobrim biološko-proizvodnim osobinama i predstavljaju značajno poboljšanje u odnosu na postojeći sortiment u pogledu prilagođenosti ekološkim uslovima, izgleda i kvaliteta ploda, rodnosti, otpornosti na prouzrokovače bolesti. Njihovo uvođenje u proizvodnju doprineće povećanju ekonomskih efekata gajenja kajsije.

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Achievements in Apricot Breeding in the World

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Summary

This paper presents the objectives and methods of apricot (*Prunus armeniaca* L.) breeding and the most significant results in the creation of new cultivars in the last 20 years. During this period, about 500 new apricot cultivars were created in the world. The largest number of new apricot cultivars was created in the United States, followed by France, Italy, Russia, Spain, Romania, Ukraine, and the Czech Republic.

The apricot cultivar development is dominated by the public sector (more than 60%), while the private sector is less involved. Private breeding programs take place only in few countries: the United States, France, Italy, Spain, Germany, Israel, and Australia.

The majority of new cultivars was obtained by controled hybridization. Much smaller number was obtained by clonal selection or selection from natural populations.

The most important achievements in apricot breeding are: extension of the harvest season (over three months), resistance to Plum Pox Virus, winter frost hardiness, increase in fruit size, more attractive fruit appearance (extensive red blush on the skin), better fruit quality (higher firmness, higher sugar content).

Many new cultivars of apricots represent a significant improvement over the existing assortment in terms of adaptation to environmental conditions, fruit appearance and quality, yield, and resistance to diseases. Their cultivation will contribute to increasing the economic effects of apricot production.

Key words: *Prunus armeniaca*, breeding, cultivars, hybridization, clonal selection.

Invited lecture

TRENDS IN APRICOT AND PEACH INDUSTRIES IN ITALY

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Abstract. Peach and apricot represent two of the main species of the Italian fruit industry, about 25% of the national area planted with fruit trees. Within EU, Italy is the leader for apricots and peaches, with an average production of 220,000 and 1,600,000 t, respectively. About the final destination, Italian peaches and nectarines are meant for the fresh market, and only about 6% of the total acreage is cultivated to canning peaches and about 22% (350,000 t) is exported. In apricot the share for the processing industry (mainly juice) is 38%, the internal fresh market demands around 53% of the total production, while the export is about 6-7%, and Italy is a net importer of apricots. There is a wealth of new cultivars for both apricot and peach, coming either from abroad (USA, France, etc.) or from national breeding programs, allowing a wide choice either for fruit quality and disease resistance (PPV virus, brown rot, powdery mildew). Several stocks are available in peach with a vigour ranging from 120% (e.g. ‘GF 677’) to 60% (e.g. ‘Sirio’) compared to peach seedlings. In contrast, the choice of suitable rootstocks for apricot is very limited to a few myrobolan clonal or European plum selections. In Italy there are mainly two orchard systems for apricot and peach: i) trees managed from the orchard floor, in order to reduce the labour cost for pruning, thinning and harvest; ii) trees managed from picking platforms. About the management of the orchard and disease and pest control the majority of the growers, and particularly those belonging to professional associations, follows the ‘integrated production’ guidelines.

Key words: fruit tree culture, orchard, horticultural techniques, cultivar, rootstock, training system.

Cultivated area and production of apricots and peaches in Italy

Peach and apricot represent two of the main species of the Italian fruit industry, about 25% of the national area planted with fruit trees (Istat, 2010). Within EU, Italy is the leader for apricots and peaches, with an average production of 220,000 and 1,600,000 t, respectively (FAO). Changes in the cultivated area depend on market demand, available cultivars and horticultural techniques.

In the last 10 years peach shows variable trends in terms of new plantation, depending on the varietal group: while standard peaches are constantly decreasing (-13% from 2001 to 2010, Figure 1), nectarines are showing a substantial hold.

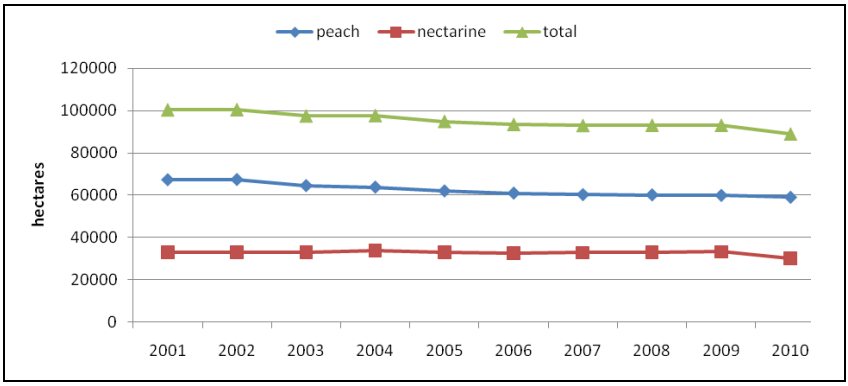

Figure 1. Peach surface trend in Italy

The situation is different depending on the area; in northern Italy the decrease is about 30% while in the southern area there is an increase of 9% in peach and nectarine new orchards (Fideghelli, 2012). The main regions are Emilia-Romagna (northern Italy) and Campania (southern Italy) that represent together about 50% of total national production, followed by Piedmont, Basilicata, Sicily and Calabria. In northern Italy, mainly in Emilia-Romagna, nectarines represent 50% of the new orchards (peach and nectarines), while in southern Italy peaches are preferred, except in Basilicata where 47.4% are nectarines (Fideghelli, 2012). The production trend is less affected than the decrease in acreage: a total 4% (peaches and nectarines), due to the new highly productive cultivars and improvement in management techniques (Figure 2).

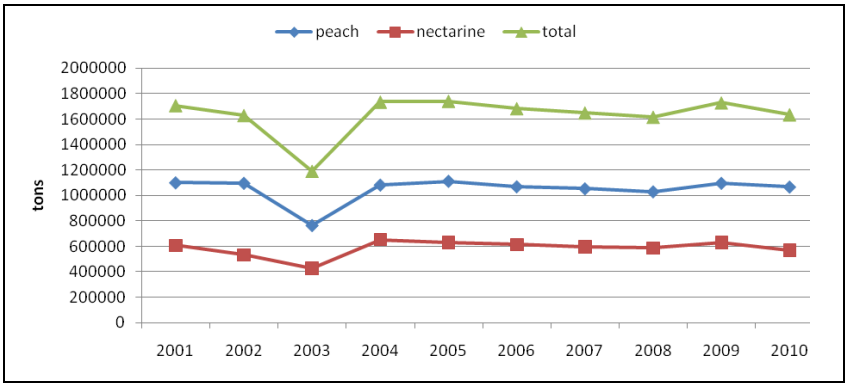

Figure 2. Peach production trend in Italy

About apricot, the total acreage in 2010 is 18,304 ha, with an increase of 9% (1,468 ha) from 2001 to 2010 (Istat, Figure 3).

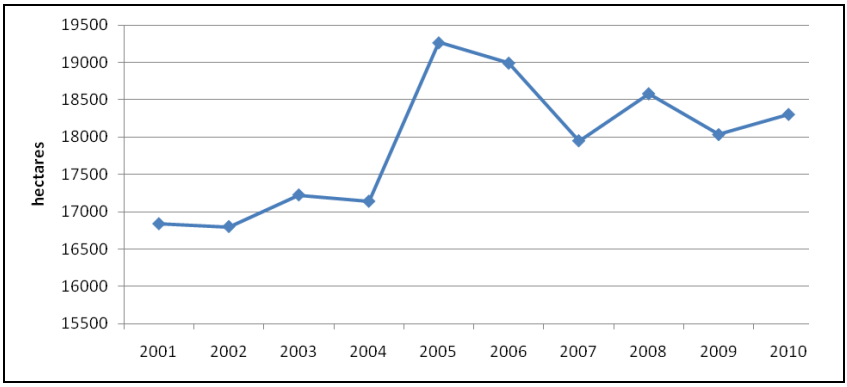

Figure 3. Apricot surface trend in Italy

Main production regions are Emilia-Romagna (4,870 ha), Campania (4,753 ha), Basilicata (3,760 ha) and Piedmont (1,043 ha), being Emilia-Romagna the leading region in terms of new orchards (648 out of a total of 994 ha: Pallotti, 2012). In this region apricot is replacing peach, particularly in the lowlands where new late cultivars ripening until the end of August are planted. The production has been growing steadily, with an increase of 29% from 2001 to 2010 (Figure 4).

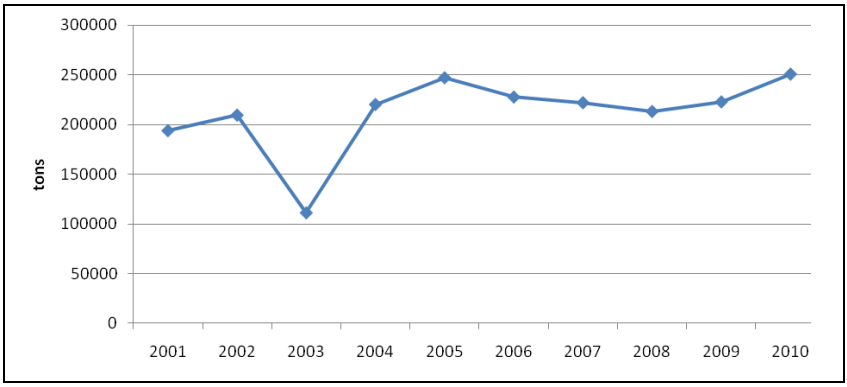

Figure 4. Apricot production trend in Italy

About the final destination, Italian peaches and nectarines are meant for the fresh market, and only 6.3% of the total acreage is cultivated to canning peaches (Fideghelli, 2012). Fresh produce is mainly for the national market, but about 22% (350,000 t) is exported, 100,000 t for peaches (decreasing) and 250,000 t for nectarines, stable since 2005 (Macchi, 2012). Comparing 1996-98 to 2006-08, the export dropped by 10%, while the import grew by 78%, around 29,000 t (Fideghelli,

2012). At the same time Spain, the major competitor of Italy, has significantly increased its export.

In apricot, the share for the processing industry (mainly juice) is 38%, with a marked difference between northern and southern productions, where 30 and 50% are sent to processing, respectively (Pallotti, 2012). The internal fresh market demands around 53% of the total production, while the export share is about 6-7%, slightly decreasing over the last years (Macchi, 2011). Italy is a net importer of apricots, about 25,000 t per year (Pallotti, 2012). Import comes from Spain for the early season (around 8,000 t) and France for the late season (22,000 t).

Consumer demand

About 6-7% of the national food and beverages expenditure is dedicated to fruit and vegetables, peaches and nectarines representing 8%, while apricots barely reach 1.5%.

Penetration index (number of families consuming fruit at least once a year) is over 80% for peaches and about 60% for nectarines. This index is stable for peach and increasing for nectarines since 2002, when it was 55%. Peaches are preferred in the southern regions while in the north nectarines are the most widely consumed. Consumption is decreasing for peaches (11 kg/family/year, while it was 16 kg at the beginning of the 2000's) and stable or in slowly decrease for nectarines (7 kg/family/year, while it was 8 kg at the beginning of 2000's (Lodi, 2010).

Consumption is concentrated within June and October, with a peak in August. While peaches are evenly distributed between retailers (51%) and supermarket chains (44%), for nectarines the supermarkets represent the largest market share (61% against 34%). Average price is 1.50 €/kg for peaches and 1.80 €/kg for nectarines, slightly increasing for the latter (Lodi, 2010).

In apricot the penetration index is increasing from the 2000's, with an average value of 70% compared to 2007. However, consumption is decreasing, about 4.5-5 kg/family/year, and is concentrated in June, July and August, with 17,000, 23,000 and 20,000 t, respectively (Lodi, 2011). In the last years, consumption is increasing in August and September thanks to the introduction of new late ripening cultivars (Pallotti, 2012). Apricots are evenly distributed among specialized retailers and supermarket chains (about 50% each); average price is about 2-2.30 €/kg, (Lodi, 2011).

About fruit type and quality there is a higher differentiation in peach than in apricot. Within peach, consumer can choose for smooth (nectarine) or fuzzy skin, colour flesh (yellow and white), flavour (acidic or low acid), flesh texture (melting, non-melting, 'slow ripening' and stony hard), and for fruit shape (round and flat). Yellow peaches and nectarines are the most popular, while the white fleshed is only a small niche. However, white nectarines is the last varietal fruit type introduced in commercial orchards, and in the future it might increase its market share.

About consumer preference several surveys have shown that, for peach, a round-oblate shape is preferred while for nectarine is better accepted a round, slightly elongated shape (Liverani et al., 2008). Consumers do not like the prominent tip, commonly found in early peaches from southern regions.

The EU project ISAFRUIT (2006-2010) has focused its attention on peach consumer acceptance showing that external appearance is not affected by the amount of overcolour, but rather by the intensity of the yellow ground colour (Liverani et al., 2008). About the taste, low acid fruits with a high solid soluble content (SSC), over 14°Brix, are well accepted by the majority of consumers (approximately 80%). In a 2007 summer survey, ‘Big Top’ nectarine taste has been defined “very good” for the 70% of the consumers. Other than sweetness, juiciness and crispiness are other characteristics sought by peach consumers. Most complained by consumers is the presence of fruit batches homogeneous for the appearance (external overcolour), but not for taste, due to the uneven ripening or, worse, to cultivars mixture.

In apricot the varietal assortment is less varied than in peach. There are slight differences on fruit shape (round or elongated) and for taste: only in recent years the first cultivars with low acid taste have been introduced (mostly from Spain). Now the major differences are the skin coloor, light yellow in the old cultivars, orange with red blush and firm flesh in the recently released ones. Consumer demand is about the appearance (bright blush) and for fruit flavour. The taste should be sweet and juicy, with melting flesh (Pallotti, 2012). However, overall appreciation is determined by flavour and aromatic compounds (Mellano, 2006). Several surveys show a preference for appropriate SSC/acidity ratio in order to meet consumer acceptance: this ratio should be around 0.5-0.7. Furthermore, while the least threshold for SSC is 14° Brix, for the acidity it is below 20-25 meq/100 g (Mellano, 2006). Other complains by consumers are batches of fruits of uneven ripening, and mealy flesh (Pallotti, 2012).

Fruit quality ideotypes

Below are some of the objectives of two Italian breeding programs, one State funded (CRA-FRF in Forlì) and one mostly private (MAS.PES.), both located in Emilia-Romagna (Bassi et al., 2010a; Bassi et al., 2010b; Bassi and Foschi, 2011). Since 2003 the activities of apricot and peach breeding in MAS.PES are co-ordinated by CRPV (a local professional organization), and co-financed by the administration of Emilia-Romagna Region and by four producers organizations (Apofruit, Apo-Conerpo, Orogel Fresco and Pempa-Corer), with the scientific contribution of the Universities of Bologna and Milan. The breeding program is aimed at the introduction of apricot and peach cultivars to be grown in Emilia-Romagna, enhancing the trait of environmental adaptation, fruit quality and resistance to major diseases (such as PPV - Sharka virus in apricot, powdery mildew and brown rot in peach). Reference ideotypes for new apricot and peach cultivars selection are shown in tables 1 and 2. Since 2007 a third source of co-financing was added by several bank foundations, specifically meant for the development of strategies for MAS

(molecular assisted selection). For this reason, the project has been named ‘MAS.PES’ (PES, for ‘peach’ in Italian: *pesco*). The project is thus recurring to both traditional techniques (cross-breeding by hand) and selection procedure based on genomic tools, other than on phenotypic traits.

Table 1. Reference ideotypes for new apricot cultivars selection (MAS.PES project)

Goal	Description
Final destination	- Fresh market: priority interest - Processing (drying, juice, frozen), suitable for mechanical harvesting: marginal interest
Tree	- Self-fertile - Growth habit: regular, expanded, easy to be trained (open vase or palmette) - Ripening season: from 15 May to 31 August - Resistant to PPV
Fruit	- Resistant to cracking (from rain) - Pre-ripening fruit drop: none - Shape: oblong or elliptic (priority), round - Size: uniform within the tree, minimum weight: 70-90 g, (60 g only for very early or very late) - Ripening: uniform within the tree and the fruit - Firmness/texture: high, melting type (primary interest); non-melting flesh (e.g. ‘Kyoto’); high ‘keeping’ (slow ripening) - Overcolour (in order of priority): a. bright red on most of the surface, with a yellow background b. only partly blushed, with a yellow background c. deep orange (poor or no overcolour) - Stone: free (without cavity)
Organoleptic traits	- Flesh: bright yellow or orange, juicy - Sugar content (°Brix): 12.5 (early season); 13-15 (middle season); over 15 (late season); over 17 (August) - Titrable acidity (meq): no more than 20-25 - Aroma: ‘tipical’ of apricot (e.g.: ‘Reale di Imola’)
Shelf life	- At room temperature: 7 days - Refrigerated: 21 days
New fruit types	- White flesh (aromatic) - Glabrous (fuzzless) skin

The actions from the traditional breeding program led to the commercial introduction of the early ripening, yellow peaches ‘Bordò’ and ‘Pulchra’, yellow nectarines ‘Rebus 028’, ‘Rebus 038’, ‘Rebus 195’, ‘Dulciva’ and apricots ‘Bora’, ‘Petra’ and ‘Pieve’.

From the works of MAS.PES, a set of QTLs (stretches of chromosome where it is likely the presence of a trait of interest) linked to fruit size, date of ripening, over colour of the skin, flesh total content of organic acids and sugars, resistance to powdery mildew and brown rot, as well as molecules responsible for the aroma of

the fruit, have been identified (Dondini et al., 2010; Eduardo et al., 2010; Eduardo et al., 2011; Ghiani et al., 2011; Pacheco and Bassi, 2010; Ruiz et al., 2010).

About CRA-FRF cultivars, yellow nectarines ‘Alice-col’ and ‘Alitop’, white peaches ‘Alipersiè’, ‘Aliblanca’ and ‘Alirosada’, and flat peaches ‘Platiforone’ (yellow flesh) and ‘Platifortwo’ (white flesh), have been recently introduced.

Table 2. Reference ideotypes for new peach cultivars selection (MAS.PES project)

Goal	Description
Varietal type	- Nectarines and peaches with yellow flesh: priority interest - Nectarines and peaches with white flesh: secondary interest - Non melting (for canning) or flat fruit: marginal interest
Tree	- Growth habit: regular, expanded, easy to be trained - Ripening season: from 1 June to 15 September
Fruit	- Shape: round, even. - Size (in priority order): 180-200 g, 200-220 g, 160-180 g, uniform within the canopy) - Ripening: uniform within the tree and within the fruit. - Flesh texture: melting, but slow-softening (e.g. ‘Big Top’ for nectarines and ‘Rich Lady’ for peaches); non melting (limited interest), stony hard (limited interest) - Skin overcolour: bright red on most of the surface with a yellow background - Stone: free from flesh (but not detached, and cavity-free), or either adherent (particularly for the late ripening season)
Organoleptic traits	- Flesh: juicy - Soluble solid content (°Brix): 12 (early season), 14 (middle season), 16 (late season), 18 (flat fruit) - Titrable acidity (meq): 11-15 (regular type, balanced flavour); 5 (minimum content for the “honey” type); acidic: 19-20 meq (at least 14-15 °Brix)
Shelf life	- At room temperature: 5-7 days - Refrigerated: 21 days

Improving peach fruit quality by breeding

Peach fruit is characterized by well-differentiated flesh types, particularly for the texture and the speed of softening. These features allow to distinguish varietal groups characterized by diverse end-uses, from fresh market to processing (juice, canning, fresh-cut, etc.). The main flesh types found in the known germplasm are, other than the standard melting and non-melting, the slow softening (as in ‘Big Top’ nectarine) and the stony hard.

Slow softening. The extraordinary success of the ‘Big Top’ nectarine is to be found primarily in the peculiar combination of some key features: extended and early skin overcolour, crispy flesh and a very sweet (slightly low-acid) flavour: the last two traits allows the fruit to be eaten when not fully mature (Bassi et al., 2010a).

The more interesting trait from the point of view of both field and shelf-life operations is the peculiar slow softening pace of the flesh. This character, however, is not exclusive to this nectarine (or other similar accessions, derived from it), because it can be found also in standard (fuzzy) peaches, e.g. the series ‘Rich’ and ‘Royal’, not to mention the old ‘Merril Gem’ which perhaps is one of the putative donor of this trait. However, this phenotype is to be regarded as belonging to the traditional ‘melting’ trait, but with a slower rate of softening, allowing an extended shelf-life.

Stony hard. The stony hard flesh, featured in many peaches from the Far East, has traits of great interest: no softening at all, even when fully ripe, high ‘keeping’ ability (up to three weeks on the tree), crunchy texture (and not rubbery, like the non-melting phenotype), no ethylene production, the only known case in peach. Although not yet spread in the western hemisphere, a first cultivar ‘line’ has been introduced by CRA (Rome) from the self-pollination of the Korean, white-fleshed ‘Yumyeong’, under the name of ‘Ghiaccio’ (ice, in Italian) because of the appearance of the fruit (white flesh, with no anthocyanins). This line consists of several selections, also characterized by a very high SSC (over 18-20 °Brix) when fully ripe. The limits of the known so far stony hard flesh accessions, can be found in the very low acidity, which gives a very ‘flat’ flavour, and in the very poor ‘peach’ taste. From the commercial point of view, the great advantage of this type of flesh is the very long shelf life. Compared to the non melting phenotype, with a good shelf-life either and also a strong ethylene producer, it is however less juicy and with no aroma. In any case, for its commercial exploitation, alternatives to fresh market are to be found, such as the fresh-cut chain.

Peaches with differentiated flavour

Obtaining fruits with high ‘keeping’ ability (characterized by a slow rate of softening), have to be coupled by enhanced flavour, which is known to be influenced by acids and sugars content, mainly.

The acidity is easily modifiable thanks to a dominant Mendelian trait (called *D*, for ‘*douce*’, sweet, in French) that causes a lack of synthesis of malic acid, inducing a titratable acidity from two to four times lower than the ‘acidic’ type, and for this reason the phenotype is called ‘low acid’. However, the acidity is also influenced in a quantitative fashion, since it can range from below 5 up to over 18 meq. The ‘D’ phenotypes show no more then 7-8 meq and are also called ‘honey type’, when a very low acidity is accompanied by a sugar content above 14-15°Brix.

The sugar content in the majority of the commercial cultivars ranges between 9 and 15°Brix, but can be higher than 25°Brix (regardless of the level of acidity), with the lowest values found in early ripening genotypes.

Taking into account the characters known today, different phenotypes with distinct flavour can be obtained, featuring peculiar combinations of acids and sugars content (Table 3). Considering the main ripening stages (early, middle and late) and the breeding stock available, a rise of two degrees Brix could be easily achievable,

compared to the cultivars available today, reaching 12°Brix for the early, 14 for the middle and 16 (or above) for the late ripening, putative new cultivars.

Moreover, according to the variability induced by the component ‘acidity’, the new obtainable cultivars could be classified into three main groups (sweet or low-acid, balanced and sour), with values in titratable acidity ranging from 7 to 11 (for values below the flavour is too ‘flat’), from 11 to 15 and over 15 meq, respectively.

Table 3. Peach commercial types of on the basis of the of some flavour fruit traits

Flavour	Flesh texture	Regular / Low acid	Brix (%)	Acidity (meq)
1. REGULAR (balanced flavour)	SS [1]	R	12-16	11-15
1a. Acidic	SS	R	14-15	19-20
2. SWEET	SS	L	12-16	5-10
2a. Very sweet	SS	L	> 17	5-10
3. LOW-ACID	SS, melting, stony hard[2]	L	> 14-15	< 5

[1] SS: slow softening flesh, like ‘Big Top’ nectarine
[2] The flesh is crispy and not juicy, it does not soften at physiological maturity

Very-very early ripening cultivars ready-to-eat (softstone). The production of early ripening cultivar is always advisable for the grower, since the fruit can be easily sold at a good price, but small size is often a problem. Two very-very early ripening cultivars (end of May in the lower Po valley, ripening together with the first apricots and cherries, ‘Borgia’ and ‘Lucrezia’ (Bassi and Rizzo, 1994) were obtained, characterized by a very peculiar trait: a very limited lignification of the stone, thus the fruit can be eaten almost whole (stone included). However, there are two limitations: the presence of amygdalin in the seed and the stone partial lignification at full ripening. These limitations can be eliminated via breeding by crossing with parents without amygdalin in the seed (Mendelian trait, recessive) and harvesting the fruit at commercial maturity.

Improving apricot fruit quality by breeding

Apricot fruit shows less variability compared to peach, however several phenotypes could be observed taking into account the commercial cultivars and the breeding stock available. Shape could be selected either oblong or round and in terms of flesh texture and ‘keeping’ ability there are some traits similar to the non melting trait in peach that can be selected. One peculiar phenotype features a very high firmness at full ripening, although the inner part being soft and juicy. Concerning flavour, a strong role is played by skin acidity that can be very sour, thus negatively affecting the overall fruit flavour. Luckily, skin and fruit acidity are not genetically linked, thus is rather easy to select independently for these two traits. In addition, flesh acidity should be below 20-25 meq in order to enhance fruit flavour. Sugar content could be improved by breeding, easily overcoming 18-20°Brix in the late ripening season.

Resistance to diseases

Obtaining new commercial cultivars showing disease resistance and with enhanced fruit quality, as described above, is an ambitious goal that requires several generations of crossing to be achieved, especially if in a single genotype more resistance traits are to be combined. This objective is pursued primarily in breeding programs where public institutions are involved, where the achievement of a 'new' cultivar includes also the introduction of valuable characters for sustainability, as resistance to diseases, and not just a mere better appearance.

Resistance to brown rot in peach fruit. In environments characterized by high air humidity and frequent rainfall at harvest time, conditions more frequent in northern than in southern Italy, the main problem is fruit brown rot (*Monilinia* spp.), both on tree and along the postharvest chain. In peach germplasm there is no completely resistance, but only tolerance, such as in the yellow peach 'Contender' and in the Brazilian, non melting yellow, 'Bolinha', other than in some cultivars of Mexican origin and from the Far East. The best selections issued from the breeding program using these resistant parents are trialled for the introduction as new putatively resistant cultivars (Pacheco and Bassi, 2010).

Resistance to powdery mildew in peach. The main source to introduce the resistance to powdery mildew is the accession of South American origin 'Oro A', characterized by very low sensitivity. After crossing with cultivars such as 'Babygold 6', 'Bolero', 'Cresthaven' and 'Red Top', it has issued selections showing a very good tolerance to the pathogen, which are now being used to enlarge the genetic basis of the resistance within the breeding stocks of the two programs mentioned above (Liverani et al., 2003).

Resistance to sharka virus (PPV) in apricot and peach. The sharka or plum pox virus (PPV) is mentioned by all the international phytosanitary agencies as the most dangerous pathogen that affects the stone fruit industry, apricot, plum and peach in particular. In Italy the situation has become alarming since the late '90s, when in several peach orchards in northern Italy was isolated the M strain, the most virulent one. In 2007, the first national research project was funded by the Italian Ministry of Agriculture ('Breeding peaches for the control of sharka virus', or 'PPVCON'), coordinated by CRA-FRF (Forlì). As sources of resistance, since in peach it has not been found yet, some hybrid ('Summer Grand' x *Prunus davidiana* L.) by INRA-Avignon and hybrids of almond x peach (by the University of Davis, California) have been used. As parents to improve fruit traits, commercial cultivars and promising selections were used. Most of the progeny showed intermediate traits compared to the parents, even if the inferior fruit quality inherited from the resistant parent often prevails. Recent findings have shown some source of tolerance to PPV also in peach, particularly in old or obsolete accessions that show a prominent delay in PPV symptoms appearance, e.g. in 'Buco Incavato', 'Capucci 18', 'Kamarat', Maruja', or 'Pieri 81' (Palmisano et al., 2009) or in one of the 'Ghiaccio' (stony hard) selections and in 'Sagittaria', a recently released Italian yellow peach.

However, these preliminary findings have to be confirmed by more deep investigations.

About building PPV resistance in apricot, the situation is less severe, particularly because several accessions showing either partial or complete resistance are known (e.g.: ‘Harcot’, ‘Harlayne’, ‘Orangered’, ‘Stark Early Orange’, etc.) and being employed as parent to transmit resistance. In the framework of an European project finished at the end of 2013 (Sharco), the genetic bases of the resistance have been unveiled, discovering at least two major genes. Molecular markers valuable for assisted selection are close to being released. Within the recent outcomes of the MAS.PES project, the early ripening ‘Bora’ apricot resistant to both D and M PPV strains has to be mentioned (Bassi et al., 2002), now widely grown both in northern and southern Italy.

Cultivars

Thanks to high number of breeding programs around the world, in the last 20 years the range of cultivars for apricot and peach has been revolutionized. From 1980 to 2007, 563 apricot cultivars (544 *P. armeniaca*, 12 *P. mume*, 5 hibrids *P .mume* x *P. armeniaca*, 2 *P. sibirica*) have been released (Fideghelli, Della Strada, 2010). At the same time, the total number of new cultivars for peach is 2584; another survey for peach from 1997 to 2006, shows that 516 peaches, 419 nectarines and 50 canning peaches have been released (Fideghelli, Della Strada, 2008).

In apricot the increase of new released cultivars starts in mid 1990s, due to breeding activities in several countries, the most important being USA, France, Italy, Romania, Czech Republic and Spain (Fideghelli, Della Strada, 2010). In peach the main contributions are from USA (43% of total new patented cultivars), France (16%), Italy (12%), China (8%) and Spain (6%) (Fideghelli, Della Strada, 2008). Many new introductions have been tested in Italy, thanks to the activity of different experimental stations (public and public/private) located all over the country, and national growers organizations. The results reported below are mainly from the “List of Recommended Fruit Varieties” project, sponsored by the Italian Ministry of Agriculture (MiPAAF) and by Regional administrations, running in several research centers: CRPV (Crop Research Center, Emilia-Romagna,), CReSO (Research and Experimentation Center on Fruit and Vegetable, Piedmont) and AASD “Pantanello” (Regional Experimental Farm, Basilicata), etc.

Apricot cultivars

Often the new apricot cultivars have been selected in environmental conditions noticeably different for those of the main Italian apricot growing areas, thus showing poor environmental adaptability, and yield failure (Massai, 2010). Introducing new apricot cultivars in Italy is very difficult due to different climatic and soil condition along the country: chilling and heat requirements, susceptibility to bacteria and

spring frost tolerance are the main restraints to their widespread cultivation. This stresses the importance of improving the knowledge on biology and phenology of the new cultivars by field testing before they are introduced in a new environment (Guerriero and Monteleone, 2006, Guerriero et al., 2006; Pennone et al., 2006).

Several new cultivars have been introduced from the mid 1980s, mainly from USA and Canada, improving fruit size and appearance (orange ground colour with red blush), flesh firmness and extended shelf life (Berra, 2010). However, flavour is not as good in all the new introductions. Most of the old local cultivars, grown for processing (particularly in southern Italy), have been replaced by those new cultivars, also extending the ripening season from 40 to 90 days in northern and from 20 to 70 days in southern Italy (Berra, 2010, Mennone, 2010). The new cultivars have been introduced mainly in Piedmont, Emilia-Romagna and Basilicata, rather than in Campania (Borrelli, 2011).

The most important cultivars recommended for three main Italian apricot districts, Emilia-Romagna, Piedmont and Basilicata, with main positive and negative features, are shown in table 4. Still recommended old local cultivars are not included in this note. In the early season, beside the old ‘Aurora’ for northern Italy, and ‘Ninfa’ (southern Italy, well adapted for under plastic production), ‘Wondercot*’ and ‘Spring Blush® EA3126*’ are spreading, bearing orange skin and medium-large fruit; flavour is medium and pollinators are required. ‘Pinkcot® Cotpy*’ and ‘Bora® BO 90610010*’ ripen two weeks earlier than ‘Kioto*’ and are preferred for their earliness, high yield, fruit size and nice appearance. Also ‘Orange Rubis® Couloumine*’ is to be mentioned, with good appearance and flavour (low acidity), but of uneven ripening on the tree. ‘Kioto*’ has replaced the old ‘San Castrese’ for the medium season for its high and reliable yield over the years, also due to a very late blooming; however, early thinning is required in order to produce marketable fruit size. Two days before the old ‘Portici’ ripens ‘Pieve*’, another ‘MAS.PES’ cultivar with excellent flavour and good appearance, with extended red blush over an orange ground colour. In the late season ‘Petra® BO88617102*’ (early July), another ‘MAS.PES’ cultivar, ‘Faralia*’ and ‘Farbaly*’ (late July) are spreading, all self fertile with high yield and good fruit quality.

Peach cultivars

Fresh market cultivars planted in Italy come from several public and private breeding programs around the world, mainly from USA, France and Italy. Since several years a change from traditional flavour to low-acid or high sweet fruit has been occurring. The preferred fruit shape is round-oblate, with and extended bright red over colour, and slow ripening, crispy and juicy flesh, as in ‘Big Top’ nectarine. The more planted cultivars are reported in tables 5, 6, 7 and 8, with main positive and negative features.

About yellow peaches there is a ripening window of 90 days in northern and 120 in southern Italy, with a predominance of the traditional flavour. Among the new

introductions, ‘Sagittaria*’, ‘Bordò*’, ‘Sugartime*’ and ‘Royal’ series, with extended over colour and high yield are to be mentioned, while the old ‘Maycrest® Minastar*’, ‘Maria Marta’ and ‘Suncrest’ are no longer recommended, either for poor flavour or blush. There are very few novelties and orchards for white fleshed peaches, because of the soft flesh and the limited interest of the large retailer chains. Nectarines, both yellow and white flesh, have undergone a dramatic change in recent years, with a predominance of low acid or very sweet flavoured fruit, with round or slightly oblong shape and extended bright red over colour. The more spread cultivars are ‘Big Bang®’, ‘Rebus 028*’ and ‘Sugartime*’ in the early season, ‘Big Top®’, ‘Alitop*’ and ‘Romagna® Big’ in the mid season, all with low acid flavour. For the late season ‘Lady Erica®’ will be probably replaced by the new ‘Dulciva*’, with more over colour and sweet and aromatic taste. Many novelties have been introduced for the white flesh nectarine, as for the ‘Romagna®’ series, other than ‘Magique®’ with large, blushed and good sweet taste fruit. ‘Romagna® Red*’ is planted because its fruit flavour and appearance in early season, while ‘Romagna® Top*’ for the mid season and ‘Nectaperle®’ series are arousing great interest among growers.

Rootstocks

Several stocks are available in peach with a vigour ranging from 120% (e.g. ‘GF 677’) to 60% (e.g. ‘Sirio’) compared to peach seedlings. In contrast, the choice of suitable rootstocks for apricot is very limited to a few myrobolan clonal or European plum selections (Table 9).

In apricot the most useful rootstocks is ‘Myrobolan 29C’, since it induces early fruiting, large fruit size and wide adaptability, particularly for lime and calcareous soils (Foschi et al., 2012a), but suckers is the main blemish. New promising clonal rootstocks are ‘Ishtara® Ferciana*’ and ‘Penta*’, with medium to low vigour, high yield and fruit size and very poor (or none, as in ‘Penta*’) suckering (Missere et al., 2010). ‘Ishtara®’ is also suitable for peach, mainly in northern Italy for high density planting (HDP). ‘Montclar® Chanturgue*’ is recommended in good soil for apricot, due to its high vigour, early fruiting and large fruit size.

In peach about 70% of total orchards is still grafted onto ‘GF677’ due to its high vigour, large soil adaptability and very good nursery management (Montanaro et al., 2011); summer pruning is recommended in order to avoid internal shadow and low fruit quality. ‘Adesoto® 101 Puebla*’ is preferred when tolerance to soil sickness or to *A. mellea* are required; vigour is lower 20-25% than ‘GF677’ and fruit ripening is earlier (3-7 days), depending on the cultivar (Missere et al., 2010). Rootstock ‘Ishtara® Ferciana*’ is also spreading in HDP peach systems due to its graft compatibility, low vigour (similar to ‘Adesoto®’) and no suckering; fruit quality is very good for red over colour and high solid soluble content, while fruit ripening is earlier than in ‘GF677’. Limited interest have had both ‘Cadaman® Avimag*’ and ‘Barrier 1*’, high vigour rootstocks showing no real improvement compared to ‘GF677’ for fruit quality and yield.

Table 4. Apricot cultivars for Italy and their main features

Cultivar	Date of ripening[1]			Self-fertility	Pollinators advised	Positive features	Negative features
	ER[2]	P[3]	B[4]				
Wonder Cot*	-37			no	Bora®, Lilly Cot*, Goldrich	fruit appearance, early ripening	pollinator required, split pits
Aurora*	-34			no	Bora®, Lilly Cot*, Goldrich, Tom Cot®, Pinkcot®, Big Red®, Sweet Red®, San Castrese	precocity and flavour	very soft flesh
Ninfa*			-28	yes		high productivity, also under greenhouse in southern Italy	poor flavour
Margotina*	-32			yes		production and appearance	small fruit size
Spring Blush® EA3126*	-32	-28		no	Bora®, Pinkcot®, Goldrich, San Castrese	fruit appearance, early ripening	pollinator required, acidic flavour
Lunafull*	-25			no	Bora®, Stella*	fruit appearance and size	pollinator required, medium flavour (sour)
Primaya*	-20			no	Farbali*	fruit appearance and size	medium flavour (low SSC)
Lilly Cot*	-15			yes		productivity, fruit apperance	small fruit size
Pinkcot® Cotpy*	-15	-19		no	Portici, Bora®, Aurora, Tom Cot®, Sweetcot®, Spring Blush®, Big Red®, Sweet Red®	fruit appearance and size	pollinator required; acidic skin; cracking after rain
Bora® BO 90610010*	-13			partial	Portici, Pinkcot®, Sweetcot*, Robada*	PPV resistance (D and M strains); fruit appearance and flavour; no sensitive to fruit drop	bacteria sensitivity on flowers (*Xanthomonas* spp.)
Sweetcot® Toyuda*	-12			partial	Bora®, Pinkcot®, Robada*, Portici, Goldrich, Vitillo	sweet flavour and fruit size	medium-low yield (southern districts), yellow skin no blush
Antonio Errani			-11	no	Goldrich	sweet flavour	soft flesh
Big Red® EA4006*		-11		no	Tom Cot®, Aurora, Pinkcot®, Spring Blush®, Sweet Red®	fruit appearance	pollinator required, small fruit size
Flopria*	-10			yes		productivity, fruit apperance	medium flavour due to acidic skin
Perle Cot*		-10		no	Tom Cot®, Flavorcot®, San Castrese	fruit appearance	medium flavour, flesh internal browning
Orange Rubis® Couloumine*	-9			yes		productivity, fruit apperance, low acid flavour	fruit uneven ripening

Robada*	-8	-11	-8	no	Petra®, Orange Rubis®, Bora®, Flavorcot®, Sweetcot®, Pinkcot®, Portici, San Castrese, Vitillo	productivity, fruit apperance and size	pollinator required, acidic flavour
Bella d'Imola	-7		-7	yes		productivity and fruit size	acidic skin
Goldrich	-4			partial	Bora®	fruit size and flesh texture (firm)	pollinator required, necrotic spots on fruit
Vitillo			-4	yes		productivity and fruit size	poor flavour and appearance (light yellow colour)
Laycot*		-3		no	San Castrese, Bella d'Imola	fruit appearance and aromatic flavour	only for northern Italy, mainly in Piedmont
Kioto*	25/6	7/7	18/6	yes		productivity and fruit appearance	medium flavour, requires intensive thinning
San Castrese			0	yes		productivity	poor flavour
Flavorcot® Bayoto*	+2	-5		yes		productvity, easy to manage tree, sweet flavour	fruit drop and small size
Pieve*	+5			yes		productivity, fruit apperance and flavour	high vigour
Tonda di Costigliole		+5		yes		productvity, sweet flavour	only for Piedmont, small fruit size
Portici	+6		+7	yes		productivity, fruit flavour	internal browning, fruit cracking
Petra® BO 88617102*	+8			partial	Augusta 3, Flavorcot®	sweet flavour and fruit texture (slow ripening)	light skin cracks on young trees
Lady Cot*		+8		yes		productivity, fruit appearance and flavour	mealy flesh
Zebra® Priboto*	+10	+9		no	Sweetcot®, Bora®, Tom Cot®, Flavorcot®, San Castrese	fruit size	poor flavour (too sour)
Faralia*	+20			yes		productivity, fruit size and flavour	irregular shape
Farbaly*	+45	+39		yes		productivity, late ripening	skin russeting and skin cracks
Augusta 3*	+53			yes		productivity and sweet flavour	small fruit size
Farclo*	+55			yes		productivity and late ripening	poor flavour and appearance

[1]Date of ripening (days compared to Kioto*); [2]ER - Emilia-Romagna (northern Italy); [3]P- Piedmont (northern Italy); [4]Basilicata (southern Italy)

Table 5. Yellow flesh peach cultivars for Italy and their main features

Cultivar	Date of ripening[1]			Positive features	Negative features
	ER[2]	P[3]	B[4]		
Sagittaria*	-30		-36	early ripening, extended red over colour	poor fruit size on weak shoot
Pulchra*	-30			high productivity, extended red over colour, aromatic flavour	early thinning recommended
Rich May*			-26	fruit size and appearance	flesh softening during ripening
May Crest® Minastar*			-24	high productivity, fruit size	poor over colour
Bordò*	-27		-18	high productivity, fruit size, appearance and aromatic flavour	strong vigour, summer pruning recommended
Zee Diamond*	-23			fruit size and appearance	acidic flavour, susceptible to spring frost
Sugar Time*	-20			fruit size and appearance	medium-low taste
Coraline® Monco*	-14		-7	high productivity, size, appearance	fruit size on weak shoot, upright growth habits
Ruby Rich® Zainoar*		-12	-7	high productivity, also under under greenhouse in southern Italy	fruit size on weak shoot, upright growth habits (summer pruning recommended)
Royal Glory® Zaifer*	-7		-4	fruit size and appearance	medium-low flavour, fruit skin sensitivity to bruising
Royal Majestic® Zaimajal*	-6			high productivity, appearance	fruit size on weak shoot, acidic flavour
Azurite® Monnoir*	-5		-5	fruit size and appearance	acidic flavour if harvest is too early
Rich Lady*	12/7	21/7	3/7	fruit size and appearance; slow softening	growth habits upright and strong vigour (summer pruning recommended)
Vista Rich® Zainobe*	+1	+3	0	fruit size and appearance; slow softening	growth habits and strong vigour (summer pruning recommended)
Royal Time® Zairetop*	+2	+3		fruit size and appearance	medium-low productivity
Maria Marta*	+8		+8	high production and size; recommended for juice	fruit appearance
Royal Summer® Zaimus*	+8	+8		high productivity, fruit size and sweet flavour	small fruit size
Summer Rich*		+8	+8	fruit size and appearance	fruit size on weak shoot
Diamond Princess*		+11	+10	fruit appearance and size	medium-small size on weak shoot
Grenat® Monafi*	+17		+17	high productivity, size, appearance	small fruit size and irregular shape on weak shoot
Royal Lee*	+14			fruit size and appearance	medium-low productivity
Suncrest	+17			high productivity, fruit size	fruit appearance
Simphonie*	+18		+18	high productivity, fruit size	fruit appearance
Zee Lady*	+18	+25	+19	fruit size and appearance; brown rot fruit tolerance	acidic flavour
Rome Star*		+20		high productivity, fruit size	fruit appearance

Royal Pride® Zaisula*	+25	+25		fruit size and appearance; slow softening	brown rot on fruit
Royal Jim® Zaigadi*	+32			high productivity, fruit size	acidic flavour if harvest is too early
Summer Lady*		+33		high productivity, fruit size	fruit appearance
Plusplus® Maillarplus*	+43			high productivity, fruit size	acidic flavour
Red Star*	+49			high productivity, fruit size	fruit appearance
Corindon® Moniajune*	+50			fruit size, appearance, flavour; slow softening	productivity to be verified
Lucie	+60		+67	high productivity, fruit size	fruit appearance
Fairtime*			+86	high productivity, fruit size	fruit appearance

[1]Date of ripening (days compared to 'Rich Lady*'); [2]ER - Emilia-Romagna (northern Italy); [3]P- Piedmont (northern Italy); [4]Basilicata (southern Italy)

Table 6. White flesh peach cultivars for Italy and their main features

Cultivar	Date of ripening[1]			Positive features	Negative features
	ER[2]	P[3]	B[4]		
Amanda® Zaibaro*	-35			early ripening, extended red over colour	fruit size on weak shoot, soft fruit
Onix® Monalu*	-14			high productivity, fruit size and flavour	early thinning recommended, acidic flavour if harvest is too early
Patty® Zaisito*	-4			high productivity, fruit size and appearance (extended red over colour)	acidic flavour
Alipersie*	-2	+5		high productivity, appearance	early thinning recommended
Bea			3	high productivity, size	fruit appearance)
Maura® Zaifisan*	+6		+8	productivity, fruit size and appearance, aromatic flavour	acidic flavour if harvesting is too early
Alirosada*		+12	+17	high productivity, size, appearance	acidic flavour if harvesting is too early
Greta*	+13		+5	high productivity, also under greenhouse in South Italy	fruit appearance and soft fruit
Benedicte® Meydicte*	+16			high productivity, size	fruit appearance and soft fruit
Tendresse® Julie*	+25			high productivity, size	fruit appearance and soft fruit
Tardivo Zuliani			+36	high productivity, size	fruit appearance and soft fruit
Aliblanca*		+36		fruit size and appearance; slow softening	strong vigour, summer pruning recommended
Kewina® Zaidaso*	+38			fruit appearance; very slow softening	medium-low fruit size and flavour
Maria Delizia	+40			fruit size and flavour	fruit appearance and soft fruit
Michelini		+40		high yield, size	fruit appearance and soft fruit
Douceur*			+49	productivity, sweet and aromatic flavour	fruit appearance and soft fruit
Gladys® Zailati*	+51		+52	very late and high yield, fruit size	acidic flavour if harvest is too early

[1]Date of ripening (days compared to 'Rich Lady*'); [2]ER - Emilia-Romagna (northern Italy); [3]P- Piedmont (northern Italy); [4]Basilicata (southern Italy)

Table 7. Yellow flesh nectarine cultivars for Italy and their main features

Low acid taste					
Cultivars	Date of ripening[1]			Positive features	Negative features
	ER[2]	P[3]	B[4]		
Rebus 028*	-22			early ripening, high productivity, extended red over colour, no split plit	medium size due to slightly oblonge shape
Big Bang® Maillara*	-19		-10	fruit size and appearance	split plit and sensitivity to spring frost damage
Noracila*	-11			fruit size, appearance and flavour	early blooming, spring frost susceptibility
Garofa*	-9		-2	fruit size, appearance and flavour	early blooming, spring frost susceptibility
Carene® 23-13-03*	-7			high productivity and fruit appearance	size only medium
Gartairo*	-4			fruit size, appearance and flavour	early blooming, spring frost susceptibility
Honey Blaze*	-2			fruit appearance and flavour	medium fruit size, with bacterial susceptibility
Big Top® Zaitabo*	10/7	15/7	25/6	fruit size, appearance and flavour	early blooming, spring frost susceptibility
Gardeta*	+4			fruit appearance and flavour	early blooming, spring frost susceptibility
Rebus 038*	+5			high productivity, appearance and sweet flavour	intensive thinning due to high fruit set
Honey Fire*	+7			fruit size, appearance and flavour	shape slightly oblong, early blooming
Alitop*	+8	+12	+14	high productivity, size and sweet flavour	yellow-green ground colour; skin russeting in cold climates
Romagna® Big	+11		+16	high productivity, size and sweet flavour	skin russeting in cold climates
Rebus 195*	+12			high productivity, size, no split pit and skin russeting	fruit shape slightly oblong and asymmetrical
Luciana*	+14			high productivity, appearance and sweet flavour	low fruit size
Nectapom® 28 Nectariane*		14		Fruit size, no skin russeting, sweet flavour	spring frost tolerance, pruning and tree management to be verified
Romagna® Gold	+18			high productivity, size and sweet flavour	pour overcolour fruit with asymmetrical shape
Nectapom® 29 Nectareine*	+20	+19		fruit flavour and appearance, with no skin russeting	early and heavy thinning and summer pruning are recommended
Romagna® Queen	+25		+36	high productivity and fruit size	medium flavour and asymmetrical shape
Honey Royale*	+26			fruit size and colour; very firm flesh, sweet flavour	skin susceptibility to rain just before ripening (bleeding)
Romagna® Giant	+30		+42	high productivity, size and sweet flavour	pour overcolour fruit with asymmetrical shape
Honey Glo® Zaipaze*	+31			high productivity and sweet flavour	low fruit size, skin sensibility to rain just before ripening
Dulciva*	+50			high productivity and size, sweet flavour	summer pruning is recommendend for good overcolour
Maria Dolce*			+40	very sweet flavour (honey)	medium-low productivity and fruit size, skin russeting
Lady Erica®			+51	high productivity and size	medium-low flavour due to low solid soluble content

Traditional taste					
Gran Sun*			-20	early ripening, high productivity	poor flavour
Rose Diamond			-14	early ripening, high productivity	fruit size
Rita Star			-11	early ripening, high productivity	fruit size
Ambra*			-9	high productivity and fruit size	poor colour with acidic flavour
Big Haven®	-7			high productivity, fruit size without skin	bacterial susceptibility (fruit and leave)
Honey Haven*				russeting	
Laura*			-3	high productivity, fruit size and flavour	poor colour, melting flesh
Maria Laura			+4	high productivity and fruit size	poor colour, melting flesh
Diamond Ray*	+14	+14	+14	high productivity and fruit appearance	acidic flavour
Red Gold	+22		+25	high productivity and fruit size	poor colour, melting flesh
(Stark Red Gold)					
Maria Aurelia			+27	high productivity and fruit size	poor colour, melting flesh
Nectaross	+25	+22	+28	high productivity, fruit appearance and size	poor colour, melting flesh
Venus*			+29	high productivity and fruit size	poor colour, melting flesh
Alma*	+27			big fruit size with very firm flesh (slow ripening)	acidic flavour when harvest is too early
Orion*	+34	+30	+32	high productivity and fruit size	poor colour, melting flesh
Sweet Red*		+33	+40	high productivity and fruit size	poor colour, melting flesh
Morsiani60®	+39			high productivity and fruit size	poor colour, melting flesh
August Red® Bradgust*			+51	high productivity and fruit appearance	fruit size
Sweet Lady*			+53	high productivity and fruit size	poor colour, melting flesh
Red Fair® Zaifane*	+55			high productivity, fruit size and appearance	poor colour with medium flavour
				(no skin russeting)	
Western Red*	+56			high productivity and fruit appearance	fruit size
Max® 7 AM7*	+63		+70	high productivity and fruit size	poor colour, melting flesh
Alexa®	+67			high productivity	poor colour, melting flesh
California*			+75	high productivity and fruit size	poor colour, melting flesh

[1]Date of ripening (days compared to 'Big Top®');
[2]ER - Emilia-Romagna (northern Italy);
[3]P- Piedmont (northern Italy);
[4]Basilicata (southern Italy)

Table 8. White flesh nectarine cultivars for Italy and their main features

Cultivars	Date of ripening[1] ER[2]	P[3]	B[4]	positive features	negative features
Low acid taste					
Turquoise® Monprime*	-19			early ripening, high productivity, sweet flavour	poor fruit size, early and heavy thinning recommended
Romagna® Red*	-7			high productivity, fruit appearance, sweet flavour	fruit size on weak shoot
Garcica*	-4			fruit size, appearance and flavour	early blooming, spring frost susceptiiblity
Cristal® Monriès*	-3			high productivity, fruit appearance and sweet flavour	early blooming, spring frost susceptiiblity
Nectasweet® 26 Nectarmagie*	+5			high productivity and fruit appearance	medium-small size
Romagna® Star*	+5			high productivity, fruit size and appearance	fruit quality and poor size on weak shoot
Magique® Maillarmagie*	+12	+12	+14	high productivity, fruit size, appearance, sweet flavour	upright growth habit, summer pruning is recommended
Romagna® Top*	+14			fruit size, appearance, sweet flavour	medium-low fruit size, skin russeting in cold climates
Nectasweet® 28 Nectaperle*	+20			high productivity, fruit appearance and sweet flavour	medium-low fruit size, skin russeting in cold climates
Nectasweet® 30 Nectarjewel*	+27			high productivity, fruit appearance and sweet flavour	medium-low fruit size, skin russeting in cold climates
Sandine® 22-01-02*	+32			high productivity, fruit size and sweet flavour	fruit slightly oblong and skin russeting
Zephir® Monphir*	+36			high productivity, fruit size and sweet flavour	fruit skin russeting
Tourmaline® Montaline*	+48			high productivity, fruit appearance and sweet flavour	medium-small fruit size
Traditional taste					
Jade® Momèe*	-9		0	early ripening, high productivity	acidic flavour
Maria Anna*	+17			high productivity, fruit size	poor colour
Romagna® Bright*	+32			high productivity, fruit size with very firm flesh	high acidity
Silver Giant*	+35		+40	high productivity, fruit size	acidic flavour
Romagna® 3000*	+52			high productivity, fruit size	poor colour

[1]Date of ripening (days compared to 'Big Top®');
[2]ER - Emilia-Romagna (northern Italy);
[3]P- Piedmont (northern Italy);
[4]Basilicata (southern Italy)

Table 9. Main clonal rootstocks for Italian apricot and peach orchards (from Loreti and Massai, 2006; modified)

Rootstock	Country of origin	Genetic origin	Apricot	Peach
‘Adesoto®101 Puebla*’	Exp. Stat. Aula Dei, Zaragoza, Spain	*P. insititia*		X
‘Barrier 1’®	IPSL-CNR, Florence, Italy	*P. davidiana* × *P. persica*		X
‘Cadaman® Avimag*’	INRA, France; Inst. Frut. Budapest, Hungary	*P. persica* × *P. davidiana*		X
‘GF 677’	INRA, France	*P. persica* × *P. amygdalus*		X
‘Ishtara® Ferciana*’	INRA, France	*(P. cerasifera* × *P. salicina)* × *(P. cerasifera x P. persica)*	X	X
‘Myrobolan 29C’	Gregory Bros Nursery, California, USA	*P. cerasifera*	X	
‘Montclar® Chanturge’	INRA, France	*P. persica*	X	X
‘Mr. S. 2/5’	DCDSL, Pisa, Italy	Spontaneous *P. cerasifera* hybrid	X	?*
‘Penta’, ‘Tetra’	Ist. Sper. Frut., Roma, Italy	*P. domestica*	X	X
‘Sirio’®	DCDSL, Pisa, Italy	*P. persica* × *P.amygdalus*		?*

* For limited conditions only, e.g. for HDP and vigorous cultivars

Orchard systems: training and pruning

In Italy there are mainly two orchard systems for apricot and peach: i) trees managed from the orchard floor, in order to reduce the labour cost for pruning, thinning and harvest; ii) trees managed from picking platforms. In both systems, trees can be trained at medium (MDP) or HDP. Difference in training systems depends on the pedoclimatic area, rootstock availability, socio-economic situation like farm size, skilled labour, mechanical equipment (Giovannini et al., 2010). HDP is extensively adopted for apple and pear, but is more limited for apricot and peach, although in recent years free spindle covers about 35% of new orchards in northern Italy, with a consequent decrease of open centre and palmette shapes. At the same time, in southern Italy, where open center is the most widespread training system, HDP by Y form is decreasing (Giovannini et al., 2010). Open center is still the major training system, along with other traditional training systems with medium-low planting densities (400-700 trees/ha). HDP is also increasing in apricot, mainly in lowland districts (Emilia-Romagna region) where late ripening cultivars are replacing peaches and nectarines. Major planting density and related training system are as follows: low density (400-700 trees/ha): open center and its modifications, and delayed vasette; MDP (700-1.000 trees/ha): free palmette, sprint palmette; HDP (1.000-2.000): free spindle, perpendicular V or Y and related training systems (Loreti and Massai, 2006; Table 10).

Table 10. Training system, planting distance and rootstocks for apricot and peach (from: Loreti and Massai, 2006; modified)

Training system	Planting distance (m)	Peach Rootstock	Apricot Rootstock
Free spindle	4.5-5.0 x 1.5-2.0	‘GF677’, ‘Adesoto®’,	‘M29C’, ‘Ishtara®’,
Perpendicular Y	5.0-6.0 x 1.0-1.5	‘Ishtara®’, ‘Mr.S. 2/5’,	‘Montclar®’, ‘Penta*’,
Open centre, Delayed Vasette	4.5-5.5 x 3.5-4.5		

Fruit load regulation takes place at different stages of the orchard life, mainly with pruning and thinning operations, the purpose is to obtain marketable fruit quality and high yield (Montanaro et al., 2011). Both winter and summer pruning are required, with the latter being very important for the containment of plant vigour and to enhance fruit quality by better light fruit exposure, and the development of dormant buds for the following year. In HDP, early summer pruning (May-June) on one year old shoot stimulates emission of sylleptic shoots that will bear fruit the following year. In apricot, time and type of pruning (short and long heading) are cultivar dependent (Neri et al., 2010). During the early years, summer pruning enables to set the final tree size and shape, while in adult trees it reduces the excessive vigour. During winter only shoot thinning is recommended, without heading which would lead to excessive vegetation sprouting in spring. Good pruning management has positive effect on fruit thinning also. Recent trials on mechanical thinning at bloom time (40-50% of open flower) have shown a significant reduction on manual labour, still needed for refining the operation (Foschi et al., 2012b). The saving can be as high as 50% compared to manual thinning, both on apricot and peach.

Management of the orchard floor, pests and diseases. About the management of orchard floor (weed control, fertilization, irrigation) and disease and pest control, the majority of the growers, and particularly those belonging to professional associations, follows the ‘integrated production’ guidelines, in agreement with the local regional Administrations, which set up the guidelines. It is estimated that about 80-85% of the production of growers association is obtained in accordance with these guidelines and two of them can be found at the following web addresses:

http://www.ermesagricoltura.it/Sportello-dell-agricoltore/Come-fare-per/Produrre-nel-rispetto-dell-ambiente/Fare-agricoltura-integrata-produzioni-vegetali/Disciplinari-di-produzione-integrata (Emilia-Romagna region);

http://www.regione.piemonte.it/agri/area_tecnico_scientifica/settore_fitosanitario/fitopatologia/disciplinari.htm (Piedmont region).

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Invited lecture

PEACH PRODUCTION IN SPAIN: CURRENT SITUATION AND TRENDS, FROM PRODUCTION TO CONSUMPTION

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Abstract. In this paper, a general overview of peach industry in Spain is given. This species has had an increasing interest and development in the last two decades because of the good adaptation to warm areas, compared to apple. This allows obtaining good yields and good fruit quality. Spain is nowadays the second largest peach producer and the first exporting country of the European Union (EU). The Spanish fruit industry has experienced a significant change in terms of technology of production in particular what is concerning the development of new cultivars, new rootstocks, training systems and development of integrated production and certification systems. Despite the intense innovation by planting new cultivars, peach consumption is low and tending to decrease. Development of flat peach has been a particular trait of Spanish peach industry with the aim to provide a fruit with a particular shape and taste highly appreciated by consumers of both domestic and export markets. The particular soil conditions of the main producing areas is a limitation to the use of rootstocks sensitive to iron chlorosis and for this reason INRA®GF-677 with a broad adaptability is the most common. New rootstocks inducing less vigour and better fruit size and greater yield efficiency are in the process of development. Because the cultivation of peach in warm areas, pests are more important that diseases, in particular Mediterranean fly and trips. The cost of production increased in the last years at a higher rate compared to the net prices received by the growers. In 2011 it ranged from 0.31 to 0.52 €/kg, depending on the cultivar, harvest time and yield.

Key words: Peach, Spain, production, exports, consumption, fruit quality, cultivars, rootstocks, training systems, crop protection, costs.

Introduction

Peach is nowadays the most important deciduous fruit species in Spain, mainly produced in the Ebro Valley and other Mediterranean areas, Andalucía and Extremadura. This species is well adapted to hot and warm climates with low rainfall and humidity; this results in lower incidence of diseases. In spite of that, the earlier blooming time compared to apple, pear and cherry increases the risk of spring frost damage. In the last two decades peach production has moved progressively towards southern regions of Spain and Italy looking for extra precocious production (end of April and May) but with significant increases of production costs. This has been possible thanks to the availability of more and better “low chilling” cultivars in terms of fruit quality and fruit yield (Clark, 2000; Byrne, 2002; Gallardo et al., 2012).

Peach production in Spain is characterized by the introduction in the last decade of a great number of new cultivars covering a wide range of maturity, with different size, appearance and fruit taste (Iglesias et al., 2005; 2007; 2010b). Also the number of rootstocks has increased significantly in the last two decades providing different options to adaptation in a great diversity of soil conditions (Moreno, 2005; Jimenez et al., 2011). The development of specific training system as the popular “catalán vase”, adapted to particular conditions of the main production areas is a characteristic of peach development in Spain (Montserrat and Iglesias, 2011). In addition, the technical advances in irrigation, fertilization, crop protection, postharvest technology, certification and traceability, allowed in the last two decades a consistent improvement of the competitiveness of Spain, in particular to export markets (Iglesias, 2010a) of European countries.

Herein are exposed the most important traits of peach production in Spain, consumption, exports, new cultivars and rootstock development, costs of production, pest and diseases control and, other aspects concerning to technology of production.

Production, export, consumption

The four main deciduous fruit species produced in Spain are peach, apple, pear and cherry. In total, the surface covered by deciduous fruit species in 2010 reached 203,321 ha (Figure 1). Peach is cultivated mainly in the Ebro Valley (Catalonia and Aragón, are the most important areas), and also in other regions as Valencia, Murcia, Andalucía and Extremadura (Figure 2). For this reason this species covers a great diversity of areas with a wide range harvest period, climatic and soil conditions from the Ebro Valley with a high availability of chilling hours (700 to 1,100 h), to Andalucía where only it’s possible to produce low chilling cultivars (180 to 250 h). A common trait of all these areas is the hot and warm summers which results in a less incidence of diseases compared to other producing areas of Italy and France (Llacer et al., 2009a,b; Iglesias, 2010a).

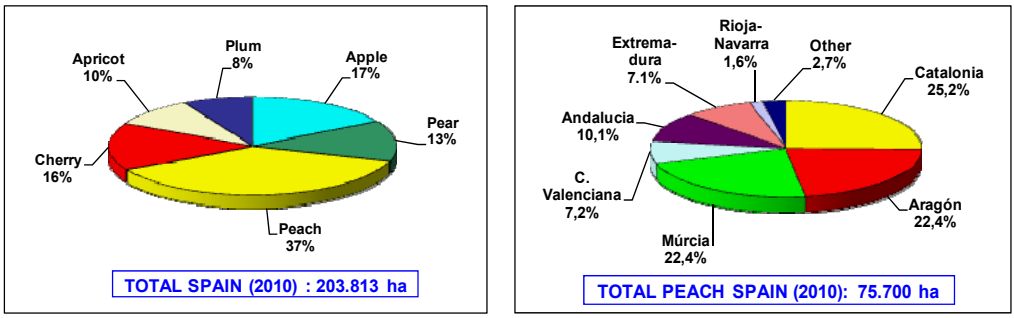

Figure 1. Distribution of surface of the main deciduous fruit species produced in Spain (left) and repartition by Autonomous Communities in 2010 (right) (MAGRAMA online http://www.magrama.es).

Peach is nowadays the main deciduous fruit species produced in Spain with a surface of 76.000 ha in 2010. This species showed a clear trend to increase production across the period 1985-2010 due to the improvement of technology of production (new cultivars and rootstocks, training systems, fertilization, pest and diseases management). Cherry and plum are also increasing the production (Figure 2).

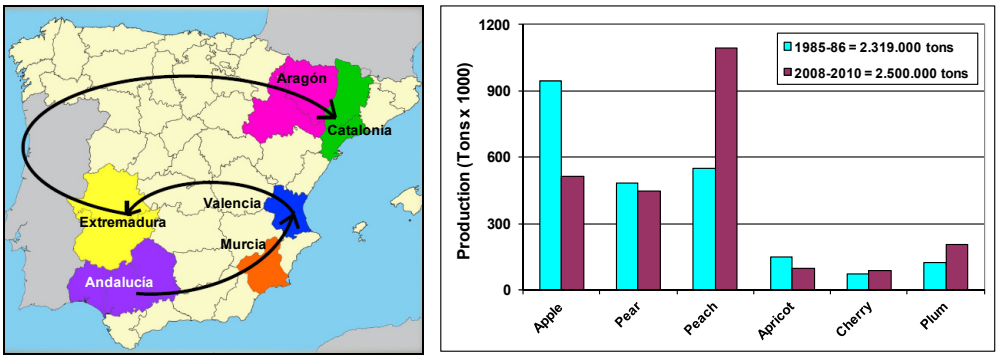

Figure 2. Main regions of peach production from more to less precocity (left) and change of production (right) of the main deciduous fruit species in Spain over the period 1985-2010 (MAGRAMA online http://www.magrama.es).

On the contrary, apple is significantly decreasing on both surface and production (Figure 2) because its worse adaptation to hot and dry conditions, typical of the main areas of fruit production in Spain. This has as a consequence a lower fruit colour development and firmness and less competitiveness compared to apple produced in mountain areas of Italy and France. Total imported apples represents the half of the Spanish production, arising 231.000 tons in 2011.

In the European Union (EU), Spain is the second largest producer of peaches after Italy, followed by Greece and France. Spain is the only country where the production is increasing consistently in the last two decades (Figure 3). The analysis of the production by fruit types or subspecies over the period 1991-2012 shows clearly an increase of nectarine and also peach (including flat peach) and a clear decrease of clingstone peaches. This fruit type is destined to both fresh consumption (52%) and canning industry (48%). The production by subspecies depends on the region (Figure 2). In Murcia and Aragón/Rioja/Navarra clingstone is still dominant but in Catalonia, Andalucía, Extremadura and Valencia, nectarine is the most important (Iglesias and Casals, 2011). In 2012 nectarines represented the 41% of the total production, followed by peaches (35%) and clingstone peaches (24%).

As mentioned previously the constant increase of peach production in Spain is mainly due to the good adaptation of this species to warm climates. A second reason is the lower cost of production compared to other competitor countries as Italy or France. In addition, the production of new and improved new cultivars allowed in

the last decade to cover the gaps existing some years ago, covering a wide range of maturity, from the middle of April (Andalucía) to end of October (late areas of Ebro Valley). Improved cultivars in terms of fruit colour, size and quality have planted at large scale by growers of the main producing areas, in particular in Catalonia.

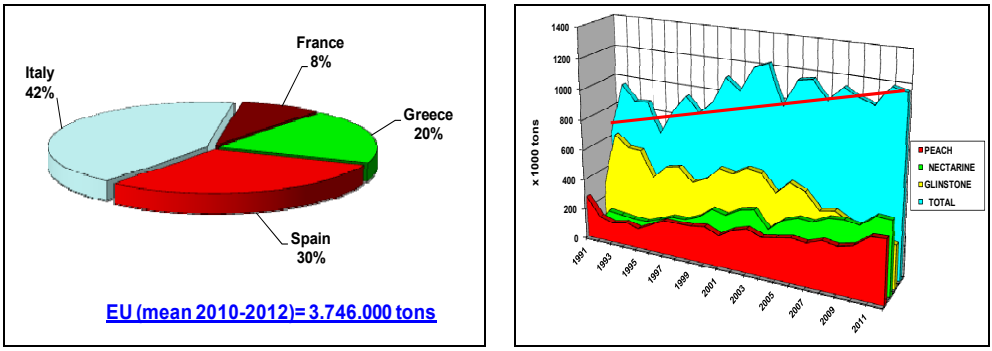

Figure 3. Share (%) of the European Union (EU) peach production by countries as mean values of the period 2010-2012 (left). Evolution of the production by subspecies or types in Spain over the period 1991-2012 (right) (Source: EUROPECH'2012).

In spite of this renewal of cultivar assortment, peach consumption in Spain is continuously decreasing from close to 8 to 4.3 kg/capita-year in the period 1989-2011 (Figure 4). A similar trend is registered in other EU countries (France, Italy, Greece, etc.) and USA. Several reports from Italy (Della Strada and Fideghelli, 2003), France (Clareton, 2000), Spain (Iglesias, 2010a) and USA (Crisosto et al., 2001; Crisosto, 2002), evidenced that the main causes of this low consumption is the inconsistent quality of the product (too hard or too soft), the lack of the taste, the absence of identification of the varieties depending of their flavor (sweet, non sweet) and the absence of brands compared to other fruit species as apple, table grape, kiwi fruit, watermelon or pineapple). In some of the mentioned countries as France, the average number of unsatisfied consumers arises to 80% which can result the low peach consumption and with the trend to decrease (Clareton, 2000).

Breeding for precocious and high colour development and bigger fruit size resulted on fruits more attractive to consumers (Fideghelli et al., 1998; Bassi et al., 2010). But in turn, with those cultivars it's more difficult to determine the appropriate harvest date to enhance consumer satisfaction (Iglesias and Echeverría, 2009; Echeverría et al., 2012). This induces usually to pick the fruits in too much immature stage, with too high flesh firmness and lack of flavor, having as a consequence low consumer satisfaction and decrease of consumption (Figure 4). A direct relationship was established by several authors between SSC and fruit firmness to consumer satisfaction (Hilaire et al., 2000; Hilaire and Mathieu, 2004; Iglesias and Echeverría, 2009; Echeverría et al., 2012). The development of the "ready to eat" and "tree ripe" concepts could help to increase consumer satisfaction (Crisosto, 2002;

Crisosto and Valero, 2006) in the future. The EU Regulation CE nº 1861/2004 from the Commission, applied from 1st March 2005 established as obligatory the following values of quality parameters for peaches commercialized in the EU: soluble solids content (SSC) ≥8º Brix and flesh firmness <6.5 kg. This means that these parameters should be reviewed and another quality parameters, different from those used traditionally (fruit colour and fruit size) and related to consumer satisfaction should be established.

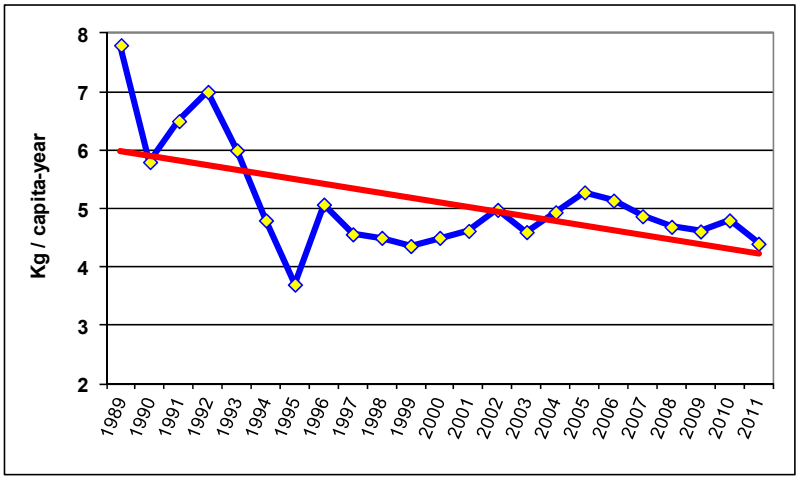

Figure 4. Evolution of peach consumption in Spain (kg/capita-year) over the period 1989-2011 (MAGRAMA online http://www.magrama.es).

The continuous improvement of technology, from the orchard to the cold storage and distribution, resulted in a more efficient peach industry. Due to the lower cost of production, adequate yield and fruit quality, the competitiveness of Spanish fruit industry increased progressively in the last decade in comparison to France and Italy. Consequently, nowadays Spain is the largest exporter of peaches among the EU countries, followed by Italy (Figure 5). Spain can offer a wide range of cultivars, a good fruit quality and a guarantee of food safety through the implementation of all the required certification systems and procedures as Global GAP, Nature's Choice, etc. From 1999 to 2011 the position of the leading export countries varied and, Spain becomes from 2006 the first exporting country. This fact compensated partially the decrease of consumption in Spain (Iglesias and Casals, 2011). The total exports (including both intra + extra EU), increased from 190,000 ton (1999) to 656,200 ton (2011) (Figure 5), which represented 55% of total Spanish production in 2011(1.189.100 tons). Of this total amount exported, 57% was nectarines and the rest peaches (including flat peaches). The main destination countries were Germany, France, United Kingdom, Poland and Russia.

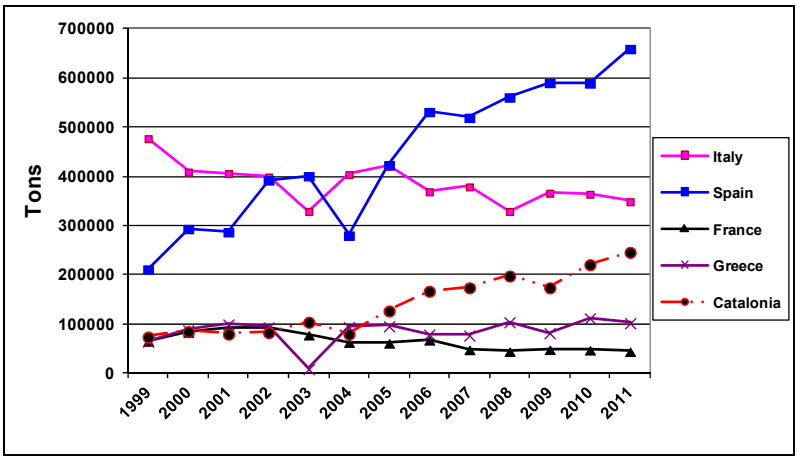

Figure 5. Evolution of intra + extra EU exports of peach (including nectarine) for the main producing countries over the period 1999-2011. (Source: Comext AGRI.C.2. / PEC19 / 12).

New cultivars: origin, trends and development

The major change experienced in Spain on the technology of peach production in the last two decades has been the high number of cultivars from different breeding programs introduced a commercial scale by the growers. Innovation through development and commercialization of new and improved cultivars has become the key strategy to enhance economic sustainability and profitability of peach industry in Spain. Major progress has been in nectarine and flat peaches compared to peaches. In only 15 years in Spain the varietal assortment has been completely renewed in subspecies as nectarine, peach and flat peach and on a lesser degree in clingstone peach (Llacer et al., 2009a,c; Iglesias, 2010a). The main objectives of breeding have been different depending on the destination of the released cultivars. Breeders have traditionally selected primarily for external fruit quality (fruit size and appearance), with organoleptic and nutritional traits being a secondary goal (Fideghelli et al. 1998; Duthie et al., 2000; Wargovich, 2000; Byrne 2002). Also selecting for new traits as “stony hard” or deanthocianic skin are nowadays breeding objectives of several programs (Frey, 1998; Nicotra et al., 2003; Bassi et al., 2010; Gallardo et al., 2012; Liverani et al., 2012). Increasing recent interest in nutraceuticals and functional foods has led plant breeders to initiate selection on different fruits (peach, plum, apple, blueberries, etc.) with higher than normal phenolic antioxidant contents (Prior et al., 1998; Gil et al., 2002). For example, the Prunus Breeding Program at Texas A&M University and the USDA Stone Fruit Breeding Program at Byron, are working at developing red-fleshed peaches [*Prunus persica* (Batsch) L.] with high levels of beneficial phenolic compounds for the fresh produce and processing market. All these programs aim to set the baseline for establishing breeding efforts, with the intention of adding value to fruits and vegetables with respect to the level and

diversity of health benefit properties that fruits as peach could impart (Duthie et al., 2000; Wargovich, 2000; Cevallos-Casals et al., 2005; Botton and Ruperti, 2009).

Nowadays fruit quality is fundamental for the acceptance of peach and nectarine cultivars by consumers, due to the high competition in the market with numerous new released cultivars. These new varieties allowed to increase significantly the range of maturity and can be produced in a wide range of climatic conditions from tropical to continental ones (Frey, 1998; Byrne, 2002; Gallardo et al., 2012). Nevertheless the main improvement of new cultivars has been in fruit appearance; in particular fruit size and fruit color. The second significant gain has been on the increase of fruit quality with a diversification of fruit taste, from sweet, balanced to acid cultivars (Carbó and Iglesias, 2002; Cantín et al., 2010; Iglesias et al., 2010a,b; Llacer et al., 2012; Batlle et al., 2012). Nowadays the industry has a great range of cultivars covering a wide harvest period, from middle of April to end of October, with a diversity appearance, taste and different agronomical performance (Iglesias and Echeverría, 2009; Reig et al., 2012, 2013). Selecting cultivars with low chill requirements has been another important objective which allowed the expansion of Spanish peach culture to South areas with low chill availability providing extra precocious and precocious productions (Byrne, 2002; Llacer et al., 2009a,c).

New cultivars origin from more than 70 active breeding programs located mainly in USA, where origin 52% of new cultivars released in the world (Badenes et al., 1998; Byrne, 2002). In Europe, Italy and France are the leading countries in the selection of new cultivars. On a worldwide scale, during the period 1970-1990 more than 827 cultivars were registered and 1,092, for the period 1991-2001, distributed as follows: 56% peach, 36% nectarine and 8% clingstone (Della Strada and Fideghelli, 2003). The origin of the cultivars produced in Spain is mainly from private breeders as F. Zaiger and N. & L. Bradford (California-USA), different universities (Davis, Florida and Michigan in the USA; Bologna, Pisa, Florence in Italy), public institutes (INRA in France, CRA-Roma and Forlí in Italy) and public or private breeders as CIV, CAV, Geoplant, A. Minguzzi in Italy; or A&L Maillard-ASF, Euro-pépinières, R. Monteux Caillet-Star Fruits, among others in France.

In the last decade in Spain around 12 breeding programs were initiated, most of them are private (PSB, ALM-Frutaria, Provedo, Planasa, etc.), some are public-privates (Novamed, Fruit Futur, etc.) and the rest publics (IVIA, CITA, etc.) (Llacer et al., 2009c, 2012; Batlle et al., 2012). This allowed in the last years to reduce progressively the dependence of foreign cultivars coming mainly from USA, France and Italy, and not always well adapted to our conditions in terms of agronomical performance and fruit quality (Reig et al, 2013). These new cultivars have demonstrated a better adaptation to the climatic conditions of the major production areas of Spain where their selection is carried out. In the case of Catalonia, as the first producing region, peach industry is interested to plant high fruit quality cultivars well adapted to the warm to hot conditions of the Ebro Valley. This reason was the start of a joint IRTA-ASF (Fruit Futur) scion breeding program in 2004 obtaining the first released varieties in 2011 (Batlle et al., 2012).

About the subspecies, nectarine is gaining importance in the last two decades in all EU countries, in particular in Italy and Spain (Figure 3). The same trend is observed in the USA where nectarine represents 35% of total production. On both peach and nectarine, yellow flesh cultivars are the most important representing 83% and 78%, respectively. The increasing production of nectarine is mainly due to the good consumer acceptation (more convenient fruit than peach) for both domestic and export markets, enhanced by the increasing availability of new highly coloured and sweet taste cultivars as 'Big Top®', covering also a wide range of maturity (Figure 6), as reported by Foschi and Missere (2009) and Iglesias et al. (2010a,b). In fact, Big Top®', introduced more than 15 years ago from USA (Zaiger's Genetics), has been the cultivar with the major impact on the European peach fruit industry and market. This particular cultivar was widely planted by growers of all regions and nowadays is the most important among yellow flesh cultivars in Spain. It is very well accepted by the markets because its particular characteristics as exceptional fruit firmness compared to traditional cultivars (Giauque and Hilaire, 2003; Mingani et al., 2006; Foschi and Missere, 2009; Iglesias et al., 2010a, b). 'Big Top®' is characterized by its very firm melting texture, similar to "stony hard", but produces ethylene and becomes melting in very last stages of ripening (Table 1). In addition it has excellent fruit size, precocious, intense and full red colour, sweet taste and low cost of thinning because of its low blooming density (Figure 11) (Carbó and Iglesias, 2002; Iglesias et al., 2010b; Reig et al., 2013).

Table 1. Classification of peach fruit flesh phenotypes from chemical analysis and sensory evaluation at physiological maturity (Source: Bassi and Monet, 2008, from several authors)

Flesh texture	Firmness	Pectins[a]		Calcium[a]	Ethylene[b]
		Soluble	Insoluble		
Melting					
Soft	Low	+++	+	++	++
Firm	High	+++	++	+++	++
Very, very firm[c]	Very high	++	++	++	+
Stony-hard	Very high	+	+++	++	-/(+)
Non-melting	Very high	+++	+++	+++	+++

a Flesh content; no clear-cut threshold between different phenotypes.
b Amount produced by whole fruits.
c Similar to the "stony hard", but produces ethylene and becomes melting in the very last stages of ripening (e.g. 'Big Top®' nectarine).
Number of + represents relative content columns, respectively; - means absence; (+) means traces.

Considering the European markets, it has been clearly demonstrated by the results of the EU project ISAFRUIT (Sixth Framework Program: www.isafruit.org), on which 11 different cultivars were tested, that 72% of consumers from five different countries (Spain, Italy, France, Poland and Germany), preferred sweet and firm cultivars. On the opposite, 28% preferred balanced or more acid cultivars. In fact most of the new sweet taste cultivars exposed in Figure 6, have as a

characteristic, in addition to sweet fruit taste, a more crunchy texture and a better maintenance of fruit firmness during the ripening and also in cold storage (Iglesias and Echeverría, 2009; Echeverría et al., 2012), similar to ‘Big Top®’. With the aim to characterize the cultivars based on fruit taste, a classification was established using as a parameter the titratable acidity (TA). Based on their values five different groups were established (Iglesias and Echeverría, 2009) and reported in Table 2.

Table 2. Classification of peach/nectarine cultivars based on the values of titratable acidity of the fruit (TA)

Group	Titratable Acidity (g acid malic/L)	Titratable Acidity (meq/100 mL)
1. Subacid (very sweet)	<3.3	<5
2. Sweet / semisweet	3.3-6.0	5-9
3. Equilibrated	6-8	9-12
4. Acid	8-10	12-15
5. Very acid	>10	>15

1 and 2 are considered sweet cultivars. 3, 4 and 5 are considered non sweet cultivars in Figure 6.

The high number of cultivars released from worldwide breeding programs increases their availability to growers, but at the same time it is difficult to select the most adapted cultivars in terms of agronomical performance and fruit quality (color, size, etc.). In all the producing European countries, significant efforts have been done in order to test the new cultivars in the main producing areas, selecting the best adapted and after transfer this information to the fruit industry (Giauque and Hilaire 2002; Hilaire, 2003; Menone et al., 2003; Della Strada and Fideghelli, 2003; Berra et al., 2011; Foschi et al., 2011; Iglesias et al., 2005, 2007, 2010b, 2012a). In general, the adaptability of new peach cultivars to different climatic conditions has not been a selection criteria in the main breeding programs developed in recent decades. For this reason, the agronomical response of some new varieties is uncertain when they are grown under climatic conditions different from those where they were originally developed. This is what the cultivar testers named commonly as the “surprise coefficient” (Iglesias et al., 2010b; Berra et al., 2011; Reig et al., 2013). As a result, European cultivars tended to show better agronomic behavior than American ones due to the similarity in climatic conditions (Reig et al., 2013). For this reason the IRTA started in 1994 a program for testing new cultivars in two Experimental Stations: Lleida and Mas Badia (Girona), located in two important areas for peach and apple production of Catalonia. During the period 1996-2012 close to 700 new peach cultivars have been tested at IRTA; among those cultivars 46% are nectarines, 25% peaches, 3% clingstone peaches and 26% flat peach/nectarine. The results obtained have been continuously transferred to fruit industry with the aim to help in the decision of choosing the most suitable cultivars. An annual list of the most interesting cultivars of peach, apple and pear is given to the fruit growers with a description of their main characteristics. Detailed information has been periodically

published with the objective to transfer this information to the industry (Carbó and Iglesias, 2002; Iglesias and Carbó, 2009; Iglesias et al., 2005, 2007, 2010b, 2012).

With the aim to illustrate the important innovation in terms new cultivars development, a maturity chart including the most interesting cultivars for the main subspecies/types has been represented in Figure 6 using two different colors (pink and green) to indicate their taste. In most of the groups, sweet taste cultivars (pink color) are the most important ones and are the basis of the new plantings in the main producing areas of Spain. The same trend has been reported in Italy (Foschi and Missere, 2009). Only in yellow flesh peaches the chart of maturity of sweet taste cultivars is not as complete compared to rest of the groups.

In yellow flesh nectarine, the group having more new cultivars available, the undisputed reference is 'Big Top®', which ripens on the first week of July in Lleida (Catalonia). Before it, 'Nectaprima^{cov}', 'Big Bang^{cov}', 'Noracila^{cov}' and 'Gardeta^{cov}'are well known cultivars. After 'Big Top®' several varieties can complete the range of maturity extending it to the end of September as exposed in Figure 6. Among them we can underline 'Extreme Red®' 'Diamond Ray^{cov}' (reference cultivar), 'Luciana^{cov}' Nectareine^{cov}', 'Venus^{cov}'(reference), 'Honey Royale^{cov}', 'Honey Glo^{cov}', 'Nectavantop^{cov}', 'Nectagala^{cov}', 'Tarderina^{cov}', 'Nectadiva^{cov}', 'Nectatinto^{cov}' and 'Zailared®'.

In white flesh nectarine, as reported above in yellow flesh, the contribution of new cultivars has been in terms of fruit size, fruit colour, sweet taste, good firmness, low susceptibility to fruit cracking and adequate yield. As example we can mention 'Nectaearly^{cov}', 'Turquoise®', 'Nectarboom^{cov}', 'Garcica^{cov}', 'Queen Glory®', 'Tourmaline®' and 'Nectarlam^{cov}'. All these new cultivars cover a wide range of maturity (Figure 6) with high and precocious colour development, sweet taste and good yield.

In peach (yellow and white flesh) the amount of cultivars available has been traditionally very important covering a wide chart of maturity. The new cultivars selected in the last years provided also a high fruit colour and smooth skin and most of them have sweet or balanced taste. The reference cultivars on yellow flesh are some of "Rich" series from Zaiger's Genetics (USA), as 'Ruby Rich®', 'Summer Rich®' or 'Rich Lady®'. 'Crimson Lady®', 'Elegant Lady®', 'Rome Star®', 'O'Henry®' and 'Tardibelle®' are other reference cultivars. Among new cultivars those with high colour, smooth skin, good flesh firmness and fruit size and sweet taste, are the widely planted in the last years, for example 'Sugar Time®', 'Crispbella^{cov}', 'Royal Summer®', 'Extreme Sweet®', 'Sweet Dream^{cov}' or 'Sweet Henry®' (Figure 6), among others. In white flesh peach, new cultivars having also improved colour, good fruit firmness and sweet or non sweet taste, were also available as 'Patty®', 'Fresh® White', 'Maura®', 'Sweetchief^{cov}', 'Summer Sweet®', Sweetreine^{cov}', 'Sweetmoon^{cov}' or 'Lucius^{cov}', among others (Figure 6).

About the clingstone peach, the evolution in terms of new cultivars has been scarcely significant, due to low importance of this type of fruit in some countries as Italy or France. In Spain this subspecies was the most important in the past (Figure 3)

by nowadays the interest is limited because it lesser adaptation to export market. The cultivars produced are the traditional, selected decades ago on each growing region for their adaptation to local conditions and, complemented by foreign cultivars as ‘Romea[cov]’, ‘Catherina®’, ‘Carson’, ‘Mountain Gold’ and the popular “Baby Gold” series.

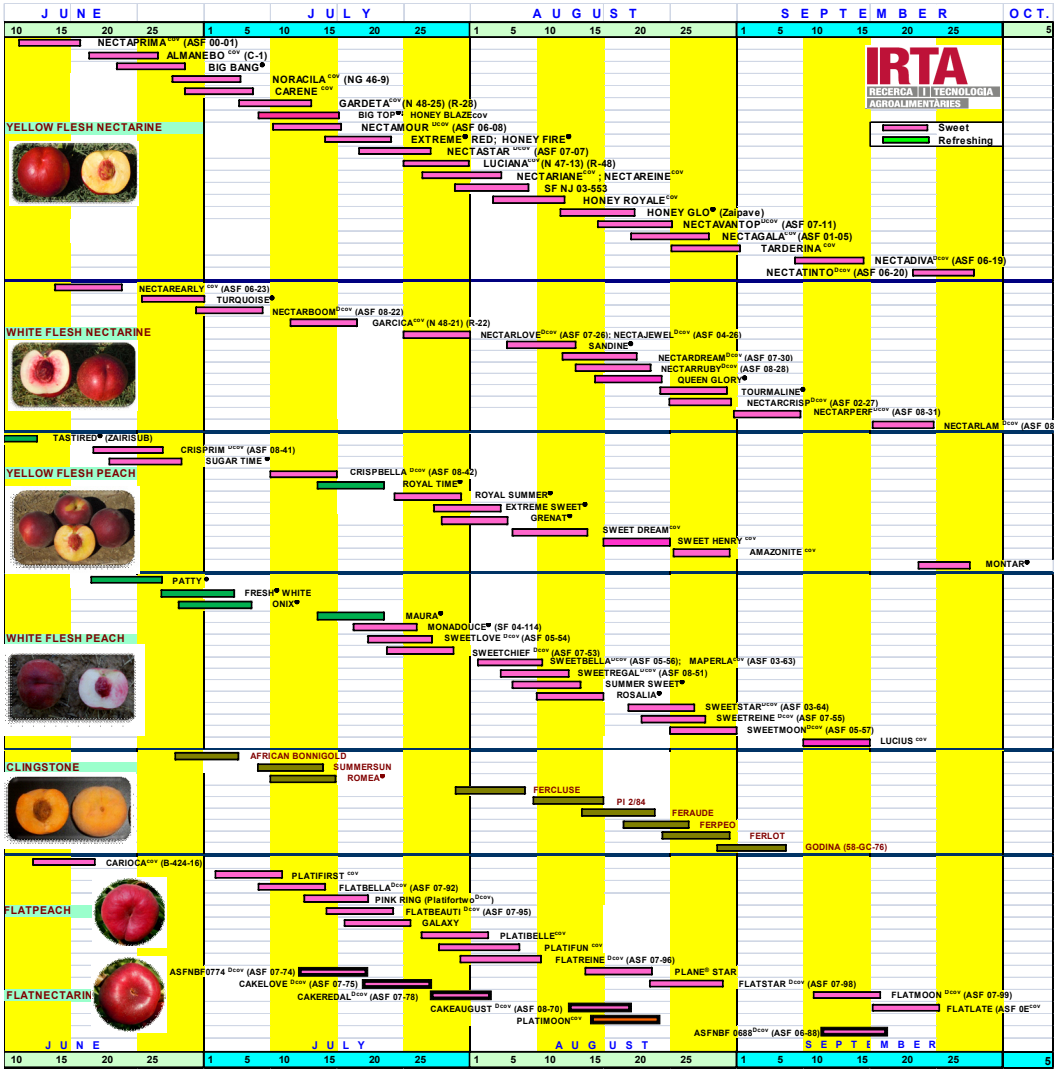

Figure 6. Chart maturity of some selected new cultivars by subspecies/types corresponding to the fruit production area of Lleida and tested at the IRTA’s Experimental Stations of Lleida and Mas Badia (Girona).
Pink colour for sweet cultivars and green colour for non sweet cultivars. See Table 1.

The origin of new cultivars of peach and nectarine introduced in the last two decades is Spain is mainly from Zaiger's Genetics, Bradford Genetics (USA), ASF, Monteux-Caillet and INRA (France), CRA Rome and Forli (Italy) and PSB Producción vegetal, Provedo, ALM&Frutaria and Planasa (Spain). In the coming years new cultivars from the new breeding programs developed more recently (IVIA, Fruit Futur, Novamed, Proseplant, etc.), will complete the wide range of cultivars available.

Considering the different subspecies of peach, the flat peach (including flat nectarines) is the one that in the last 10 years experienced the largest increase of both surface and yields as illustrated in Figure 7. Pomological diversification developing this particular type of fruit has been a strategy of marketing carried out by Spanish peach industry to encourage fruit purchases by consumers and increase profit to growers. This type of fruit is included in "peach" in Figure 3 and, nowadays Spain is the only country in the world producing it at a large scale. In 2012 the estimated production was 163,800 tons (14% of total Spanish peach production, 1,183,000 tons) from a total surface of 9,415 ha.

The main producing regions are Catalonia, Aragón and Murcia (Figure 7). Around 62% of total production is exported to several countries on the EU (Germany, United Kingdom, Belgium, Norway, etc.), Europe (Russia and Poland) and others. The rest is destined to domestic markets were flat peach has been traditionally consumed and highly appreciated by its particular sweet and aromatic taste (Sorrenti et al., 2010; Reig et al., 2012). The mean prices received by the fruit growers in the period 2005-2012 decreased from 1.40 to 0.63 (Category I). The price paid by consumers for the same period on domestic markets ranged from 4.60 (2005) to 2.20 €/kg (2012). The cost of production is extremely dependent on the cultivar and in particular of harvest time, blooming intensity and yield (Iglesias and Carbó, 2009; Iglesias et al., 2010b). It ranges from 0,52 €/kg for precocious cultivars, high blooming density, limited fruit size and low-mid yield because the precocity as 'UFO-3®', to 0.32 €/kg for late harvest cultivars, mid blooming density and high yield and fruit size potential, as 'Flatlate^{cov}'. Even de constant decrease of price of flat peaches, it has been in the last years from 1.5 to 4 times higher compared to those of peach and nectarine for a similar harvest date. Thinning, harvest, packing and packaging costs are greater than peach or nectarine.

Flat nectarine cultivar development has been not as important compared to flat peach, because a limited range of interesting cultivars was available. Lack of fruit colour, sensitivity to cracking and sometimes limited yield and/or fruit size, were the main limitations of old cultivars (Iglesias and Carbó, 2009; Liverani et al., 2012). This particular fruit type is not known by the consumers because in Spain only flat peaches have been traditionally consumed. Flat nectarines represents 13% of total flat fruits produced (Figure 7). 'Mesembrine^{cov}' and 'Subirana®' are the reference cultivars. In more recent years new cultivars as 'Cakelove^{cov}', 'Cakeredal^{cov}', 'Cakeaugust^{cov}' or 'ASFNBP0688^{cov}' (ASF), 'Platimoon^{cov}' (INRA&QN) and

different cultivars from CRA-Rome as “Platinet” series or ‘302-Q I-27’, covering a wide range of maturity (Figure 6), are introduced to test at IRTA and most of them are nowadays planted. They are characterized by the high colour, adequate size, sweet and aromatic taste and low sensitivity to fruit cracking. In spite of this, flat nectarines are not well known by marketers and consumers and this leads to their more difficult sale.

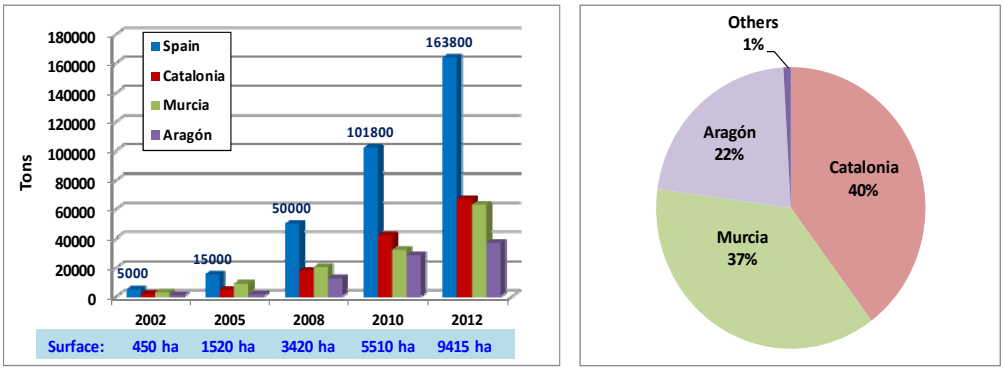

Figure 7. Evolution of flat peach production (flat nectarine also included) in Spain by regions over the period 2002 to 2012. At the bottom part also indicated the total Spanish surface (left). Share (%) of flat peach production in 2012 by regions (right). In both cases flat peach and flat nectarine are included. (Source: own data elaborated from Europech’2012, Afrucat, DAAM-Generalitat de Catalunya, Consejería de Agricultura Region de Murcia and Cooperativas Agroalimentarias).

The interest for both, flat peaches and flat nectarines, is due to two reasons: the taste of all cultivars is sweet and aromatic and, the convenience to consumption (because the flat shape) is easily associated by consumers to taste. The key question for the success of flat peach lies in the introduction and development of a wide range of new cultivars covering the whole harvest period, from the end of May to the end of September (Sorrenti et al., 2010). Most of them are characterized by a full red color, smoothie skin, perfect closure of calyx end cavity, adequate yields and good fruit firmness (Iglesias et al., 2010b; Sorrenti et al., 2010; Reig et al., 2012, 2013), which is an enormous advantage for handling and marketing. ‘Sweet Cap®’ a cultivar from A. Maillard has been and still is the most important, because the high potential of yield and fruit size and its excellent taste. ‘UFO-3®’ (initially) and ‘UFO-4®’ (nowadays) are still important and reference cultivars. Latter on, a wide range of new cultivars have been planted by the growers, mainly from France (ASF, INRA, INRA&QN), Italy (CRA Rome and Forli) and Spain (Provedo) (Sorrenti et al., 2010; Iglesias et al., 2010b). The “UFO”, “Regalcake®”, “Platty®” and “Plane®” series, are nowadays the most important and popular.

Rootstocks

In peach the availability of rootstocks offers a wide range of possibilities in comparison to other stone fruit species. This is because different species and/or inter specific hybrids from *Prunus* genus can be used. Due to this diversity, differences conferred by the rootstock on tree vigour, fruit quality, adaptation to soil conditions (sensitivity to iron chlorosis, tolerance to water logging, replant situations, etc.), are large. Interspecific hybrids, different selected seedlings, and plums (mainly *P. insititia*) were the main rootstocks used in Spain. Because the main areas of peach production are located in Mediterranean basin (Valle del Ebro, Comunidad Valenciana and Región de Murcia) the main problem of the seedlings (traditionally used) is their sensitivity to iron chlorosis. For this reason during the 80's and 90's the interspecific almond x peach INRA®GF-677 was the most planted because its easiness of propagation, tolerance to iron chlorosis (Rubio-Cavetas et al., 2005) (Figure 8) and good yield efficiency, in particular for mid and late harvest cultivars.

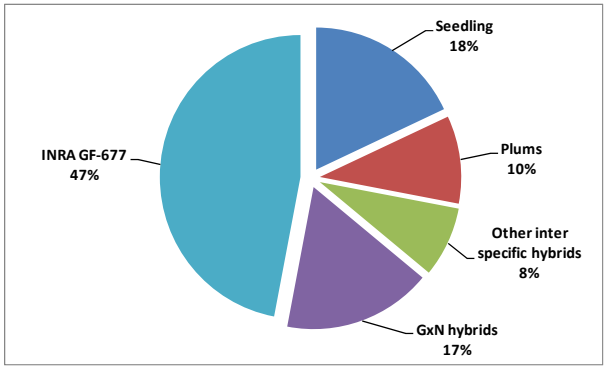

Figure 8. Distribution (%) of the main rootstocks used in Spain (Source: Rubio-Cavetas et al., 2005).

In areas with soils where the iron chlorosis is not a problem as Andalucía or Extremadura, the seedlings INRA GF-305® and Montclar® are the most used. In Murcia, because very calcareous and low drained soils, different selections of local plums (*P. insititia*) (Adesoto®101, Montizo®, Monpol®, etc.) are still used in combination with other new rootstocks. The main problem is their sensitivity to root suckering. Several references about their behaviour in some Mediterranean areas were reported by Moreno (2005), Iglesias and Carbo (2006) and Jiménez et al., (2008, 2011). Nevertheless, its sensitivity to replant situations and water logging and the excessive vigour conferred, moved in the last decade to look for alternative rootstocks, inducing less vigour and, providing a better tolerance to replant situations. From those rootstocks different selections from "GxN" series (Garnem®, Monegro®, Felinem®) from CITA (Aragón), and in a lesser extent Cadaman and Barrier® have been planted in the last years by the growers.

New and reference selected rootstocks from different species were tested at IRTA's Experimental Stations of Lleida and Mas Badia (Girona) during the period 1996-2005. Some of them provided a good agronomical performance, induced early yields and good fruit size (Figure 9). INRA®GF-677, Barrier and Cadaman (this one tested only at IRTA Mas Badia), despite the mid to high vigour conferred, show good yield efficiency. Most of the rootstocks tested, except plums, are more sensitive to iron chlorosis than INRA®GF-677 and reduced significantly tree vigour, providing also good yield efficiency (Iglesias et al., 2012b). INRA GF-305® and Montclar® induced less tree vigour than most of the hybrids, better fruit size and fruit colour in early harvest cultivars and, are still planted.

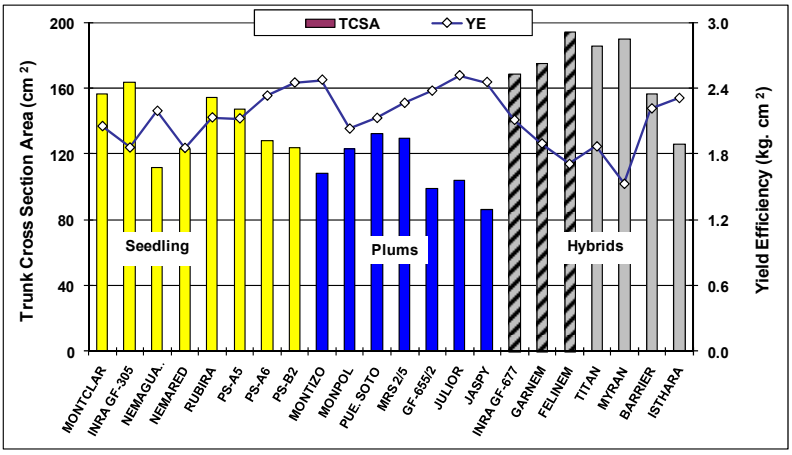

Figure 9. Tree vigour (expressed as TCSA) and yield efficiency (YE) of 'Elegant Lady®' peach on several rootstocks at the IRTA Experimental Station of Lleida at 10th year of planting.

In a near future the increasing restrictions of the EU to use growth regulators as paclobutrazol, could be an important problem when vigorous rootstocks as INRA®GF-677, Garnem or Cadaman® are used. In the last decade new rootstocks have been selected by the breeders (Pinochet, 1997, 2010; Moreno, 2004; Jimenez et al., 2011). Some of them are tested in a new trial carried out at IRTA Experimental Station of Lleida since 2008 with the nectarine cultivar 'Big Top®'. From those, some of the RootPac® series (from Agromillora Catalana, Spain), induced a wide range of tree vigour. RootPac®20 and RootPac®40 reduced significantly tree vigour as far as 60% and 40%, respectively, compared to INRA®GF-677. Other interspecific rootstocks as MB 1-37 (from IRTA), Castore and Poluce (from Univ. of Pisa, Italy) and different plums (from CISC and CSIC-Agromillora Catalana) showed at the fifth year of planting medium vigour, and provided early yields, good yield efficiency and fruit size, in particular RootPac®40. Some more years will be required to judge consistently the interest of some of these new rootstocks in the sense to provide a major range of tree vigour, better fruit quality and agronomical performance and broad adaptability to specific soil conditions compared to those used nowadays.

Plantation trends and training systems

Traditionally, in Spain several training systems have been used in the past, the most important was the traditional open vase with trees from 2.5 to 3.5 m tall (400 to 700 trees/ha). The palmette has been always used at minor scale in almost all the areas, because it allows the mechanization of pruning, harvest (by mechanical platforms) and, in recent years thinning. This mid density planting system (600 to 1,200 trees/ha depending on the rootstock used) requires support structure and this increase the cost of planting. The transversal ypsilon, is a mid density planting system (from 1,000 to 1,500 trees/ha) which provides early yields and a good yield efficiency, not requiring support structure and is easy to train. The central axis is a common system increasingly developed in Italy in the last decade (mainly in the Emilia Romagna region), with the aim to obtain early and high yields and allowing the mechanization of thinning, pruning and harvest. This system is scarcely developed in Spain until the last years when medium to low vigour rootstocks (RootPac® series, plums and other interspecific hybrids) are available for growers. Tree vigour control is the major problem with this system when vigorous rootstocks as INRA®GF-677, Garnem® or Cadaman® were used. Density of planting ranges from 1,100 to 2,500 trees/ha. Support structure is required and planting costs increased compared to other less intensive systems.

In a long term trial carried out during the period 1995-2004 at IRTA (Gimenells, Lleida), 6 training systems were evaluated with the peach cultivar ‘O’Henry®’: Ypsilon, Central axis, Vase, Double Y, Palmette and Tatura. A study of both agronomical and economical performance was reported by Nuñez et al. (2006). All the systems except Gobelet and Double Y required support structure. Planting costs were greater for Central axis and Tatura, because the support structure. The greater cumulative yield was obtained with Ypsilon and the lowest ones with Double Y (small vase with four branches). Neither, mean fruit weight nor fruit size distribution was affected by the system (Table 3).

Table 3. Cumulative yield (from 2nd to 10th year of planting, no production in 2005), mean fruit size and mean fruit weight of peach cultivar ‘O’Henry®’ on six training systems at IRTA Experimental Station of Lleida (Source: Montserrat et al., 2005, *personal communication*)

System	Cumulative yield (t/ha)	Percentage (%)	Fruit weight (g)	Fruit size distribution (%)			
				Φ 65-70	70-75	75-80	>80 mm
Ypsilon	295.3	113	222	11	22	33	33
Central axis	285.6	109	228	9	21	30	40
Vase *	260.7	100	232	8	20	32	41
Double Y	224.8	86	235	6	18	31	45
Palmette	264.1	101	233	8	19	32	41
Tatura	285.3	109	231	11	19	28	42

* Control (=100) for cumulative yield %

The lowest annual current cost (without amortization and interest) was obtained with the Double Y because low tree density and, all labours were done from the ground and there is no need of mechanization. The greatest cost was obtained with Tatura and Double Y. In terms of economical performance and compared to the Gobelet (reference system), Ypsilon was the best and Double Y the worse. Considering duration of plantation of 15 years, Ypsilon and Gobelet were the most profitable systems in terms of net return for the grower, but in both cases mechanization of some labours as thinning is not possible.

Nowadays the main training system used in Spain (around 86% of orchards) is the vase (open vase) with different modifications depending on the area of production. One of the most important modifications/adaptations developed in the last decade is a particular and small vase named “Catalan vase” or “Summer vase”. The importance of this system is because it allows obtaining early yields (Table 4), the investment for planting is cheap, compared to more intensive systems, it allows the mechanization of the summer/winter pruning and specialized labour is no required to train it. The low cost of planting it´s due to the mid density of plantation, around 700 trees/ha, being the range of planting distances from 5 to 6 m (between rows) by 3 to 3.5 m (between trees), and the most commonly used 5 x 3 m. “Catalan vase” has been developed during the last two decades, starting in the area of Lleida (Catalonia) and latter on some areas of Aragón and the rest of Spain (Montserrat and Iglesias, 2011). The basis of this system leads in two summer pruning interventions (July and August), during each of the two first years. The objective of these interventions is to multiply the branches with the aim to fill the space assigned to each tree as fast as possible (Figure 10). At third year of planting tree should be almost finished and important yields can be achieved (Table 4). At fourth year full yield should be obtained in most of the cultivars. To achieve this goal a mid to high vigorous rootstock (INRA®GF-677, Garnem, Cadaman, etc.) is required in order to provide the adequate tree vigour. When the tree forming is finished, the use of growth regulators (as pacobutrazol), allows tree vigour control if necessary.

Summer pruning during the first year is done by hand (Figure 10). In the second and third year it is done mechanically by “topping”. After the third year of planting the topping is done one or two times per season depending on the cultivar and the tree vigour. It can also be applied on both, the top and the laterals.

Table 4. Mean yields obtained using the training system “Catalan vase” with cultivars of early harvest and mid-late harvest using a planting distance of 5 x 3 m (667 trees/ha)

Harvest time	Cultivar	2nd year		3rd year		4th year		5th year	
		kg/tree	t/ha	kg/tree	t/ha	kg/tree	t/ha	kg/tree	t/ha
June	‘Rich May®’	6	4.1	18	12.1	32	21.3	40	26.6
July	‘Big Top®’	4	2.7	28	18.7	44	29.3	61	40.5
August	‘Venus®’	16	10.7	35	23.3	64	42.6	76	50.3

Source: Iglesias and Montserrat (2011)

Earlier yields are obtained with cultivars that produce better on one year old shoots and with mid to high blooming density as ‘Nectaprima[cov]’, ‘Ambra[cov]’, ‘Noracila[cov]’, ‘Carene’, ‘Honey Glo’, ‘UFO-4[cov]’, ‘Sweet Cap[®]’, etc., than in cultivars producing on old wood and with lower or mid blooming density as ‘Big Top[®]’, ‘Honey Royale[®]’, ‘Rome Star[®]’, ‘Zee Lady[®]’, ‘Elegant Lady[®]’ or ‘O’Henry[®]’. This training system allows the harvest of almost all the yield from the ground or using small and cheap ladders. Common tree high is around 2.2 m tall. Mechanical pruning (“topping”), must be combined with manual pruning, both on summer and winter. Tree canopy is composed of four to six main branches on which the fruiting branches were inserted.

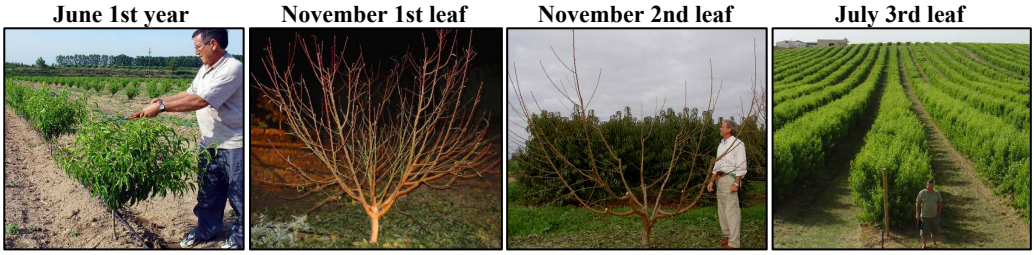

Figure 10. Different stages to train the “Catalan vase”, from the first to third year of planting at dormant bud.

Pests and diseases

The most important disease in terms of economical losses of peach is brown rot, caused by *Monilinia* spp. Fortunately, in Spain peach is mainly planted in warm and dry areas, where the climate conditions are less favorable for the development of this disease. However, the problem is present in mid season and late varieties in years and situations with humid conditions. It is important to point out that in the EU postharvest application of fungicides is not allowed, which makes the control of this disease more difficult compared to other producing countries as USA or Chile. Chemical sprays in the field are the main control tool and some new active ingredients with good efficacy have been registered in the last years. In a near future the availability of tolerant and/or resistant cultivars will provide a major advantage in order to decrease the number of treatments and drive the production towards a more sustainable way (Frey, 1998; Pascal and Monteux-Caillet, 1998; Bassi et al., 2010; Gallardo et al., 2012). Powdery mildew (*Sphaerotecha pannosa*) is a disease with a major incidence in dry and warm climates. The active chemicals available (triazole group and others) are efficient enough and, in most of the cases, with a right spray program this disease do not represent a major economical problem.

Concerning pests, the Western flower thrips (*Frankliniella occidentalis*) and the Mediterranean fly (*Ceratitis capitata*) along with aphids, are the most important ones. In the first case, the main problem appears in sweet taste and red nectarine

cultivars (like ‘Big Top®’). So far, chemical sprays provide the most efficient control of this pest. In this moment, very few active ingredients are available (spinosad, acrinatin) and possible appearance of resistances, as has happened in vegetable crops, is major concern for growers. Mediterranean fly (*Ceratitis capitata*) is nowadays the most important pest in peach, especially in milder areas and in mid season and late varieties. The availability of efficient chemicals to control this pest has been drastically reduced in the last years and only some piretroids, and, metil clorpirifos are available nowadays. In this scenario another efficient strategies have been developed and are extensively used by the fruit growers: mass trapping (Tripack®, etc.), attract and kill (M4®, Agrisense®) or chemosterilization (Adress®), which can reduced significantly the number of treatments. Aphids, mainly *Myzus persicae,* are also a major pest of peaches. Their impact is increasing in the last years because of the decreasing efficacy of chemical control. Aphids present different levels of resistance to neonicotinoids, the products that traditionally have been used against this pest and few alternative strategies are now available for their control.

In the EU, the reduction of active compounds has been very significant in the last two decades and will also continue in the future as a result of application of the Commission Directive 91/414/CEE (1993), the RD 2163/1994 (in Spain) and the EU Regulation CE 1095/2007. As a result, the availability of active compounds to pest and diseases control has been reduced in a 72% in the last 15 years (from 835 in 1993 to 239 in 2010). For this reason, their efficient control at a reasonable cost will be in the future a major challenge for peach production in Mediterranean areas. As a positive effect to the intra EU exports, it should be mention the recent unification of the RMLs for the whole EU by the EU regulation R-CE-149/2008 of the Commission.

Cost of production

The cost of production has been increasing as much as twice in the last eight years in Spain. Based on the data of 2011 the cost in the area of Lleida (Catalonia) ranged from 0,31 to 0,52 €/kg (Table 5), depending on the cultivar, yield and harvest data. This is significantly much more than the net prices received by the growers, which in 2005, 2009 and 2011 were lower than the cost of production. The major increase of price affected fuel, fertilizers, electricity, chemicals and labour (Miarnau, 2009). Based on the data from France (Roussillon), Italy (Emilia Romagna) and Spain (Lleida) the total cost/hour in 2011 of labour for peach harvest was: 7.80; 10.80 and 12.10 €/h, respectively. The total cost of production (orchard) for Italy, Spain, Greece and France were: 0.43, 0.36, 0.32 and 0.57 €/kg, respectively, for a mid season cultivar (Figure 11, right). In this figure the postharvest cost is also indicated for the same countries.

Current annual costs include labour, irrigation, inputs (fertilizers, chemicals), machinery, hail protection and others. Annual amortization includes the annual cost of scions, planting, royalties, drip irrigation, and the costs during the first and the

second year. The share of each of the mentioned costs in the total cost is represented in Figure 11, considering a mid season cultivar, with a total production of 40 tons/ha and 12 years as an expected duration or the orchard.

Table 5. Total annual costs (current + amortization) considering an early, mid and late season harvest cultivar in 2011 (Source: Miarnau, 2012; *personal communication*)

CONCEPT	€/ha-year			€/t		
	25 t/ha	40 t/ha	45 t/ha	25 t/ha	40 t/ha	45 t/ha
Current costs	10,664	11,700	12,100	414	283	258
Amortization	2,625	2,600	2,565	105	65	57
TOTAL	13,289	14,300	14,665	519	348	315

Labour cost (pruning, thinning and harvest) represents close to 50% of total cost. Manual fruit thinning has a direct effect on the total orchard cost and depends mainly on blooming density and fruit set of the cultivar. The total cost can range from 0.31 €/kg for low blooming density cultivars as ‘Big Top®’, ‘Honey Royale^{cov}’ or ‘Elegant Lady®’ to 0.42 €/kg for high blooming density cultivars as ‘Ambra®’, ‘Noracila’ or ‘Honey Glo®’ (Figure 11, left). This difference is due to the increase of thinning cost from 13% to 24% of total cost, for low and high blooming density cultivars, respectively. For this reason, thinning at blooming is recommended on these cultivars in areas with mid to low risk of spring frost.

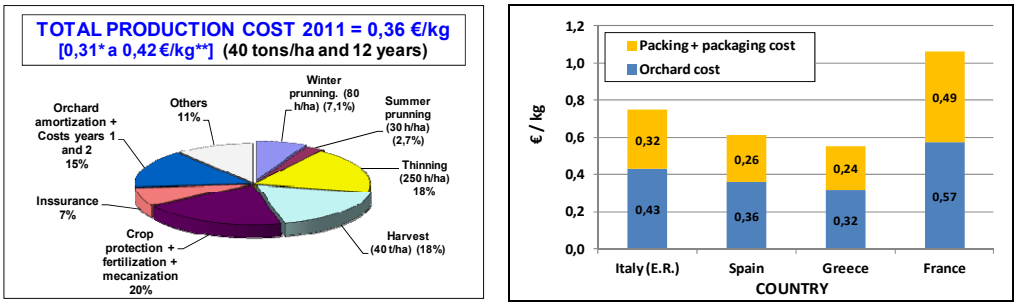

Figure 11. Distribution (%) of total cost of production in Lleida (Catalonia) for a mid season nectarine cultivar, trained in “Catalán Vase” and, an expected duration of the plantation of 12 years (left). Orchard costs plus packing and packaging costs corresponding to four different countries in 2011 (right). In both cases a mid season cultivar with a total yield of 40 t/ha was considered.

Conclusion

The increasing importance of peach production in Spain justifies the huge efforts carried out by the fruit industry during the last two decades. This has been possible through the improvement of technology on both, field and postharvest. In the first case the main innovation has been the introduction and development of new

and improved cultivars in terms of appearance and taste. The increasing importance of flat peach production is an example of adding value by new cultivar development. Unfortunately, this intense renewal of traditional cultivars has not influenced on an increase of consumption. The development of specific training systems, well adapted to conditions of the main growing areas as the “Catalán vase”, allows the efficient use of labour, early yields and low cost of plantation. In addition, the implementation of integrated production and certification systems puts Spanish fruit industry in the right way to gain competitiveness on a global market. Special attention should be devoted in the future how to increase peach consumer satisfaction. Production in a more sustainable way by the development of new cultivars resistant or tolerant to main pest and diseases is a key point because the progressive reduction in the EU of chemicals for pest and diseases control. Fruit quality parameters should be established for the new highly and precociously coloured cultivars in order to guarantee consumer satisfaction and enhance its consumption across European countries. In the near future more effort should be devoted to add value to new cultivars through the promotion of fruit consumption and identification of cultivars based on their taste. This should improve consumer satisfaction, increase demand and in turn peach production will be more profitable for the growers.

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Invited lecture

CHANGES OF THE APRICOT VARIETY CHOICE IN HUNGARY

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Abstract. 30 years ago, Hungary was one of the most significant apricot producers in Europe, which produced around 100,000 tons and exported yearly about 20,000 tons of apricots. The present figures are 20,000 – 40,000 t/year production and 2-3,000 t/year export. The considerable variation of yields is caused by the risk of winter and spring frosts coupled with obsolete technologies. The security of production could be improved substantially by transferring the plantations from the lowland to the hilly regions of the country of 170-350 m above sea level. At the same time, technologies have been developed with the purpose to moderate the risk of spring frosts. The majority of traditional plantations is planted loosely (8 x 5 m, 7 x 4 m) with long trunks and umbrella crowns. Irrigation and fruit thinning were not applied generally.

During the last decennia, however, intensive orchards have been planted on several hundred hectares (5-6 x 4 m, short trunks, vase-type crowns). They start fruiting early, yield profusely (20 - 30 t/ha) and produce excellent fruit quality.

The reorganised national food commerce and the increasing international retailers have requested a different range of fruit qualities. The assortment was partially replaced with new type of apricots.

The yielding safety and marketability of the new varieties has been studied on a range of growing sites. Threefold difference in the flower bud densities were observed between varieties. Frost damage has been scored both in the field as well as in laboratory tests. Under Hungarian conditions, those varieties yielded good and regularly, which develop many flower buds and stay dormant for a longer time, i.e. they are frost tolerant in a practical sense.

Less decline in quality during storage, i.e. storability is also an advantage of most new varieties. The highest scores received the varieties ‘Bergarouge’, ‘Goldrich’, and ‘Tom Cot’.

For sensory tests, a judging system has been developed with 100 points applied to 11 parameters. An easily perceptible profile-diagram visualises the differences of the varieties compared. The Hungarian consumers generally require a taste and aroma typical of apricots, beside sugar content and juiciness. This is proved by the tight correlation between general impression and taste ($r = 0.888$), as well as between general impression and sweetness ($r = 0.917$).

Key words: apricot, variety, safety of production, storability, sensorial evaluation.

Introduction

Since the beginning of 1990-es, the structure of fruit production and the conditions of husbandry changed radically including the marketing of products. As a consequence of privatisation, profitability gained special importance in commercial enterprises. Growing sites, varieties and information concerning the actual market are appreciated much more than earlier. The region of Kecskemét is frequently threatened by ruinous late frosts, but the danger lost its importance with the change of varieties. Meanwhile apricot plantations are established on the hilly sites of the community Gönc.

Before two decades, the apricot picking season lasted from end of June until end of July. The majority of fruits on the Hungarian market is represented by the variety group ‘Magyar kajszi’. The huge volume of suddenly ripening fruit overburdens the apricot market.

Due to innovations of the variety choice, nowadays apricot picking lasts from early June until early September, and in some years, the season ended in late September. Stored fruits are offered in Hungary until the mid of October (Szabó, 2012).

Apricot (*Prunus armeniaca* L.) is one of the most famous fruit species in the Mediterranean. It is characterized by an early blooming period, so it faces many problems as at the end of winter, very low temperatures may still occur. In Hungary, winter and spring frosts are environmental factors that determine apricot yields, as it may cause heavy damage to flower buds. During the autumn-winter period, until apricot flower buds are in an endodormancy stage, many reports recorded high tolerance to frost damage. At the beginning of bud swelling, during the ecodormancy release (end of winter-beginning of spring) frost tolerance decreases concomitantly with the reactivation of bud growth (Szalay et al. 2006). In this stage, frost can cause irreversible damages such as browning of flower bud tissues (Guerriero et al. 2006). During this phase, the vascular connection between the floral organs and bud axis is restored, the xylem vessels reach the ovary and the water moves into the flower tissues. This condition can determine the development of ice crystals that destroy the integrity of the cell walls with the appearance of extra-cellular damages (Szalay et al. 1999).

Apricot fruit has a limited postharvest life. The fruit is climacteric and undergoes rapid ripening, including softening. As a rule, fruits are picked at a pre-climacteric stage in order to be firm enough to withstand packinghouse handling and marketing. The storage time limits the rapid softening after harvest (Ezzat et al., 2012).

The marketing value of the fruit depends largely on the preference of the consumers. The fruit offered on the market is often checked by sensorial tests. The parameters observed in the apricots are: external appearance, disorder colour of the skin, flavour, skin thickness, firmness, juiciness, apricot-taste, sweetness, acidity, unpleasant by-taste, general impression. The sensorial test has been performed

according Meilgaard et al. (2000). The reliability of the data raised depends largely on the competence of the jury and their practical skill of members (Guinart & Petit, 1996). The sensorial evaluation indicated the overall quality to be positively correlated with flavour, sweetness and juiciness (Valentini et al., 2006). Good correlations with intrinsic parameters such as firmness and SSC (but only up to 14 °Brix). To evaluate other variables, including melting, juiciness and floury texture, sensorial evaluation resulted as the only suitable method (Lespinasse et al., 2006). Negative characteristic of apricots is flesh mealiness (Kantor et al., 2008). On the other hand, the prevailing positive characters of apricots were pointed out as ‘easy to eat’ and ‘attractive’. The most desired characteristics were ‘sweet’ and ‘aromatic’, considered far more important (63%) than ‘juicy’ and ‘melting’ (27%).

Sensorial evaluation coupled with consumer science can provide predictions in consumer preference trends and help breeder’s decision-making in selection (Gatti et al., 2009).

Materials and methods

The apricot varieties examined are bred and introduce by the GYKF Ltd at Cegléd and the Corvinus University, Faculty of Horticulture at Budapest. Pioneering role of introducing foreign varieties is owed to Tradecot Ltd. started in 1998 and continued by the Gyümölcsért Ltd. after 2007.

The experiments and observations have been performed at three sites: University of Debrecen assortment of varieties at Pallag station, moreover at the community Boldogkőváralja and at Balatonvilágos in a commercial plantation (Table 1).

Table 1. Characterisation of plantations as sources of samples

Site property	Debrecen	Boldogkőváralja	Balatonvilágos
Geographic elevation	127 m	270 m	160 m
Soil	sandy	heavy, clay	intermediate
Planting date	2005	2000-2007	1998-2005
Rootstock	myrabolan seedling	myrabolan seedling	myrabolan seedling
Planting system	5 x 3 m	6 x 4 m	5 x 4 m
Form of the crown	vase	vase	vase
Soil surface	fallow	lawn	lawn
Irrigation	no irrigation	irrigated	irrigated

Safety of production. This research was conducted during two seasons continuously studying the differences between some apricot varieties regarding tolerance or even resistance to frost during the winter time in Hungary.

For this experiment, 4 trees per variety and 4 branches per tree were tagged. The tagged branches were distributed all over the 4 cardinal points (north, south, east and west).

On the experimental branches measurements have been performed as follows:

Shoot length, total number of buds, number of flower buds, number of vegetative buds number of mixed buds. The flower bud density was expressed by the number of flower bud per cm length of the shoot, i.e. bud/cm. Before the dates of 7 March 2011 and 21 February 2012 temperature dropped dramatically. Subsequently, the flower buds were examined. The buds were cut longitudinal by scalpel and examined by binocular microscope.

As for a check, during 2012, 10 branches per variety (‘Ceglédi óriás’, ‘Bergeron’, ‘Gönci magyar kajszi’ and ‘Sylred’) were collected. The flower buds were counted, and then the shoots were placed into a computer controlled climatised chamber.

After gradual cooling, the plant parts were kept at the experimental temperature for 4 hours. Then the temperature was gradually raised.

The cooling rate of temperature change was 2 °C per hour. After finishing the treatment, the branches were kept at room temperature for 24 hour. The extent of frost damage was determined by a visual observation of the longitudinal section of buds.

The experiment was conducted twice at different dates 19/02/2012 and 23/02/2010.

Storability. This study investigated the effect of storage at the temperature of 3 °C on fruit quality during a storage period of different length (1, 2, 3 and 4 weeks) of the following apricot varieties: ‘Goldstrike’, ‘Goldbar’, ‘Gold Cot’, ‘Bergarouge’, ‘Flavor Cot’, ‘Bergarouge’, ‘Bergeron’, ‘Jumbo Cot’ (‘Goldrich’), ‘Robada’, ‘Tom Cot’ and ‘Sweet Cot’ grown in Hungary. The present investigation was carried out over two successive seasons 2010 and 2011 at Boldogkőváralja, Hungary. Fruits of experimental varieties were considered in both seasons. Fruit chosen for this study were uniform in size, colour and weight and were immediately transported to the laboratory of pomology. Each sample involved 90 fruits per variety. All the measurements were performed on about 10 fruits immediately after harvest. Other fruits were stored at 3°C for 7, 14, 21 and 28 day long periods and examined subsequently in order to assess the effect of storage on fruit quality. The following parameters were determined after cold storage: weight loss (%), fruit firmness (kg/cm^2) by Magness Taylor penetrometer juice TSS% by hand refractometer and juice acidity (%).

Sensorial evaluation. Measurements are performed in 2011, at the Debrecen University, Centre of Agriculture and Husbandry, Institute of Horticultural Science, where 14 varieties were examined derived from different growing sites.

Soluble solids (Brix %) and acidity (%) are measured instrumentally on 10 samples per lots.

Sensorial tests are carried out according to the scale shown in Table 2.

Preparation of the samples has been performed according to the following manner: Two dishes were used for each sample: one for the entire fruits, another for the sliced fruits. The jury could decide upon the outside and inside characters by

considering both parts of the sample: skin, flesh, consistency, flavour, taste. The results are expressed by a number of the scale 1 – 100 instead of the former 1 – 5 scale, in order to widen the possibility of distinction. The complex presentation of several properties on a single diagram was preferred. At three successive dates of the ripening process fruits have been tested (2011. June 27; July 11 and July 22), by the jury consisted of 10-14 persons.

Table 2. Items of the sensorial tests

Parameter	Range	Scale
Shape and skin disorder	scatheless……..……scared	1 –100 point
Skin colour	pale …….....typical, intense	1 –100 point
Aroma (flavour)	atypical, faint……..…….... intense	1 –100 point
Skin thickness	too thick ……..... optimal	1 –100 point
Flesh firmness	soft ……....…….……firm	1 –100 point
Juiciness	dry ……..……..optimal, juicy	1 –100 point
Apricot flavour	faint ……..……...……intense	1 –100 point
Sweet taste	feeble or too strong…….……. optimal	1 –100 point
Acid taste	feeble or too strong…..…….…..……. optimal	1 –100 point
By flavour not desired	intense …….…… absent	1 –100 point
General impression	rejected……....… ……..very good	1 –100 point

Additionally, the summed up results may help to put the varieties in a successive range, and compared the diagrams of the varieties of nearly the same ripening date.

The data raised with instruments as Brix % and acidity (%) represented 10 fruits per sample. Instrumental and sensorial results are compared with each other and evaluated within the groups of ripening dates.

Result and discussion

The choice of variety

Earlier, the Hungarian apricot production was based on national (local) varieties. Initially the most important varieties were adapted directly to the National List in 1956 or some were selected from landraces during the 1950’s and 60’s. The clones of well-known ‘Hungarian Best’ like ‘Gönci magyar kajszi’ and ‘Magyar kajszi C.235’ dominate the main season till nowadays since the consumers on the domestic market prefer their excellent flavour. The giant fruit-size of ‘Ceglédi óriás’ and similar types enjoy similar popularity in the less intensive orchards.

The popularity of late ripening, so called “Rózsa” apricots, declined in importance on the market partly because of their Plum Pox Virus sensitivity, during the 1980’s. There are some extraordinary examples. The ‘Mandulakajszi’, named after their almond-shaped fruit, kept its position due to the unique quality and

adaptability to the environmental conditions. Their producers specialised for the national and German market. Other old varieties disappeared from the professional plantations.

In the 1980's and 90's, new varieties were introduced to the Hungarian market originating mainly from cross breeding. The productive local varieties were combined with each other or crossed with foreign (Eastern European) apricots. The good flavour was one of the purposes during the projects. The majority of above mentioned, widely-grown varieties cover the season from the mid-early ripening till the mid-late time. However, the growers would like to extend the season.

With the expansion of chain stores and new possibilities of export, new fruit characters appeared as desirable. Large fruit size, dark orange fruit skin with largely covered by a red colour are considered to be most attractive. A firm consistency, which tolerates manipulation instead of getting soft and a prolonged shelf life are the ideal.

The national list of varieties to be multiplied contains 31 items. 22 of those are Hungarian, 3 from the USA, 2 French, 1 Canadian, 1 Afghanistan, 1 Uzbekistan. (Figure 1). Out of the foreign varieties, the French 'Bergeron' is the most successful since 1987. Beginning with 1980-es, mainly Romanian varieties have been acclimatised being late ripening types (e.g. 'Selena', 'Sulmona'). Acclimation of Canadian varieties appeared during the early 1980-es with the most successful 'Harcot'. In the USA as well as in the Mediterranean countries the change of varieties speeded up since the 1980-es (US, French, Italian and Spanish varieties appeared in the plantations). The same are represented after the end of 1990-es also in Hungary. The majority of plantations held Hungarian varieties until 2008. (Figure 2), but since then, foreign varieties prevailed (Table 3).

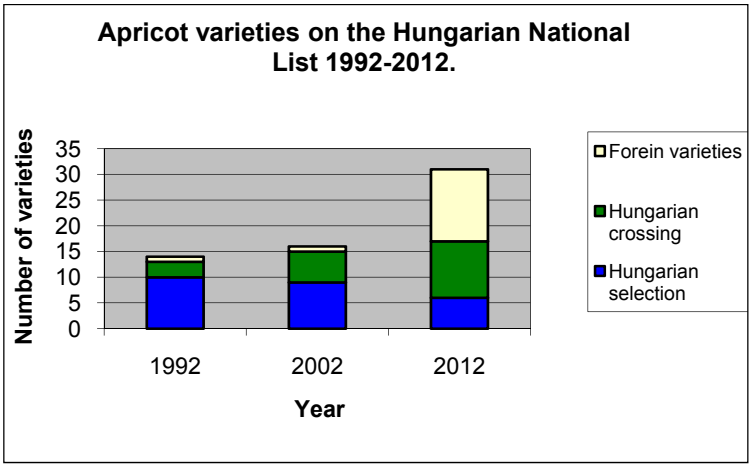

Figure 1. Apricot varieties on the Hungarian national list 1992-2012

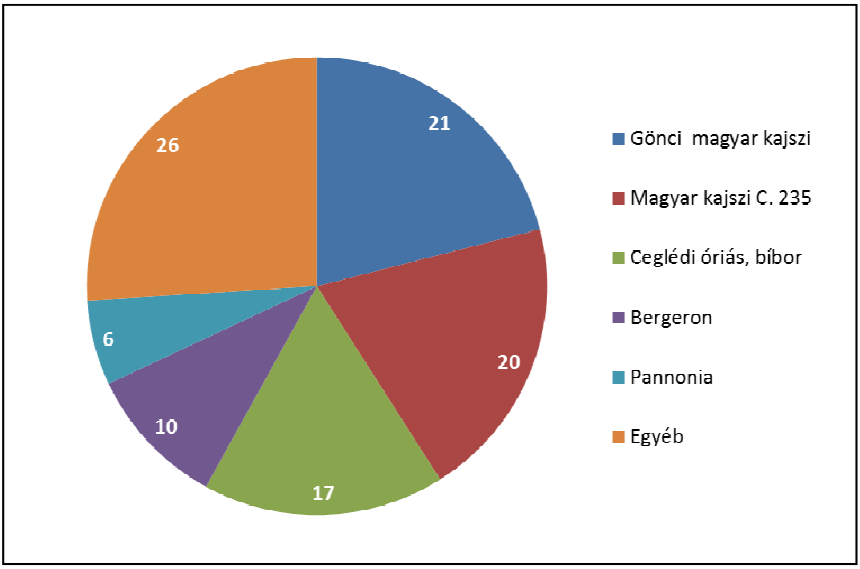

Figure 2. Rate of apricot varieties in Hungarian plantations in 2007 (*Source: Ferencz, 2012*)

Table 3. Ratio of apricot varieties in new plantations in Hungary after 2008

Variety	Share in new plantations (%)
Gönci magyar kajszi	14.1
Magyar kajszi C.235	9.4
Bergeron	7.5
Pinkcot	7.2
Bergarouge	5.8
Ceglédi arany	4.5
Pannónia	4.2
Kioto	4.1
Roxana	3.7
Harcot	3.0
Flavor Cot	2.7
Big Red	2.6
Bergecot	2.4
Tardif de Valence	2.0
Goldrich (Jumbo Cot)	2.0
Mandulakajszi	1.6
Ceglédi bíbor	1.4
Sweet Red	1.4
Orangered	0.9
Ceglédi Piroska	0.6
Other varieties	18.9

Source: Ferencz, 2012

Safety of production

The dates in Figure 3 showed that during 2012 the late frost damage percentage was higher than the injured percentage in 2011. The ‘Tardicot’ variety was less affected by frost meanwhile the ‘Silver Cot’ and ‘Palumella’ exhibited the highest damage, about 82 % and 85 % loss in 2012, respectively. On the other hand, it was noticed that ‘Silver Cot’ and ‘Palumella’ were not the most affected in 2011, because ‘Ceglédi óriás’ suffered most and at the same time ‘Sylred’ was less affected. Almost every variety exhibited significantly different damages between the two seasons. We - can conclude that not any definitive trend exists, which causes the differences between varieties or seasons (Figure 3).

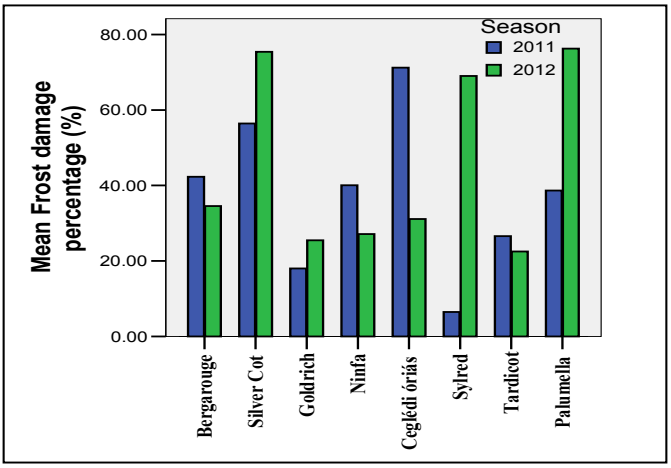

Figure 3. Mean frost damage percentage for some apricot varieties during the spring of 2011 and 2012

Concerning flower bud density, Figure 4 shows that there are significant differences between the two years of study for each variety except the case of ‘Bergarouge’ and ‘Palumella’. This may supported by the fact that flower bud density is determined by many factors like genetic characters, maturation status and fruit load of the previous year.

‘Bergeron’ did not show any change in flower but percentage at- 17 ^{o}C and -19 ^{o}C but it achieved high percent reached to about 90 % at – 21 ^{o}C.

‘Sylred’ showed highest percentage of loss especially at – 19 ^{o}C and – 21 ^{o}C reached to more than 65 % and 79 %, respectively. ‘Gönci magyar kajszi’ appear to be the most tolerant one as it achieved the lowest percentage of damage during all temperature categories (Figures 5 and 6**)**. The percentage of injured buds was higher at the date of 23/02/2012 for all varieties because the flower buds were less tolerant when they reached the state of ecodormancy at the end of winter and/or the beginning of spring.

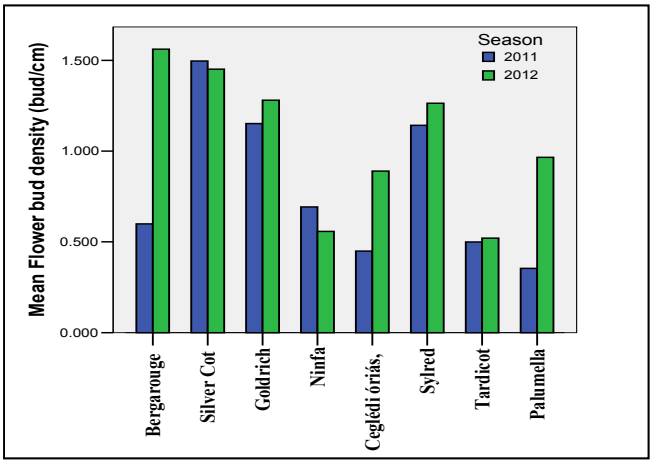

Figure 4. Mean of flower bud density of some apricot varieties during the 2011 and 2012

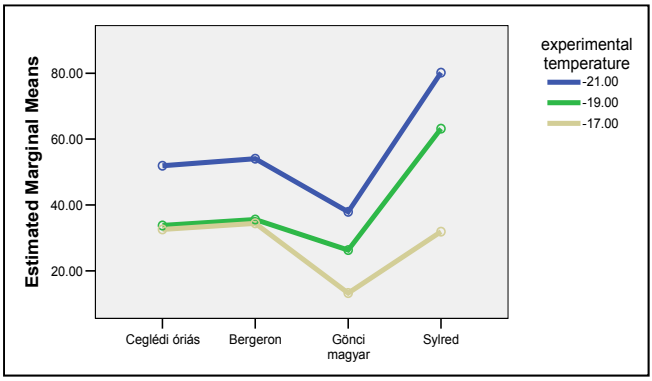

Figure 5. The frost damage percentage for four apricot varieties as affected by three temperature regime in artificial freezing experiment at 19.01.2012

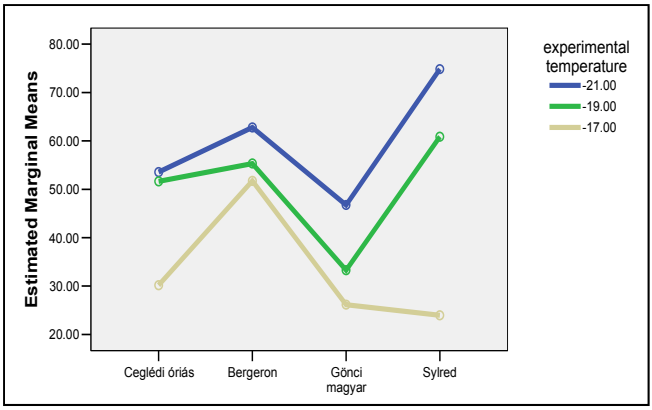

Figure 6. The frost damage percentage for four apricot varieties as affected by three temperature regime in artificial freezing experiment at 23.02.2012

Storability

Data in Table 4 show that the percentage of fruit weight loss of all tested varieties increases with the prolonged storage period. Regarding the differences between varieties, it is clear that the following varieties ‘Sweet Cot’, ‘Robada’ Gold Cot’, ‘Flavor Cot’ and ‘Bergarouge’ gave the highest percentage of fruit weight loss after 28 days as 8.2, 7.8, 7.1, 6.9 and 6.6, respectively in 2010. Meanwhile in 2011, these varieties followed different trends.

Table 4. Percentage of fruit weight loss of 10 apricot varieties as affected by storage for 7, 14, 21 and 28 days (Boldogkőváralja)

Varieties	Harvest weight (g)	Storage period			
		7 Days	14 Days	21 Days	28 Days
2010 season					
Goldstrike	77.40	1.07	1.97	2.72	2.65
Goldbar	63.3	1.54	2.41	1.58	5.01
Gold Cot	48.3	2.02	3.98	6.52	7.13
Flavor Cot	42.3	1.06	2.84	4.67	6.59
Bergarauge	67.2	1.56	3.05	5.66	6.92
Bergeron	47.2	1.59	4.56	5.09	5.45
Jumbo Cot	90.3	1.55	2.71	4.13	5.48
Robada	65.7	1.22	2.63	6.89	7.81
Tom Cot	57.5	1.74	2.74	3.61	4.32
Sweet Cot	58.9	1.65	3.77	7.19	8.16
2011 season					
Goldstrike	55.2	1.81	2.66	1.81	1.47
Goldbar	54.1	2.59	1.85	1.85	6.10
Gold Cot	44.3	2.2	3.50	3.50	4.29
Flavor Cot	48.8	1.43	2.20	2.2	5.02
Bergarauge	47.8	1.57	3.45	3.45	209
Bergeron	32.7	2.37	4.20	4.2	3.06
Jumbo Cot	63.1	1.31	1.58	1.58	5.74
Robada	50.2	6.83	4.26	4.26	8.20
Tom Cot	40.9	2.44	7.82	7.82	9.84
Sweet Cot	51.9	5.43	6.63	6.63	6.64

Regarding fruit firmness during fruit ripening, a loss of firmness occurs, which is a key factor limiting postharvest life. A wide range of fruit firmness at commercial maturity has been observed in different cultivars. So the data in figures 7 and 8 showed that firmness is reduced during the prolonged storage period. Concerning individual varieties, there are no big differences after harvest but the varieties take different trends after storage as we noticed from data that the ‘Robada’, ‘Tom Cot’ and ‘Goldbar’ gave the high firmness after harvest and after storage for 28 days in 2010. This trend was different in 2011, as ‘Bergarouge’, ‘Bergeron’, and ‘Jumbo Cot’ displayed the highest firmness as 2.8, 2.41 and 2.32 kg/cm^2 respectively.

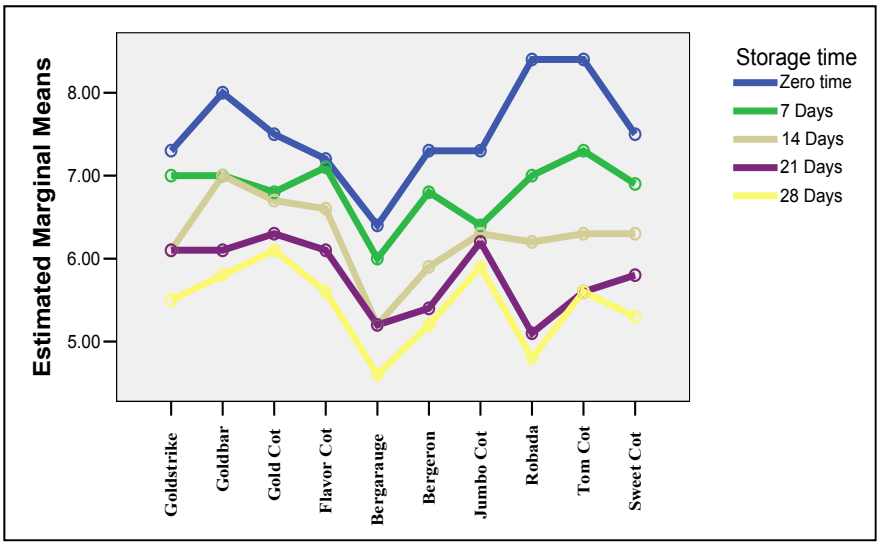

Figure 7. Change in fruit firmness of some apricot varieties as affected by storage periods of experiment (zero time, 7 days, 14 days, 2 days and 28 days) during 2011

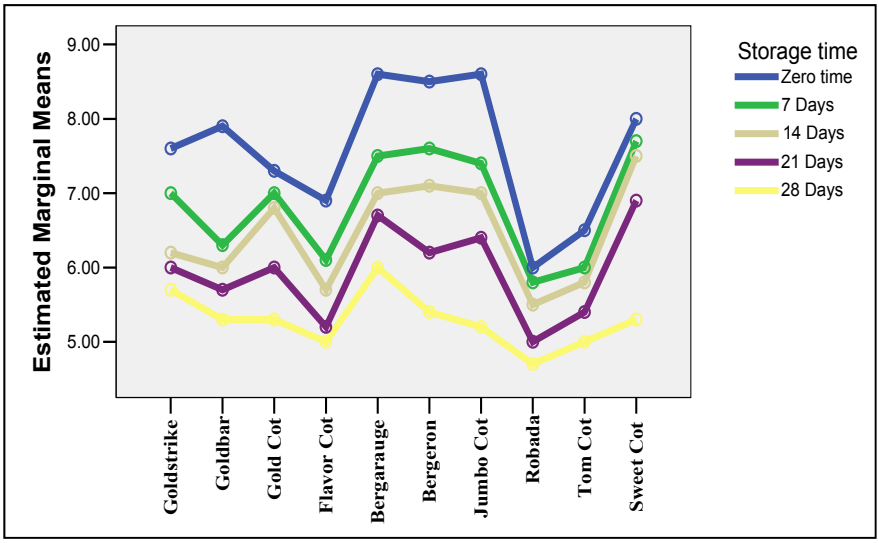

Figure 8. Change in fruit firmness of some apricot varieties as affected by storage periods of experiment (zero time, 7 days, 14 days, 2 days and 28 days) during 2012

In addition, it is clear from data in figures 9 and 10 that T.S.S (total of soluble solids) is different between varieties at harvest and are reduced during storage. Also, the difference between T.S.S of all varieties was significant. ‘Bergarouge’ achieved the highest reduction in T.S.S value after 7-day storage, meanwhile in ‘Goldstrike’ the T.S.S values ranged from about 12.3 to 11 after 28 days of storage. During 2012, the T.S.S values followed the same trend as in 2011.

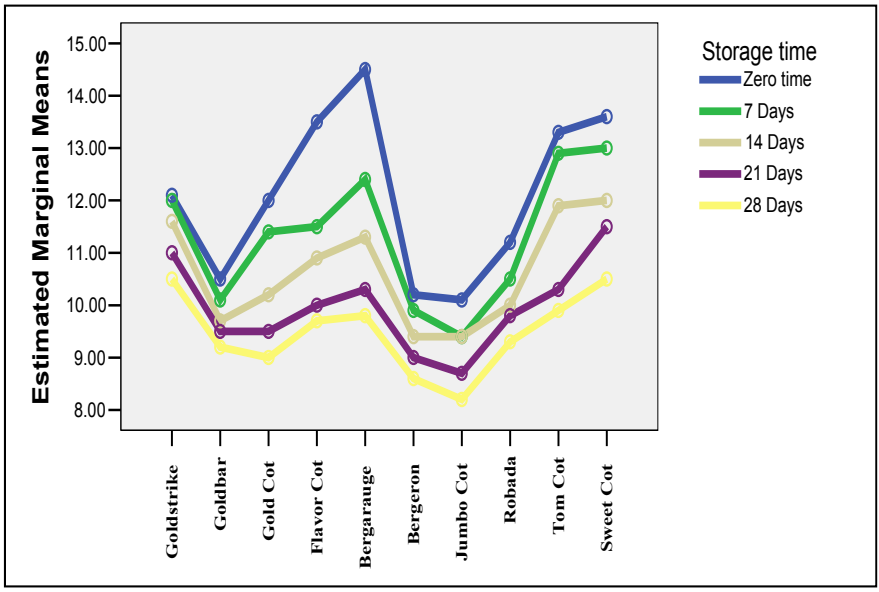

Figure 9. Change in soluble solids of some apricot varieties as affected by storage periods of the experiment (zero time, 7 days, 14 days, 2 days and 28 days) during 2011

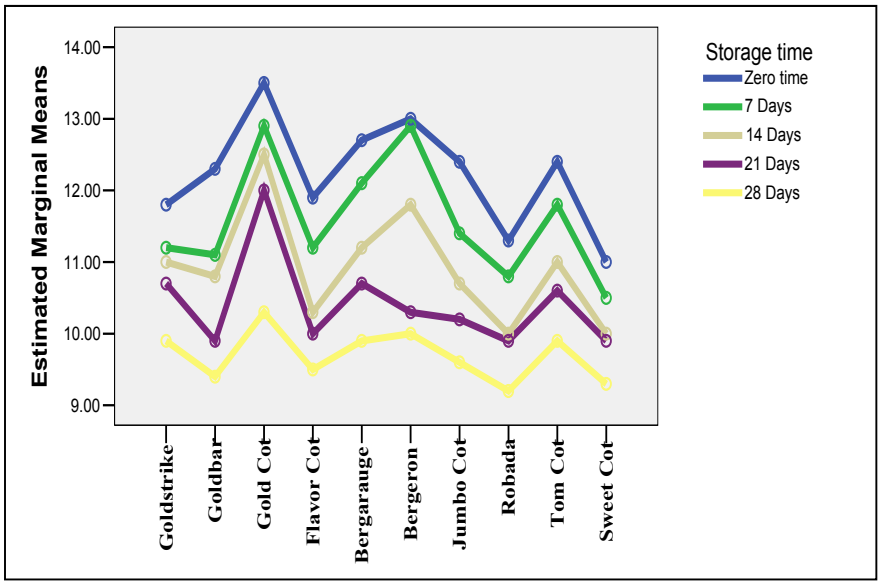

Figure 10. Change in soluble solids of some apricot varieties as affected by storage periods of the experiment (zero time, 7 days, 14 days, 2 days and 28 days) during 2012

Information in figures 11 and 12 show that the acidity of all varieties got reduced with increasing storage time during both seasons.

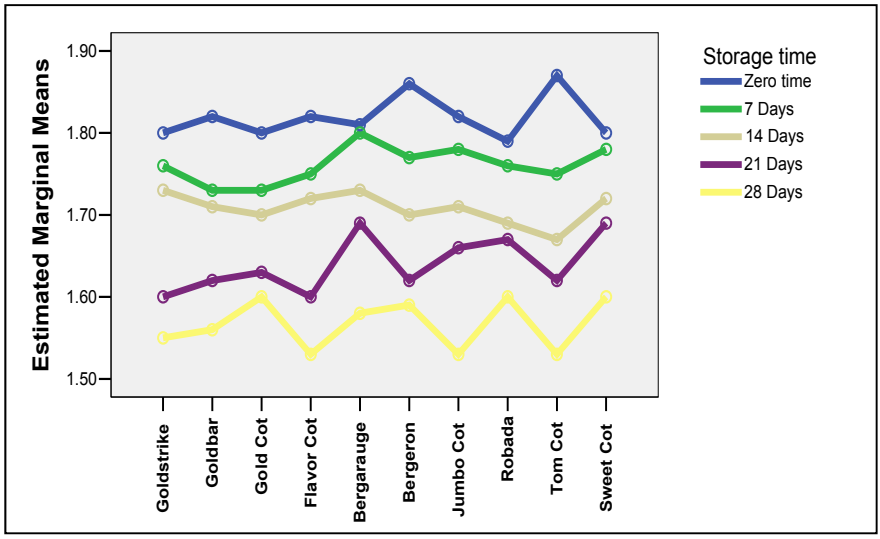

Figure 11. Change in fruit acidity of some apricot varieties as affected by storage periods of the experiment (zero time, 7 days, 14 days, 2 days and 28 days) during 2011

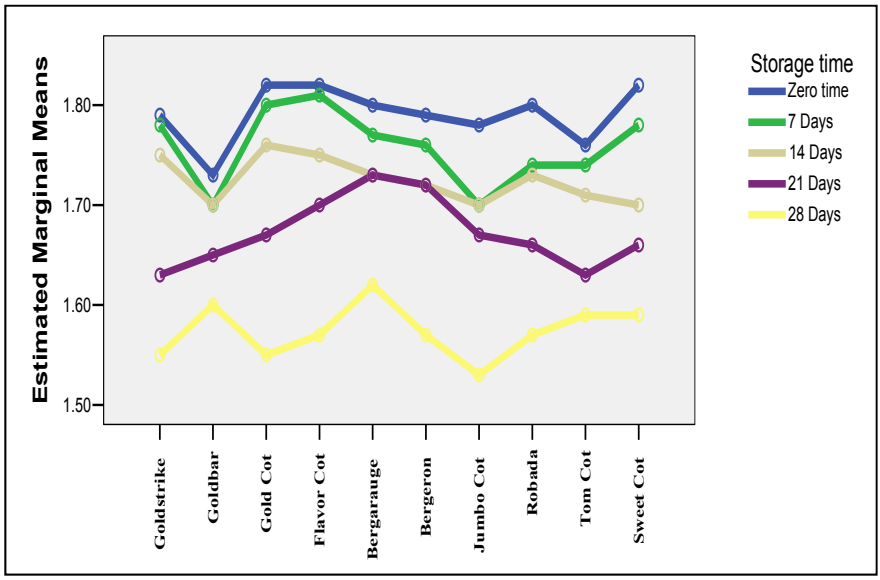

Figure 12. Change in fruit acidity of some apricot varieties as affected by storage periods of the experiment (zero time, 7 days, 14 days, 2 days and 28 days) during 2012

Sensorial evaluation

Conspicuous differences are observed between the samples of varieties regarding their maturity. This was the case especially in samples of a provenience from Nagykutas and Boldogkőváralja because those fruits have been picked earlier

for export purposes. This fact has been confirmed by the data of acidity and soluble solids (Table 5). As a consequence, total number of points was reduced (804-850) in those, less ripe samples with lower values of sugar and higher acidity (Table 5). It was stated that the highest scores are given to samples of Boldogkőváralja: ‘Ceglédi óriás’ and ‘Bergarouge’ (943.93 and 935.43 repectively out of the maximum 1100), as well as ‘Pinkcot’ (935.71) from Nagykutas.

Table 5. Rating of apricot varieties and growing sites in sensorial and instrumental tests (Debrecen, 2011)

Variety and growing site	Early season	Inter-mediate	Late season	Sum of points	Soluble solids (Brix %)	Acid content (%)
Pinkcot - Nagykutas	**X**			935.71	17.60	2.80
Tom Cot - Boldogkőváralja	**X**			844.14	15.10	2.50
Goldstrike - Boldogkőváralja	**X**			918.14	11.90	1.10
Robada - Pallag	**X**			868.57	12.50	2.50
Robada - Boldogkőváralja	**X**			851.93	14.60	2.90
Jumbo Cot - Boldogkőváralja	**X**			840.36	10.40	2.90
Ceglédi óriás - Pallag		**X**		850.14	11.80	1.60
Ceglédi óriás – B.kőváralja		**X**		943.93	13.40	1.90
Flavor Cot - Boldogkőváralja		**X**		913.07	9.60	1.00
Mandulakajszi - Pallag			**X**	870.93	12.98	1.40
Zebra - Boldogkőváralja			**X**	803.57	10.20	1.30
Bergarouge – B.kőváralja			**X**	935.43	12.30	1.50
Bergarouge - Nagykutas			**X**	914.57	18.80	2.30
Bergeron - Boldogkőváralja			**X**	825.00	11.60	2.30

For comparing the early ripening varieties, radial diagrams have been constructed (Figure 13). It is evident that the total number of scores does not facilitate a convincing evaluation of the varieties because the relative relation or interaction of the individual properties should be also considered. It is clearly expressed in the varieties ‘Pinkcot’ and ‘Goldstrike’, as in ‘Pinkcot’ acidity and firmness reduces the quality considerably, whereas ‘Goldstrike’ excels with its duly balanced character.

In the mid season group, three varieties have been examined only (Figure 14). ‘Ceglédi óriás’ samples from Boldogkőváralja excelled with their well balanced character. ‘Flavor Cot’ is lagging behind with its taste and flavour.

Among the late ripening group (Figure 15) ‘Bergarouge’ from Boldogkőváralja is the best in almost all characters examined.

From a comparison of 14 varieties we may conclude that the soluble solids content, i.e. sugar content or sweetness are most decisive. While foreign consumers (e.g. in Germany as an important foreign market) prefer less ripe fruits, the Hungarian consumers require higher sugar content i.e. sweetness. Consequently, outer appearance of the samples is less appreciated, whereas pretty samples receive

low scores because of low sweetness. Thus the correlation between sweetness and general impression was most tight (Figure 16).

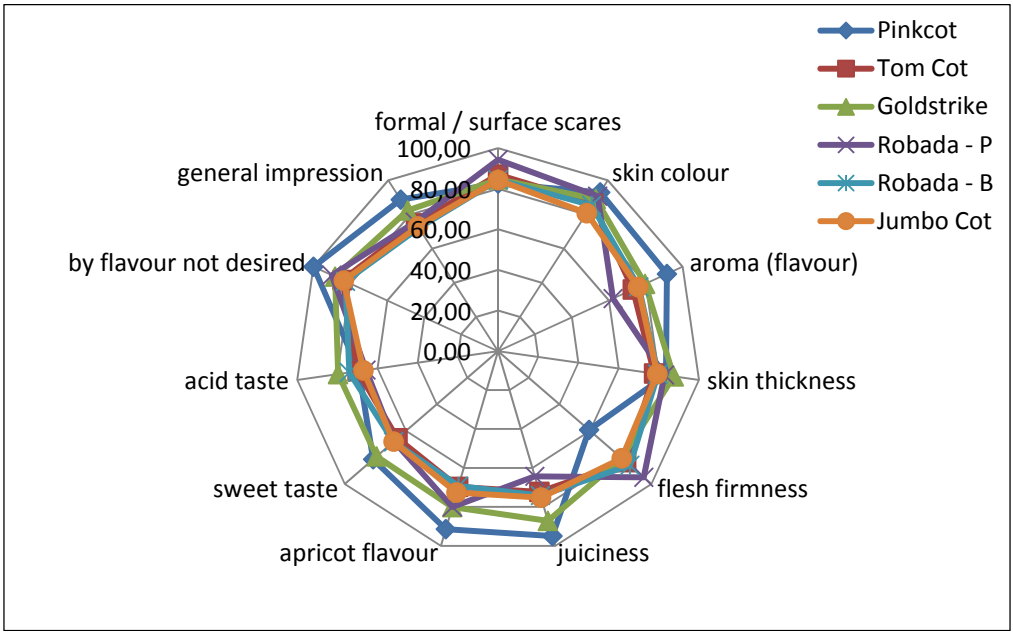

Figure 13. Radial diagram of early apricot varieties in sensorial tests (Debrecen, 2011)

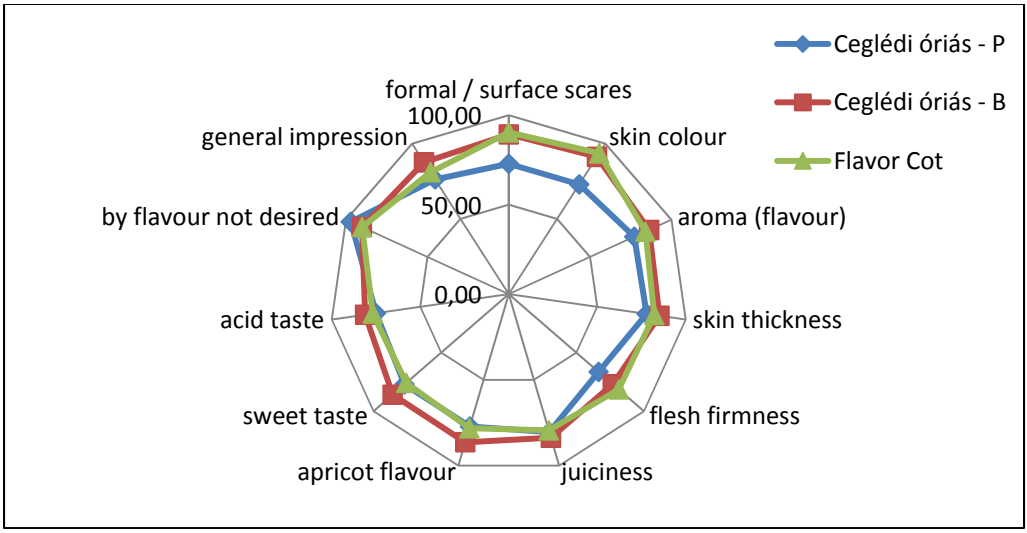

Figure 14. Radial diagram of mid season apricot varieties in sensorial tests (Debrecen, 2011)

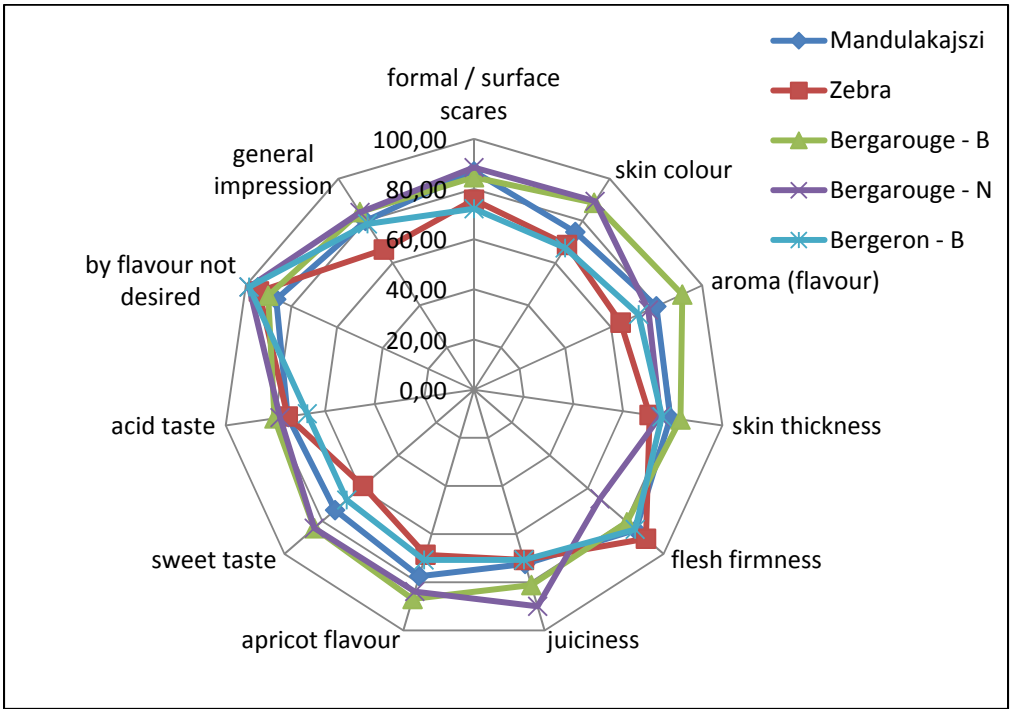

Figure 15. Radial diagram of late season apricot varieties in sensorial tests (Debrecen, 2011)

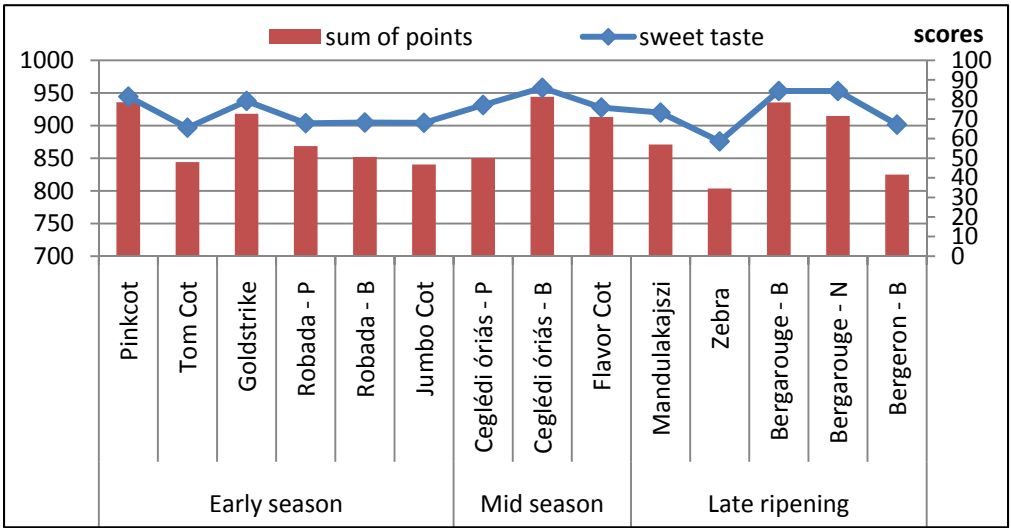

Figure 16. Scores received by sensorial tests of apricot varieties showing the correlation between the sum of points and sweetness of taste (Debrecen, 2011)

A matrix of correlation coefficients has been calculated between the results of the sensorial judgements and the instrumental results as soluble solids, and acidity (Table 6). We concluded that aroma and juiciness as well as aroma and sweetness, moreover, their correlation with general impression was in all cases more than 0.739. This is a proof that properties related with the degree of maturity dominate the results of sensorial tests of Hungarian persons. General impression is tightly correlated with the apricot taste and sweetness, i.e. 0.888 and 0.904.

Table 6. Matrix of the correlations between sensorial ratings with each other and laboratory tests of apricot varieties (Debrecen, 2011)

Properties	Skin colour appearance	Aroma/ flavour	Flesh firmness crispness	Juiciness	Apricot taste and	Sweet taste	Sour taste, acidity	General impression	Sum of points	Soluble solids Brix %	Acid content %
Skin colour, appearance		0.472	-0.251	0.483	0.629	0.573	0.243	0.580	0.792	0.396	0.128
Aroma / flavour			-0.619	0.739	0.699	0.794	0.498	0.790	0.789	0.240	-0.151
Flesh firmness, crispness				-0.873	-0.601	-0.676	-0.215	-0.611	-0.499	-0.568	-0.130
Juiciness					0.724	0.802	0.487	0.746	0.746	0.526	-0.066
Apricot taste and character						0.877	0.370	0.888	0.905	0.430	-0.087
Sweet taste							0.621	0.904	0.917	0.411	-0.186
Sour taste, acidity								0.395	0.567	0.026	-0.659
General impression									0.908	0.455	-0.096
Sum of points										0.377	-0.188
Soluble solids (Brix %)											0.508
Acid content (%)											

Acknowledgement

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Invited lecture

APRICOT BREEDING AT THE FACULTY OF HORTICULTURE IN LEDNICE

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Abstract. The aim of the apricot breeding programme in the Horticultural Faculty in Lednice developed since 1981 was to obtain new adaptable cultivars, which combine most of the valuable biological traits. Standard breeding techniques, such as crossing by emasculation and hand pollination, self-pollination and open pollination, were employed. A total of 1.154 crossings were produced from more than 110 different parents. So far more than 20.000 seedlings have been obtained, of which about 13.000 have already been evaluated. The most interesting selections were grafted and planted in trial orchards (we now have more than 650 elite genotypes). Ten of these have already been registered, and furthers promising new hybrids have been submitted for registration and law right protection (LE-3276 - Betinka, LE-2927- Candela, LE -2926 – Sophie and LE-3241- Adriana).
The basic prerequisite for the initiation of breeding program was a large collection of genetic resources, established and gradually supplemented since the 70s of last century. At the present time, we preserve and manage more than 300 accessions of apricot trees. In the frame of the description work of the genetic resources and in order to be used in breeding, a collection of apricots has been evaluated so that we selected the genotypes and characters relating to an increased level of adaptation to the environment.

Key words: selection, breeding, productivity, resistance, cultivars, PPV.

Introduction

Apricot production in Central Europe has many risks, mainly during the post-dormancy period. To improve the yield stability and profitability of apricot production it is first necessary to develop new varieties. Additional problems are diseases like viruses and phytoplasma. Many breeding programmes are focused on selecting for sharka (PPV) resistance (Dosba et al., 1991; Balan et al., 1995; Bassi and Audergon, 2006).

Among all pests and pathogens affecting the stone fruit production, the most detrimental both in orchards and nurseries is the sharka disease (Cambra et al., 2006). This disease, which is due to a virus, the Plum pox virus (PPV), was first detected in Bulgaria one century ago (Atanassoff, 1932) but since then has spread throughout Europe and is now found worldwide. It affects the fruit quality and production and its

cost, including fruit marketing, eradication of infected trees and sharka management, has been estimated at 10,000 million euros over the last 30 years (Cambra et al., 2006).

Syrgiannidis (1980) and Syrgiannidis and Mainou (1991) state in their works that the cultivars Stark Early Orange and Stella did not show any symptoms on their leaves after regrafting in the first two years.

Currently, the research of Plum Pox Virus including the creation of new resistant cultivars continues in fruit research institute in Skydra (Greek Macedonia), headed by Karayiannis (Karayiannis and Mainou,1999) selected from both, field trials and artificial tests of resistant cultivars for their breeding programs. Most of them come from North America: Early Orange, Stella, NJA 2, Sunglo, Veecot, Harlayne, Goldrich and Henderson, Lito and Pandora. The two cultivars Harcot and Bebecou were classified as tolerant ones. In Italy Faggioli et al. (2000) and Crescenzi et al. (2001), based on artificial inoculation - chip budding on woody indicator GF-305, have found the following tolerant cultivars: Antonio Errani, Cafona, Fracasso, Noumo, Paviot, Pelese di Giovanillo, Portici, Stark Early Orange, Stella and Veecot.

One of the possibilities to improve the market quality of apricot cultivation is the breeding and the subsequent selection of elite seedlings chosen in order to cross donors presenting a high level of adaptation with donors having high quality fruits. Another way to provide the selection of apricot genotypes suitable to given cultivation conditions is to introduce cultivars coming from around the world. This is the reason why several varieties, for example Veecot and Bergeron, were registered in the former Czechoslovakia. At the present time, other varieties such as Goldrich, Harcot, Harogem and Harlayne are being registered.

It is a very difficult breeding task to combine the valuable pomological traits together with environmental adaptability and yield reliability. This is the aim of this work.

Material and methods

The observation and preservation of several collections of apricot genotypes have been done in the seventies in the frame of the research program of the Department of Pomology in Lednice. In this zone, the average level of annual precipitation is 516 mm and the annual average temperature is 9,1^{o}C. It is a warm area; however frost often occurs during the periods of dormancy and post dormancy and also during the periods of blooming and of fruit formation. The gathered material of genetic resources of apricots comes from different areas and countries in the world as well as from our country. The collection consists of more than 300 accessions and clones and of more than 650 elite hybrids. Plantations were gradually realized, plants were cultivated as dwarf trees with free vase crown respecting a placing of 6 x 2 m. Orchards were regularly fertilized and protected against pests and diseases. Five individuals of each cultivar were planted. The evaluation of quantities and qualitative characters was done according to our own methodology of selection of elite seedlings

(Vachůn et al., 1999) and according to classification for the species *Armeniaca* (Nitranský 1992).

Since 1981 the donors of resistance towards the sharka virus – the cultivars Stark Early Orange (SEO), and Henderson - were used in crossings with the following donors of fruit quality: Vestar and Velkopavlovická (a clone of Hungarian Best). Standard breeding techniques, such as crossing by emasculation and hand pollination, self – pollination and open pollination were employed. A total of 1,154 crossings were produced from more than 110 different parents. So far more than 20,000 hybrid seedlings have been obtained.

We are also studying the genetics of resistance in many other crossings, using sharka-resistant donors like Henderson, Orangered, Goldrich, Veecot, Harcot, Harlayne, Sunglo and Riland. Later we included our own hybrids for the PPV resistance – LE-3276, LE-3241, LE-2926, LE-2927, LE-3246, LE-2904 and others.

To verify the resistance of apricot genotypes to PPV the following methods have been used: top-working of tested hybrids directly into the infected trees in plantation with flat expansion of PPV (strain Rec.), and the methods described by Audergon and Morvan (1990) with the use of woody indicator of GF-305 peach seedling. In some populations of crossings we used direct inoculation into one-year seedlings on own roots to accelerate the breeding process. The method used was chip budding using two buds of PPV-D or PPV-M strains. For genotypes, where after a one-year evaluation of visual symptoms no symptoms were found, the one-year shoots were inoculated with the GF- 305 indicator.

The virological phenotypic assessment of populations for resistance to PPV was conducted partly at the Crop Research Institute Prague - Ruzyně, partly at Horticultural Faculty in Lednice, due to the training organized by Dr. J. Polák and his team.

Control cultivar is Velkopavlovická as one of the numerous clones of Hungarian Best.

Results and discussion

In 60s to 70s an apricot research programme was started at the Horticulture Faculty in Lednice with the aim of improving the production of apricots in the Czech Republic, by prof. Vachůn and prof. Vávra.

The breeding aims in the first phase of the breeding programme were to extend the ripening time and to increase the frost hardiness of the flower buds. We subsequently registered the firts generation of new cultivars: Lejuna, Leskora, Lebela, Ledana, Leala and Lerosa. Except for the cultivar Leskora, these are mostly only propagated for hobby growers.

Many hybrids used in this period came from the breeding program co-ordinated by Prof. L.F.Hough at Rutgers University in New Jersey, USA. The collaboration with him was a great help and provided a good starting point for increasing our apricot germplasm.

The main breeding aims in the second phase were: fruit size and resistance to the sharka virus. Since 2004 we have registered the following cultivars Minaret, Svatava, Palava, Marlen, Lenova and Lemeda (Table 1). The cultivar Marlen is a clone of Hungarian Best.

Table 1. A simple classification of new apricot cultivars from Lednice

Cultivar	Productivity	Fruit quality	Health	Total no. of points	Purpose
		II generation			
Lemeda	+++	++	+++	8	FM, PR
Marlen	++	+++	++	7	FM, PR
Palava	++	++	+++	7	FM
Svatava	++	+++	++	7	FM
Minaret	+++	+++	++	8	FM
		III generation			
LE-2904	+++	+++	++	8	FM
LE-2927 (Candela)	+++	+++	++	8	FM, PR
LE-2926 (Sophie)	++	+++	++	7	FM, PR
LE-3241 (Adriana)	+++	++	++	7	PR, FM
LE-3246	++	+++	++	7	FM
LE-3187	+++	++	++	7	PR
LE-3276 (Betinka)	+++	+++	+++	9	FM
		Standard control cultivar			
Velkopavlovická	++	+++	++	7	FM

Notice: +++ = the most desirable value; ++ = commercially acceptable value; + = low value;
FM = fresh market; PR = processing, scale-1-9 points

The third phase of our breeding programme is currently focused on appearance, firm flesh and PPV resistance. The cultivar Betinka (LE-3276) has a high level of resistance to the PPV D-strain, and medium resistance towards the M-strain (Krška et al., 2000). The cultivar Candela (LE-2927) has semi-columnar type of growth, and excellent fruit quality. Other hybrids with different levels of resistance, market value and fruit characteristics are described in Table 2.

The study of several collections of genotypes during several years of observations helped choose the most important characters connected with adaptability to environment. The analysis of these characters enables breeders to choose parents – donors of characters and conservation of genetic characters to set up a core collection. Genetic improvement of apricots in the frame of the species is possible in all characters relating to adaptability increase. However it usually takes a longer period of time.

Table 2. Average values of selected features of new varieties of apricots for the period 2007-2012

Cultivars	Productivity (1- 9)	Fruit size (g)	Flesh firmness (1-9)	Taste (1-9)	Precocious decline (1-9)	Total evaluation (1-9)
Tomcot	8	47	7	7,5	7	7
Goldrich	9	56	8	7	8	8
Harlayne	8	43	7	7,5	7	7
Betinka (LE-3276)	8	57	8,5	8	7	8
Adriana (LE-3241)	8	55	8	8	8	9
Candela (LE-2927)	8	54	7	8	8	9
Sophie (LE-2926)	8	63	8	7	7	7

Selection of donors of characters related to an increase of adaptability

Frost hardiness of flower buds: Harlayne, Harval, Leala, Lejuna, Leronda, Leskora, Neptun, NJA 1 A, Vivagold, Volschebnyi, Vynoslivyi, Yulskyi, Frostina, “Pozdně kvetoucí”, Harrow Star.

Late termination of dormancy: Henderson, Chuan Zhi Hong, Lebela, Oranzevo-krasnyi, Stark Early Orange, Vegama, Veharda, Zard, Vynoslivyi, Candela.

Frost tolerance of juvenile fruits: Leala, Lefrosta, Lejuna, Lemira, Leskora, Marculesti, Neptun, Re Umberto, Frostina, “Pozdně kvetoucí”, Candela, Goldrich.

Late Blooming: Early Gold, Machova, Marculesti, *P.brigantiaca* x Olymp, Re Umberto, Sulmona, Stella, Vynoslivyi.

High level of self-fertility: Alfred, Bergeron, Minaret, Vestar.

Climatic Adaptation: Bergeron, Goldrich, Marculesti, Kecskemete Rose, Leala, Lejuna, Leskora, Re Umberto, Rose Early, Candela.

Conclusion

Currently assessed and newly created hybrid platform offers an opportunity to select additional new genotypes with appropriately combined characteristics regarding the resistance to abiotic and biotic pathogenic agents, but also in terms of the requirements regarding fruit ideotype and growing commercial requirements.

For practice growing we offer four promising PPV resistant varieties with high market value of the fruits. These varieties are now in the process of registration and low protection.

Acknowledgements

In the Czech Republic, the preservation and use of the genetic resources of cultivated plants are treated by the law Ministry of Agriculture (MZe) of the so called National program of utilization and maintenance of plant genetic resources. This work was partially financed by project QI 91A032 by the Ministry of Agriculture, NAZV Agency. On the base of those projects we have been able to carry out this work.

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Invited lecture

RECENT SCIENTIFIC ACHIEVEMENTS TO PROMOTE APRICOT CULTURE IN HUNGARY AND ELSEWHERE

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Abstract. Demand for knowledge transfer in the fruit growing industry has witnessed an ever increasing trend over the last decades. Recent developments in biochemical and molecular research provide valuable tools for producers to overcome challenging tasks in the orchard. Our efforts are focused on two main topics: characterizing human health-related value of apricot fruit and ensuring adequate pollination and fruit set in orchards. Altogether 15 cultivars newly introduced into Hungary were compared to a group of traditional cultivars containing landraces from Central Europe to Central Asia. Although new cultivars have low antioxidant power compared to other cultivars, ‘Tomcot’ and ‘Toyesi’ were the best in the group of introduced apricots. Welch test indicated means of ferric reducing antioxidant power and total phenolic contents of the traditional cultivars were significantly higher ($P < 0.005$) than the respective average values of the introduced new cultivars. Fruit antioxidant capacity is determined genetically, although both weather and ripening stages affect its value. Out of ten cultivars coming from US, French or Italian breeding programs five were self-compatible. Their *S*-genotype was determined and is now available for incorporation into an information database. Our results may help growers either in orchard planning or opening new markets for apricot.

Key words: antioxidant, apricot, cultivar association, health-compounds, self-incompatibility.

Introduction

Hungary is characterized by a minor production quantity of apricot (approx. 27000 tonnes in 2010) compared to the Mediterranean or Asian countries (Faostat, 2010). However, apricot culture is of great economic importance in the Hungarian horticultural sector and intensive orchards of French or Canadian cultivars have been recently established. Firm fleshed fruit of the introduced cultivars are sold on the export markets. On the other hand, Hungary and other Central European countries have a range of adapted landrace cultivars long respected for their superior taste and overall organoleptic characteristics compared to the most popular commercial

cultivars (Milatovic and Djurovic, 2006). The cultivar ‘Magyarkajszi’ is still predominant in Hungary and is also widely grown in the neighbouring countries under the name ‘Hungarian Best’ (Milatovic and Djurovic, 2006; Mády and Szalay, 2003). In contrast to the new cultivars, such traditional cultivars or landraces have soft fruit not suitable for longer transport.

Owing to consumer preferences, internal fruit quality is becoming a priority goal, including nutritional quality, the content of health-related compounds (Zhebentyayeva et al., 2012). Apricot (*Prunus armeniaca* L.) fruit contains three major types of antioxidant molecules: water-soluble vitamin C, lipid-soluble carotenoids and polyphenolics comprising both hydro- and lipophilic components (Hegedűs et al., 2010; Ruiz et al., 2005a,b). Total carotenoid and β-carotene contents determined with high performance liquid chromatography (HPLC) demonstrated a nearly three-fold variation in total carotenoid content in seven Hungarian apricot cultivars (Sass-Kiss et al., 2005). Total carotenoid contents in Spanish cultivars and breeding materials were assessed by Ruiz et al. (2005b) and a close correlation between carotenoid content and the colour parameter, hue angle was reported. A nearly 1.4-fold difference in hue angle reflected an 11-fold difference in total carotenoid content. In the same set of genotypes, a five-fold difference was obtained between the highest and lowest polyphenolic contents (Ruiz et al., 2005a). Significantly higher variations in antioxidant capacity and polyphenolic content were recorded among Mediterranean, North American and Asian genotypes (Drogoudi et al., 2008; Hegedűs et al., 2010).

Specific characteristics of apricot cultivars originated in Central Europe might be associated with their evolutionary history. Genetic relationships between Hungarian and Turkish (Irano Caucasian germplasm) cultivars were clearly demonstrated based on molecular markers (Halász et al., 2010). A relatively recent connection between these two gene pools resulted in a considerable number of common alleles between the two germplasm; however, genetic variability was dramatically reduced in the Central European germplasm due to the emergence of self-compatibility.

Breeding programs in several countries used plant material originated in Asian countries and possessing more diverse phenotypic characteristics. Several important traits like PPV resistance were introduced, but some unfavourable characters like self-incompatibility were also transmitted to the released cultivars. This trait is controlled by the highly polymorphic, multiallelic *S*-locus, which is composed of two genes, the pistil *S-ribonuclease* (*S-RNase*) (McClure et al., 1989) and the pollen-expressed *S-haplotype specific F-box* (Entani et al., 2003). Cultivars carrying the same pair of *S*-alleles are cross-incompatible and cannot fertilize each other. In North American and Spanish apricot cultivars, seven *S*-alleles have been described for self-incompatibility and one for self-compatibility, and labelled as S_1–S_7 and S_C, respectively (Alburquerque et al., 2002). Halász et al. (2005) identified nine novel *S*-alleles (S_8-S_{16}) from Eastern European cultivars using stylar RNase electrophoresis and consensus PCR. Later, S_{17}-S_{20} (Halász, 2007) and S_{21} (A. Raz and M. Goldway,

unpublished) were also deposited in the nucleotide sequence database. From Chinese apricot cultivars, many additional *S-RNase* alleles (S_1- S_{30}, S_{35}-S_{52}) were identified using different assays (Halász et al., 2012).

Our work is associated with two focal points of apricot industry: ensuring optimal fruit set in orchards and opening new ways for apricot marketing, both of which may have the potency to promote apricot industry.

Materials and methods

Plant material. Altogether 15 new cultivars recently introduced into Hungary (‘Bergarouge’, ‘Flavorcot’, ‘Jumbocot’, ‘Latter Sabatini’, ‘Ninfa’, ‘Palumella’, ‘Perlecot’, ‘San Castrese’, ‘Sungiant’, ‘Tomcot’, ‘Toyesi’, ‘Toyiba’, ‘Toyuda’, ‘Vitillo’ and ‘Zebra’) were analysed and compared to a group of old cultivars (‘Aurora’, ‘Baneasa 4/11’, ‘Bergeron’, ‘Ceglédi arany’, ‘Ceglédi óriás’, ‘Stepniak’, ‘Gönci magyarkajszi’, ‘Harmat’, ‘Kech-pshar’, ‘Konservnyi pozdnii’, ‘Korai zamatos’, ‘Pisana’, ‘Preventa’, ‘Samarkandskyi rannii’ and ‘Shalakh’) also containing landraces from Central Europe to Central Asia (Hegedűs et al., 2010).

Fruit extraction for redox assays. Fruit were harvested at three ripening stages based on the fruit size and background fruit color (unripe: undeveloped green fruits, half-ripe: normal sized and slightly yellowing fruits, fully ripe: normal sized, soft, yellow coloured with red blush). In the laboratory, apricots were divided into three batches of approximately 200 g fresh weight. Fruits were halved, pitted then homogenized using a 350 W house blender (Bosch MMR0800, Stuttgart, Germany) and centrifuged (Hettich Mikro 22 R; Tuttlingen, Germany) (4°C, 35 min, 18750 *g*). The supernatants were used for the redox assays. Samples for further analyses were kept at –80°C until use. For all spectrophotometric measurements, a Nicolet Evolution 300 BB spectrophotometer (Thermo Electron Corporation, Cambridge, England) was used.

Antioxidant activity based on the ferric reducing antioxidant power (FRAP) assay. Antioxidant capacity was determined using the FRAP assay (Benzie and Strain, 1996). Absorbance was measured at 593 nm at 0 and 6 min. Ascorbic acid was used as a control to obtain the standard curve and FRAP value was calculated relevant to the activity of ascorbic acid and expressed as ascorbic acid (AA) equivalents.

Measurement of total phenolic content (TPC). Total phenolic content was measured using Folin-Ciocalteu’s reagent according to the method of Singleton and Rossi (1965). Absorbance was monitored at 760 nm and the content of soluble phenols was calculated from a standard curve based on gallic acid concentrations.

DNA extraction. Genomic DNA was extracted from buds using the DNeasy Plant Mini Kit (Qiagen, Hilden, Germany). DNA concentrations and purification parameters were measured using a Nanodrop ND-1000 Spectrophotometer (Bio-Science, Budapest, Hungary).

Genomic PCR with S-RNase and SFB-specific primers. PCR was conducted according to Sutherland et al. (2004) using the degenerate primers EM-PC2consFD and EM-PC3consRD for the amplification of the second intron region of the *S-RNase* gene. To amplify the first intron, the fluorescently labelled ($_{JOE}$) forward primer SRc-F (Romero et al., 2004) was used in combination with the reverse primer SRc-R (Vilanova et al., 2005).

For the identification of the S_C-haplotype, AprSC8R and PaConsI F as well as AprFBC8-F and AprFBC8-R were used as described by Halász et al. (2010). The amplification was carried out using a temperature profile with an initial denaturing of 94 ^oC for 2 min, 35 cycles of 94°C for 30 s, 55°C for 1.5 min and 72°C for 2 min, and a final extension of 72°C for 5 min.

PCR was carried out in a PTC 200 thermocycler (MJ Research, Budapest, Hungary). For amplification of the *S-RNase* first and second introns, we used the programs originally described for the primers (Halász et al., 2010; Sutherland et al., 2004; Vilanova et al., 2005). Approximately 20–80 ng of genomic DNA were used for PCR amplification in a 25 μL reaction volume, containing 1 × PCR buffer (Sigma, Budapest, Hungary) with final concentrations of 10 mM Tris-HCl (pH 8.3), 50 mM KCl, 1.5 mM $MgCl_2$, 0.2 mM of dNTPs, 0.4 μM of each primer and 0.625 U of *Taq* DNA polymerase (Sigma, Budapest, Hungary).

The PCR products were separated on 2% TAE agarose gels at 100 V for 2 h and DNA bands were stained with ethidium bromide. Fragment sizes were estimated by comparison with the 1 kb + DNA ladder (Promega, Madison, USA). For exact size determination of *S-RNase* first intron region fragments smaller than 500 bp, the fluorescently labelled products were run in an automated sequencer ABI PRISM 3100 Genetic Analyzer (Applied Biosystems, Budapest, Hungary) using the GENOTYPER 3.7 software and GS500 LIZ size standard (Applied Biosystems, Budapest, Hungary).

Real Time PCR. Real-time PCR amplification and analysis was performed using a Rotor-Gene 6000 fluorometric thermal cycler (Corbett Research, Qiagen) as described by Pfeiffer (2012).

Statistical analyses. Data presented for each cultivar represent the mean values determined from three independent homogenates. After tested for normal distribution and equality of variances, one-way analysis of variance (ANOVA) and Duncan's multiple range test with $P < 0.05$ or Welch-test was carried out to determine significant differences. Statistical analyses were carried out and boxplot diagrams were constructed using SPSS 13.0 (SPSS Inc., Chicago, IL, USA).

Results and discussion

Apricots as superfruit

The realization of the fact that apricot might be more than merely a delicious fruit may open new ways on the market. Strong scientific evidence support now that

increased fruit consumption may lower the risk of degenerative diseases (Boeing et al., 2012); however, considerable increase in fruit consumption has not yet been achieved in any countries (Stables et al. 2002). In conclusion, the enhancement of fruits' health-effects may provide an alternative approach in health promotion.

Previously we identified apricot genotypes characterized by outstanding antioxidant capacity and rich in ascorbic acid and specific polyphenolic compounds (Hegedűs et al., 2010). Some of those compounds are known to have anti-inflammatory and anti-carcinogenic effects. Since some introduced cultivars are of great popularity in current cultivation, it was interesting to evaluate their functional properties. 'Tomcot' and 'Toyesi' are two cultivars accumulating relatively higher levels of antioxidant capacity and polyphenolic content. However, these levels were low compared to those detected in a group of traditional cultivars originated in the region between Central Europe to Central Asia.

The antioxidant capacity and total polyphenolic contents of some newly introduced apricot cultivars were compared to those of selected traditional cultivars (Figure 1). The number of cultivars in both groups were identical ($n = 15$) and data are demonstrated as parallel boxplots. The length of the boxes indicates that both FRAP and TPC data were more variable among the traditional cultivars compared to those of the introduced cultivars. Ferric reducing ability in fruits of the introduced cultivars ranged between 0.26 ('Toyuda') and 1.39 mmol AA/L ('Flavorcot') compared to 0.47 and 10.35 mmol AA/L in the other group (Figure 1a, Table 1). The total phenolic contents ranged between 0.53 and 2.76 mmol GA/L and 0.99 to 20.57 mmol GA/L in 2006 and 2007, respectively. The median (the middle value) of the data pool was higher in the traditional cultivars both for FRAP and TPC. The distribution is reasonably asymmetric for FRAP values in both groups and for TPC data in the traditional group. Skewed distribution of the FRAP data in both groups indicates that several cultivars accumulate high quantities of antioxidant compared to the median. Interestingly, 'Zebra' was obtained as a mutation of 'Jumbocot' (syn. 'Goldrich') but 'Zebra' fruits had almost two-times higher antioxidant capacity and polyphenolic content than those of 'Jumbocot'.

Welch test indicated means of FRAP and TPC of the traditional cultivars were significantly higher ($P < 0.005$) than the respective average values of the introduced new cultivars. Interestingly, only one outlier (a value over three box lengths from the upper end of the box) was registered among the FRAP and TPC values of traditional cultivars. Those values were higher compared to the rest of the data and belonged to the previously characterized genotype 'Preventa' (Hegedűs et al., 2010; 2011).

These data indicate that introduced cultivars tested in this study are not well suited to health-uses but might be used in functional breeding programs in parental combinations with donor genotypes like 'Preventa'. 'Preventa' itself may not be a successful cultivar as this genotype is characterized by some unfavourable agronomic characteristics (pale fruit colour, low SSC/TA ratio, and trees prone to over-cropping resulting in small fruit), but it may be used in hybridization with other genotypes

having high levels of carotenoids and several favourable agronomic characteristics (e.g. ‘Orange red’ or ‘Gönci magyarkajszi’).

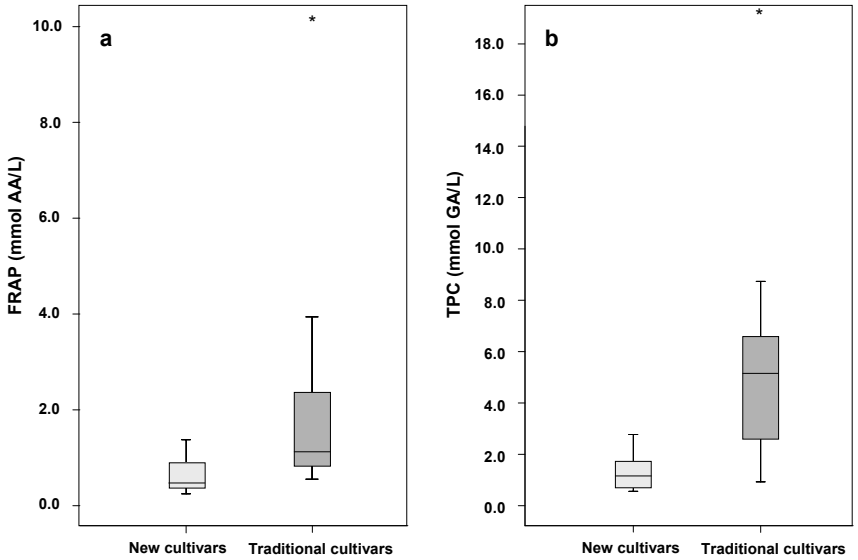

Figure 1. A boxplot of fruit antioxidant parameters of commercial and landrace apricot cultivars. **a** Ferric reducing antioxidant power (FRAP); **b** total phenolic content (TPC). The dark line in the middle of the boxes is the median of the values. Bottom and top of the boxes indicate the 25th and 75th percentiles, respectively. Whiskers indicate the lower and upper quarters; asterisks refer to outlier values higher than three box lengths. Means of the two cultivar groups were statistically significant at $P < 0.001$ according to the Welch test.

The high antioxidant capacity of ‘Preventa’ fruit was clarified to be a genetically controlled character less influenced by year-effects (Hegedűs et al., 2010). Genotype-dependent variations were found among cultivars in other crops, as well (Granelli et al., 2012; Scalzo et al., 2005). Our study revealed that a huge level of variability exists within the available apricot germplasm and consequently antioxidant capacity of fruits might be improved through designing appropriate parental combinations and performing subsequent selection. Heritability estimates in several fruit crops implied that the improvement of this trait is possible through breeding (Scalzo et al., 2005; Cantín et al., 2009).

Throughout ripening, apricot fruit showed consistent weight increase and accumulation of soluble solids parallel to the colour transition from green to yellow (Figure 2a-c). Since a close correlation between carotenoid content and the colour parameter, hue angle was reported by Ruiz et al. (2005b), this parameter characterizes the accumulation of carotenoids in apricot. It is worth realizing that hue angle value in fully ripe ‘Gönci magyarkajszi’ fruit flesh was significantly lower than the corresponding value for ‘Preventa’, indicating ‘Preventa’ accumulates lower

amounts of carotenoids in its fruit flesh. However, levels of all water-soluble antioxidants were higher in ‘Preventa’ than ‘Gönci magyarkajszi’. Apricot fruit also showed constant increases in vitamin C and polyphenol contents throughout ripening, which resulted in a rising trend of total antioxidant capacity (Figure 2d-f).

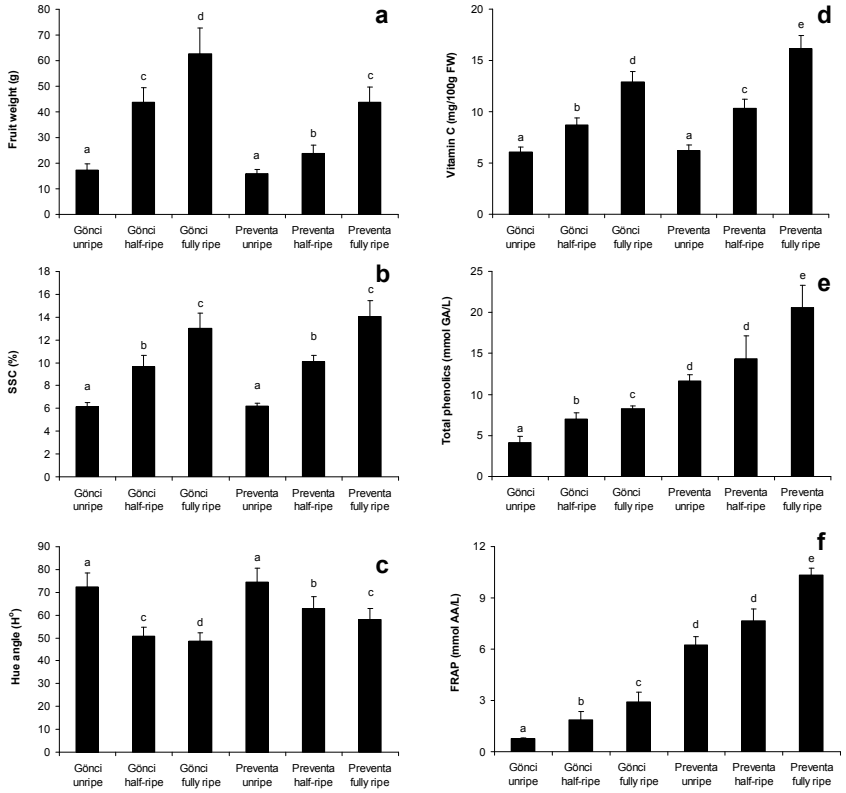

Figure 2. Characterization of ripening process of apricot. Fruit weight (**a**), soluble solid contents, SSC (**b**), hue angle (**c**), vitamin C content (**d**), total phenolic content (**e**) and ferric reducing antioxidant power, FRAP (**f**) of ‘Gönci magyarkajszi’ and ‘Preventa’ apricots at three different ripening stages. Vertical lines represent SDs (n=3) and different letters indicate significantly different values at $P \leq 0.05$ according to a Duncan’s multiple range test.

This trend points again to an important message for growers by showing that ripening stage influences not only fruit quality parameters like soluble solid contents or acidity, but fruits’ health-promoting efficiency is also controlled by ripening. The close correlation between carotenoid accumulation and contents of antioxidant phytochemicals suggests that colour indices provided by nondestructive analysis will be useful to monitor fruit antioxidant properties and determine the best harvest date.

In contrast, our most recent work clarified that expression of polyphenol biosynthesis genes shows a marked decrease during ripening. Fruits of ‘Preventa’ are characterized by higher relative transcript quantities for several polyphenol biosynthesis genes (e.g. *chalcone synthase, chalcon isomerase, anthocyanidin synthase* and others) as compared with the fruits of ‘Gönci magyarkajszi’ (Figure 3). There is a considerable difference in the relative expression level of many of the genes between ‘Preventa’ and ‘Gönci magyarkajszi’ at the first ripening stage with ‘Preventa’ having considerably higher expression levels. This indicates that transcriptomic alterations at the early phase of ripening will have a dramatic consequence on the total polyphenolic content and antioxidant capacity in ripe fruits.

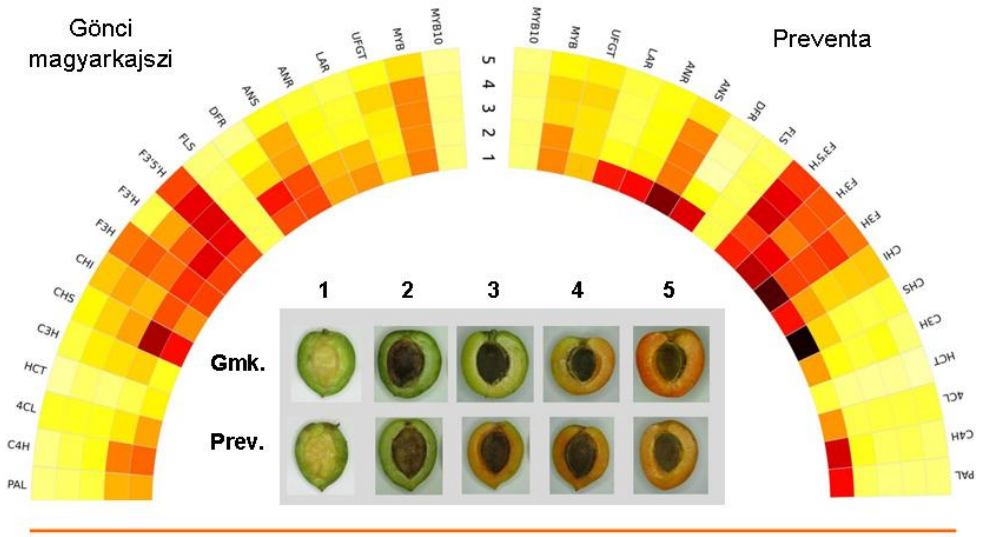

Figure 3. Real-time qPCR expression analysis for major genes involved in flavonoid biosynthesis of ‘Gönci magyarkajszi’ and ‘Preventa’ apricot fruit flesh during ripening (stages 1-5 as shown on the photo). Colours from white to black indicate increasing expression level of the specific gene. *RP-II* was used as reference gene.

Genetic basis of fertilization efficiency

Another aspect of our long-term study is the genetic investigation on cultivar association in orchards. Most European apricots are self-compatible and hence can be grown in mono-varietal orchards (Halász et al., 2005). However, some of the old and perspective newly introduced cultivars are self-incompatible and cross-incompatible pairs of cultivars (which are not able to fertilize each other) can be also found. For example, ‘Jennycot’ and ‘Zebra’ share a common *S*-genotype of S_1S_2 (Table 1). It

means they are cross-incompatible and require an additional pollen donor genotype for eligible fruit set. In addition, those cultivars will be also incompatible with all others in the 1st incompatibility group of apricot (Egea and Burgos, 1996) including ‘Hargrand’ or ‘Lambertin-1’.

Table 1. Origin, self-incompatibility phenotype, *S*-genotype, antioxidant capacity (FRAP) and total polyphenol content (TPC) of some new and traditional apricot cultivars

Cultivar	Origin	Self-(in) compatibility	*S*-genotype	FRAP (mmol AA/L)	TPC (mmol GA/L)
New cultivars					
Bobcot	USA	Self-compatible	S_CS_{17}	–	–
Flavorcot	USA	Self-compatible	S_CS_1	0.40±0.02	0.53±0.04
Jennycot	New Zealand	Self-incompatible	S_1S_2	–	–
Latter Sabatini	Italy	Self-compatible	S_CS_1	0.70±0.05	2.53±0.23
Polumella	Italy	Self-compatible	S_CS_1	0.42±0.05	1.19±0.06
Zebra	France	Self-incompatible	S_1S_2	0.37±0.04	1.44±0.15
Tomcot	USA	Self-compatible	S_CS_{17}	1.28±0.09	2.07±0.13
Toyesi	USA	Self-incompatible	S_2S_{17}	1.39±0.12	2.76±0.23
Toyiba	USA	Self-incompatible	S_1S_{17}	1.04±0.06	1.71±0.16
Toyuda	USA	Self-incompatible	$S_2S_?$	0.26±0.03	1.09±0.09
Traditional cultivars					
Aurora	USA	Self-incompatible	$S_{17}S_?$	1.04±0.06	0.99±0.07
Bergeron	France	Self-compatible	S_CS_2	3.57±0.12	8.77±0.82
Ceglédi arany	Hungary	Self-compatible	S_CS_9	0.95±0.06	5.20±0.31
Ceglédi óriás	Hungary	Self-incompatible	S_8S_9	1.21±0.20	6.06±1.20
Gönci magyarkajszi	Hungary	Self-compatible	S_CS_8	2.93±0.53	8.24±0.39
Harmat	Hungary*	Self-incompatible	$S_{10}S_{11}$	0.51±0.01	2.74±0.24
Kech-pshar	Central Asia	Self-incompatible	$S_{15}S_{18}$	2.33±0.06	2.01±0.20
Korai zamatos	Hungary*	Self-incompatible	$S_{12}S_{13}$	0.47±0.11	3.04±0.70
Preventa	Central Asia	Self-incompatible	$S_4S_?$	10.35±0.40	19.57±2.72
Shalakh	Armenia	Self-incompatible	$S_{11}S_{13}$	1.74±0.45	7.27±0.39

*Hungarian commercial cultivars with Armenian pedigree
$S_?$: unknown allele

New cultivars carry the S_{17}-allele relatively frequently, which might have originated from cultivars like ‘Blenril’. This allele was previously shown only in US cultivars like ‘Aurora’ (Halász, 2007). Currently, at least XIV incompatibility groups are known in apricot (Halász et al., 2010). An ongoing revision is required to keep this information updated since a cross-incompatibility table would be useful all over the world during orchard planning. We have determined the (in)compatibility genotype of approximately 200 apricot cultivars originated in Turkey, Eastern and Western Europe, North Africa and the USA (Halász et al., 2005, 2007, 2010). If the *S*-genotype of ‘Magic cot’ (data not shown) and ‘Toyesi’ (Table 1) can be confirmed, another cross-incompatibility group will be established. These data are to be collated

to provide growers information of practical value: the genetic ability of fertilization between any of the cultivars, which may orientate future cultivar association in orchards.

This might be used in different ways. In specific regions, self-compatibility is important to ensure fruit set, and self-compatibility was always a preference in commercial orchards. Self-incompatibility may induce failure in fruit set especially in regions of cold and wet springs where pollinator insects are not sufficiently active. In this case, only occasional transfer of pollen grains within a single flower or between the neighbouring flowers will result in fruit set and hence self-compatibility is advantageous (Tao et al., 2007).

Semi-compatible cultivars that share one of their *S*-alleles have been widely grown together within the same orchards, which is not always optimal. Schneider et al. (2001) reported that the apple cultivar ‘Jonathan’ (S_7S_9) was a low potency pollenizer for ‘Topred’ (S_9S_{28}) trees in Israel. Also, semi-compatibility between pear cultivars was shown to be the reason for the relatively low yields (Zisovich et al., 2004). This indicates that under specific ecological/climatic conditions full or semi-compatible cultivar couples may influence the efficiency of cross-fertilization.

Most European apricot cultivars are self-compatible (Halász et al., 2007). Self-incompatibility was realized as a novel and unfavourable character in the middle of the last century. Later, many self-incompatible cultivars were identified in various countries (Egea and Burgos, 1996; Halász et al., 2005, 2010; Milatovic and Nikolic, 2007) and self-compatibility became a primary goal in breeding programs. Out of ten cultivars coming from US, French or Italian breeding programs five were self-compatible (Table 1).

However, the appreciation of self-compatible phenotype of apricot seems to be challenging. This is because market demands large-sized fruits and most new cultivars are characterized by 2- or 3-times higher flower abundance than traditional cultivars and hence over-setting of trees will make thinning inevitable. In intensive orchards, self-incompatibility is sometime preferable to self-compatibility (at least in some regions), which helps avoid over-cropping and decrease the cost of thinning. In such cases, cautious planning is required to adjust the ratio of compatible pollen grains among several self-incompatible cultivars presenting semi- or fully compatible pairs in the orchard. For such planning, the *S*-genotype of the cultivars must be known.

Conclusions

Recent studies indicated that an apricot-rich diet might ameliorate the detrimental effects of low-dose x-rays on testis tissue and even alleviate myocardial ischemia-reperfusion injury (Parlakpinar et al., 2009; Ugras et al., 2010). Apricots containing elevated levels of health-related compounds might be used as “superfruits” in future and open new markets. Since antioxidants may also influence

the shelf life of fruit, a detailed knowledge on the formation and accumulation of such compounds may have also practical value.

Adequate fruit set is very important in commercial orchards. Cultivar association may help avoid over-cropping while ensuring sufficient fruit set. This might be managed by determining self-(in)compatibility genotype of perspective cultivars and arrange the information in easily accessible databases. Similarly to sweet cherry or almond, self-incompatibility genotypes are now included into the description of apricot cultivars (Szabó, 2012). Our results may help growers to choose cultivars that can be associated to produce reasonable quantity and quality of fruit marketed in the rapidly rising market of healthy food.

This analysis highlights the need for screening the local germplasm in many countries and finding genotypes of superfruit attributes that might be used in functional breeding programs. This knowledge combined with mild processing technology may also allow production of apricot-containing functional food including beverages and others, which is now a high priority interest in the Western European food market.

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Predavanje po pozivu

ZAŠTITA BRESKVE I NEKTARINE OD PROUZROKOVAČA BILJNIH BOLESTI I ŠTETOČINA

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Izvod. Zaštita breskve i nektarine od prouzrokovača biljnih bolesti i štetočina ima izuzetan značaj i preduslov je visokog prinosa i dobrog zdravstvenog stanja stabala. Proizvodnju ovih voćaka redovno ugrožava nekoliko oboljenja među kojima su najznačajnija: kovrdžavost lišća, sušenje grančica i trulež plodova, šupljikavost lišća, pepelnica i rđasta prevlaka ploda. Najznačajnije vrste štetočina su: breskvin smotavac, zelena breskvina vaš, dudova štitasta vaš i trips.

Kritični periodi za suzbijanje moraju se ispoštovati. Prvo tretiranje u cilju suzbijanja *T. deformans*, *S. carpophila* i smanjenja infekcionog potencijala od *Monilinia* spp. obavlja se u jesen kada opadne 90% lišća sa preparatima na bazi jedinjenja bakra. Tretiranje u fenofazi neposredno pre bubrenja pupoljaka namenjeno je suzbijanju *T. deformans* i to sa ciramom, hlorotalonilom ili delanom. U fenofazi bubrenja pupoljaka do pojave mišijih ušiju vrši se tretiranje mineralnim uljima radi suzbijanja prezimljujućih formi štetočina (štitaste vaši, biljne vaši i grinje). U fenofazi roze pupoljka treba obaviti tretiranje koje je namenjno suzbijanju pepelnice sa triazolima ili strobilurinima. U ovoj fazi mogu se suzbiti trips i vaši, a od insekticda mogu se koristiti akrinatrin, neonikotinoidi ili hlorpirifos. U fenofazi cvetanja izvodi se suzbijanje *Monilinia* spp. prouzrokovača sušenja grančica primenom tiofanat metila, boskalida, piraklostrobina, ciprodinila, tebukonazola ili iprodiona. U fenofazi precvetavanja vrši se suzbijanje biljnih vašiju, pepelnice i šupljikavosti lista. Posle precvetavanja neophodno je obaviti još 2-3 tretiranja za suzbijanje biljnih bolesti i štetočina.

Pravilno sproveden program zaštite breskve i nektarine u skladu sa meteorološkim uslovima i biologijom prouzrokovača bolesti i štetočina, uz pravilan izbor preparata pesticida i njihova pravovremena primena, obezbediće visoke prinose ovih voćaka.

Ključne reči: breskva i nektarina, bolesti, štetočine, suzbijanje.

Uvod

Breskva predstavlja vrlo značajnu voćnu vrstu u Srbiji. Površine pod zasadima breskve, a naročito nektarine se sve više šire poslednjih godina, a uzrok je ekonomski isplativa cena ovog voća na tržištu. Sa povećanjem površina pod zasadima breskve i nektarine prouzrokovači bolesti i štetočine postaju značajniji. Ekonomski najznačajniji prouzrokovači bolesti breskve i nektarine su: *Taphrina deformans* prouzrokovač kovrdžavosti lišća, *Monilinia s*pp., prouzrokovač sušenja grančica i

truleži plodova, *Stigmina carpophila*, prouzrokovač šupljikavosti lišća, *Sphaerotheca pannosa,* prouzrokovač pepelnice, *Podosphaera leucotricha*, prouzrokovač rđaste prevlake na plodovima. Najznačajnije vrste štetočina su: *Cydia molesta*, breskvin smotavac, *Myzus persicae*, zelena breskvina vaš, *Pseudaulacaspis pentagona*, dudova štitasta vaš i *Frankliniella spp*., trips.

Najznačajniji prouzrokovači biljnih bolesti breskve i nektarine

Taphrina deformans, prouzrokovač kovrdžavosti lišća

Značaj. Kovrdžavost lista predstavlja jedno od ekonomski najznačajnijih oboljenja breskve. Javlja se svake godine i ukoliko se ne sprovedu mere zaštite može doći do potpune defolijacije biljaka. Zbog ponovnog porasta lisne mase posle defolijacije, plodovi ostaju sitniji, a biljke se iscrpljuju. Kovrdžanje lista je karakterističan simptom ove bolesti. Naime, usled prisustva patogena dolazi do proliferacije lisnog tkiva, lišće postaje krupnije u odnosu na nezaraženo i na kraju dolazi do njegovog opadanja.

Biologija. T. deformans prezimljava konidijama koje su locirane oko pupoljaka ili u šupljinama kore breskve. U proleće u vreme bubrenja pupoljaka, kada oni počinju da se razmiču, konidije klijaju u kapi vode i ostvaruju primarnu zarazu. Dakle, za ostvarivanje primarnih zaraza neophodna je kiša (Sharma i sar., 1987). Najjače zaraze se dešavaju kada je u ovoj fazi kišovito vreme sa temperaturama između 15-21°C. Na temperaturama ispod 10°C zaraze su retke. Kada se pojave prvi listići, od fenofaze roze pupoljka, oni ne mogu biti zaraženi. Kasnije tokom vegetacije nema novih zaraza jer *T. deformans* ne ostvaruje sekundarne zaraze. Na zaraženim listovima formiraju se askospore i blastospore koje vetar raznosi na pupoljke susednih biljaka čime se obezbedjuje prezimljavanje ove gljive.

Suzbijanje. Suzbijanje *T. deformans* mora se obaviti pre kretanja vegetacije. Prvo tretiranje treba izvesti u jesen posle opadanja lišća. Cilj ovog tretiranja je da se suzbije infekcioni potencijal na stablima breskve. Navedeno tretiranje se izvodi preparatima na bazi jedinjenja bakra (Pscheidt i Koepsell, 1992). Sledeće tretiranje treba obaviti u proleće neposredno pre bubrenja pupoljka preparatima na bazi cirama, hlorotalonila ili delana. Potrebno je istaći da tretiranja protiv *T. deformans* tokom vegetacije ne daju nikakve efekte.

Monilinia spp., prouzrokovači sušenja grančica i truleži plodova

Značaj. Gljive iz roda *Monilinia* predstavljaju patogene koji nanose najveće gubitke u prinosima voća u svetu. Štetnost u kišovitim godinama može biti i do 100%, ako se uzme u obzir sušenje grančica i trulež plodova. *Monilinia* spp. na breskvi prouzrokuje dva tipa simptoma. Prvi tip simptoma javlja se u vidu paleži cvetova i sušenja grančica, a drugi u vidu truleži plodova. U odnosu na ostale

koštićave voćne vrste sušenje grančica je manje izraženo, dok je trulež plodova mnogo veći problem.

Biologija. Vrste iz roda *Monilinia* prezimljavaju u rak ranama ili mumificiranim plodovima. U proleće sa kretanjem vegetacije dolazi do aktivacije gljive i stvaranja novih konidija. Najčešće, infekcije se dešavaju u vreme cvetanja preko žiga tučka što kasnije dovodi do sušenje grančica. Infekcije plodova se dešavaju kada su plodovi mladi i u vreme njihovog dozrevanja. Mladi plodovi mogu biti zaraženi (tzv. latentne infekcije) i na ovaj način se uvećava količina inokuluma za ostvarivanje infekcija poluzrelih i zrelih plodova (Luo i Michailides, 2001). Takođe, plodovi mogu biti zaraženi i usled mehaničkih povreda. Optimalne temperature za infekciju su 22-25°C. Na ovim temperaturama dovoljno je da cvet bude vlažan 3-4 h, dok je na nižim temperaturama potrebno duže vlaženje cveta da bi došlo do infekcije.

Suzbijanje. U suzbijanju *Monilinia spp*. neophodno je primeniti integralni koncept suzbijanja biljnih bolesti. Na prvom mestu treba primeniti agrotehničke i pomotehničke mere, a potom hemijske. Ukoliko se ne primene agrotehničke i pomotehničke mere, efekti primene fungicida mogu izostati.

U agrotehničke i pomotehničke mere spadaju:

- formiranje uzgojnog oblika koji će obezbediti optimalno provetravanje voćnjaka
- sakupljanje i iznošenje mumificiranih plodova
- orezivanje i spaljivanje zaraženih grančica
- optimalno đubrenje azotom
- adekvatno suzbijanje štetočina i sprečavanje mehaničkih oštećenja.

Posle sprovođenja navedenih mera treba pristupiti primeni fungicida. Tokom mirovanja vegetacije treba izvršiti tretiranje preparatima na bazi jedinjenja bakra. Cilj ovog tretiranja je smanjivanje infekionog potencijala *Monilinia* spp. Za sprečavanje sušenja grančica kod breskve dovoljno je obaviti jedno tretiranje u punom cvetanju. Za suzbijanje truleži ploda potrebno je izvesti dva tretiranja kada su plodovi mladi, protiv latentnih infekcija i dva tretiranja kada su plodovi poluzreli pa do njihovog potpunog sazrevanja (Holb, 2004). Od fungicida mogu se koristiti: tiofanat metil, boskalid, piraklostrobin, ciprodinil, tebukonazol, iprodion. *Monilinia* spp. može razviti rezistentnost na navedene fungicide i zbog toga je neophodno da se ovi fungicidi naizmenično korisite u programima zaštite.

Stigmina carpophila, prouzrokovač šupljikavosti lista

Značaj. S. carpophila predstavlja ekonomski značajno oboljenje breskve. Zaraženi listovi gube fotosintetsku aktivnost, a zaraženi plodovi gube tržišnu vrednost. Na listu se nalaze pege crvenkasto smedje boje oivičene uskom zonom žute boje. Kasnije u okviru pega tkivo odumire i taj deo ispada. Pojavljuje se tipičan simptom šupljikavosti lista. Slične pege se mogu javiti na mladarima koji deluju kao da su oštećeni gradom. Na plodovima se javljaju pege koje podsećaju na kraste pošto su u donosu na površinu ploda ispupčene.

Biologija. Gljiva prezimljava u rak ranama na granama. Tokom proleća, pri vlažnim uslovima, u ovim rak ranama dolazi do stvaranja konidija koje mogu zaraziti list, cvet, mladar i plod (Ram i Bhardwaj, 2004). Za ostvarivanje zaraze neophodna je kiša uz optimalne temperature od 18-21°C. Godine sa kišovitim prolećem su veoma povoljne za razvoj ovog patogena (Grove, 2002).

Suzbijanje. S. carpophila ne predstavlja veliki problem u dobro negovnim zasadima. Od agrotehničkih mera treba uraditi orezivanje i uklanjanje rak-rana kao izvora inokuluma. Prvo tretiranje treba izvesti u jesen po opadanju lišća sa preparatima na bazi jedinjenja bakra. Tretiranjem ovim preparatima značajno se smanjuje količina inokuluma i sprečavaju se infekcije mladara. Tokom vegetacije prvo tretiranje treba obaviti u fenofazi precvetavanja, a sledeća dva u intervalu od 10-20 dana. Ako je kišovito vreme ovaj interval treba da bude kraći. Od jedinjenja za ove namene mogu se koristiti preventivni fungicidi: kaptan, mankozeb, metiram-metil, ditianon i dr. Sistemični fungicidi slabije deluju na ovog patogena.

Sphaerotheca pannosa, prouzrokovač pepelnice

Značaj. Pepelnica breskve se javlja svake godine i predstavlja ekonomski značajno oboljenje breskve i nektarine. Treba istaći da je nektarina osetljivija na pepelnicu od breskve. Usled pojave pepelnice na lišću može doći do defolijacije, što se nepovoljno odražava na krupnoću plodova i vitalnost biljaka za sledeću godinu. Simptomi pepelnice breskve se ispoljavaju na lišću i plodu. Na zaraženim delovima javlja se brašnasta micelijska prevlaka što je opšti simptom i kod ostalih prouzrokovača pepelnica.

Biologija. Prouzrokovač pepelnice breskve prezimljava micelijom u pupoljku. Iz zaraženih pupoljaka u proleće kreću beli mladari koji su osnovni izvor inokuluma za ostvarivanje sekundarnih zaraza. Tokom vegetacije može biti više sekundarnih zaraza, sve dok traje porast letorasta. Posebno je osetljivo mlado lišće. Optimalne temperature za razvoj gljive su 20-27°C uz povišenu relativnu vlažnost vazduha (Anonymous, 2011).

Suzbijanje. U zasadima gde je konstatovano prisustvo većeg broja belih mladara treba obaviti njihovo mehaničko uklanjanje po kretanju vegetacije. Primena fungicida predstavlja osnovu zaštite od pepelnice breskve. Prvo tretiranje treba obaviti u fenofazi precvetavanja, a kasnija u intervalu od 10-14 dana. Kod nektarine potrebno je izvesti 4-5 tretiranja. Od fungicida mogu se koristiti preventivni, kao što su sumpor i dinokap. Sistemični fungicidi su efikasniji od preventivnih. Od sistemičnih najčešće se koriste fungicidi iz grupe triazola: miklobutanil, penkonazol flusilazol, flutriafol i dr. Pored ovih jedinjenja može se koristiti i krezoksim - metil.

Podosphaera leucotricha, prouzrokovač rđaste mrežavost plodova

Značaj. Rđasta mrežica koju prouzrokuje *P. leucotricha* u našim uslovima se javlja na sortama Samerset, Sankrest i Fajet. Na ovim sortama oboljenje je veoma

štetno, posebno u zasadima breskve koji se nalaze blizu zasada jabuke. Plodovi koji su zahvaćeni mrežicom gube tržišnu vrednost, a štete zavise od intenziteta zaraze. U nekim godinama štete mogu biti veće od 50%. Prva moguća mera u suzbijanju ovog oboljenja je gajenje navedenih sorata što je moguće dalje od zasada jabuke. Ukoliko to nije izvodljivo suzbijanje treba izvesti fungicidma. Ovo oboljenje se suzbija istim fungicidima kao i *S. pannosa.* Osnovna razlika je u tome što se sa suzbijanjem *S. pannosa* počinje u precvetavanju, a *P. leucotricha* u fenofazi roze pupoljka (Dolovac, 2011).

Najznačajnije štetočine breskve i nektarine

Cydia molesta, breskvin smotavac

Značaj. Breskvin smotavac se javlja svake godine nanoseći značajne štete u proizvodnji breskve i nektarine. Štete mogu biti direktne i indirektne. Larve svojom ishranom prave direktne štete na plodovima izazivajući crvljivost, kao i na letorastima u čije vrhove se ubušuju izazivajući sušenje. Takođe, larve svojim oštećenjima stvaraju povoljne uslove za razvoj truleži plodova i time prave indirektne štete.

Biologija. C. molesta prezimljava u stadijumu larve u kokonu. U proleće, tokom maja, posle precvetavanja, javljaju se leptiri koji odlažu jaja iz kojih se pile larve koje se ubušuju u vrhove letorasta ili plodove. Prva generacija je homogena, pošto nisu prisutni svi razvojni stadijumi u istom trenutku. Kasnije generacije se prepliću, tako da u svakom trenutku mogu biti prisutna jaja, larve i imaga (Rothschild i Vickers, 1991). U našim agroekološkim uslovima razvija četiri do pet generacija. Ovo znatno otežava određivanje rokova tretiranja.

Suzbijanje. Određivanje rokova suzbijanja vrši se praćenjem leta leptira feromonskim klopkama i odlaganja jaja. Na lokalitetima gde *C. molesta* predstavlja veliki problem, prvo tretiranje treba uraditi na početku odlaganja jaja jednim od sledećih insekticida: fenoksikarb, piriproksifen, lufenuron, teflubenzuron. Sledeće tretiranje za suzbijanje prve generacije treba obaviti pre ubušivanja gusenica u plodove sa hlorpirifosom ili hlorantraniliprolom. Izuzetno je važno da se dobro suzbije prva generacija, jer će kasnije tokom vegetacije biti mnogo slabiji napad ove štetočine. Sledeća tretiranja se obavljaju u određenim vremenskim intervalima (oko 15 dana) u zavisnosti od perzistentnosti preparata. Od insekticida mogu se koristiti: hlorpirifos, fenoksikarb, piriproksifen, lufenuron, teflubenzuron ili hlorantraniliprol. Za suzbijanje letnjih generacija u svetu se koristite klopke “*mating disruption*” (Kutinkova i sar., 2010). U našim agroekološkim uslovima ova metoda još nije razvijena, tako da se koriste insekticidi za ova tretiranja i to: hlorantranilprol, piretroidi ili spinosad. Kada se radi poslednje tretiranje obavezno treba poštovati karencu.

Myzus persicae, breskvina zelena vaš

Značaj. Na breskvi se može javiti više vrsta biljnih vašiju, ali ekonomski najznačajnija je *M. persicae*. Ona se javlja svake godine i može naneti 100% štete. Poslednjih godina postaje sve veći problem u proizvodnji breskve u svim rejonima njenog gajenja. Ona prouzrokuje uvijanje lišća i vrhova mladara i njihovo sušenje, a biljke zaostaju u porastu. Plodovi ostaju sitni i na njima se javlja intenzivna medna rosa, na kojoj se razvijaju gljive čadjavice. Ovakavi plodovi gube tržišnu vrednost.

Biologija. M. persicae prezimljavaja u stadijumu jaja, koja su locirana u pazuhu pupoljka na jednogodišnjim letorastima. U proleće, pre cvetanja breskve iz jaja se legu osnivačice koje stvaraju kolonije vašiju koje naseljavaju novopriraslu lisnu masu. Kolonije vašiju se nalaze na naličju listova i mogu prekriti njihovu celu površinu. Kod nektarina se često nalaze i u čašici cveta, u vreme cvetanja. U junu prelazi na sekundarne domaćine, zeljaste biljke i time prestaje opasnost od njenog daljeg napada. S jeseni se ponovo vraća na breskvu gde u ovom periodu ne pravi štete, ali odlaže jaja i time obezbeđuje razvoj populacije u sledećoj vegetacionoj sezoni (Retan i Thornton, 1982).

Suzbijanje. Suzbijanje *M. persicae* na breskvi predstavlja veliki izazov. Osnovni problem je što ova vaš veoma brzo razvija rezistentnost na insekticide. Ova pojava ograničava izbor insekticida za njeno suzbijanje (Elezović i sar. 2006). Biljne vaši imaju prirodne neprijatelje koji donekle mogu da regulišu njihovu brojnost. Iz ovog razloga treba koristiti selektivnije insekticide, čime se održavaju prisutne populacije predatora i parazitoida vašiju. Prva mogućnost za suzbijanje je tretiranje mineralnim uljima od bubrenja pupoljaka do fenofaze mišije uši, čime se značajno redukuje populacija vašiju. Osnovno tretiranje za suzbijanje biljnih vašiju je u fenofazi neposredno pre cvetanja ili u precvetavanju (Retan i Thornton, 1982). Od insekticida mogu se koristiti: hlorpirifos, neonikotinoidi (acetamiprid, tiamotoksam) ili pimetrozin.

Pseudaulacaspis pentagona, dudova štitasta vaš

Značaj. Štitaste vaši na breskvi i nektarini u poslednje vreme postaju sve veći problem. U poslednjih desetak godina došlo je do proširivanja površina pod nektarinom, koja je vrlo osetliva na ovu štitastu vaš. Smatra se da je to glavni razlog jače pojave štitastih vašiju na breskvi i nektarini. U uslovima jačeg prisustva ove štetočine dolazi do sušenja pojedinih delova krošnje. Direktne štete prave i na plodovima, jer usled prisustva ove štetočine smanjuje se tržišna vrednost plodova.

Biologija. Štitaste vaši prezimljavaju u stadiujumu nedozrele ženke, ispod voštanog štita koji luče, na starijim delovima krošnje. U proleće ženka nastavlja sa razvojem i u maju odlaže jaja ispod štita. Iz ovih jaja se pile L1 larve tzv. “lutalice”, koje se određeno vreme kreću po biljci i tada su podložnije delovanju insekticida. Posle ovog perioda larve nastavljaju sa razvojem, dajući drugu generaciju. Treba

istaći da su ostali larveni stadijumi pokriveni voštanim štitom, koji predstavlja izvesnu barijeru insekticidima (Graora, 2004).

Suzbijanje. Osnovna mera suzbijanja *P. pentagona* i ostalih štitastih vašiju je primena mineralnih ulja od mirovanja vegetacije do bubrenja pupoljaka. Sledeći tretman je u vreme pojave larvi “lutalica”. Za suzbijanje ovih štetočina mogu se primeniti preparati na bazi hlorpirifosa ili fenoksikarba (Graora, 2004).

Frankliniella occidentalis, trips

Značaj. U poslednje vreme na breskvi, a posebno na nektarini, trips dobija na značaju. U osnovi navode se dva razloga njegove jače pojave: globalne klimatske promene (sušnije godine) i povećanje površina pod nektarinama. Javlja se svake godine i na nektarini nanosi značajne štete. Trips na nektarini može izazvati dva tipa oštećenja. Prvi tip je plutavost i udubljenost plodova. Ovaj tip oštećenja se javlja kao posledica ishrane tripsa tokom cvetanja i precvetavanja. Drugi tip je belilo pokožice ploda na obojenim sortama. Ovaj tip oštećenja javlja se kao posledica ishrane tripsa kada su plodovi poluzreli ili zreli. U oba slučaja plodovima se smanjuje tržišna vrednost.

Biologija. Trips prezimljava u stadijumu imaga na korovima. U proleće se aktivira i prelazi na breskvu, gde odlaže jaja na list ili delove cveta. Iz jaja se pile larve koje se hrane epidermisom i time prave tipična oštećenja na mladim plodovima. Kod obojenih sorata kada su plodovi poluzreli ili zreli dolazi do pojave belih mrlja. Tokom godine može imati više generacija. Najveći broj generacija razvija u godinama sa toplim i sušnim prolećem i letom (Pearsall i Myers, 2000).

Suzbijanje. Suzbijanje korova u voćnjaku i oko njega doprinosi manjoj brojnosti tripsa. Ovo je neophodno uraditi pre cvetanja breskve. U zavisnosti od brojnosti tripsa prvi tretman treba obaviti ili pre cvetanja ili u precvetavanju. Ako je veća brojnost štetočine, tretiranje treba izvesti pre cvetanja (McLaren i Fraser, 2000). Od insekticida mogu se koristiti: hlorpirifos, akrinatrin i neonikotinoidi (acetamiprid, taikloprid, tiametoksam). Na obojenim sortama nektarine pred berbu neophodno je izvesti suzbijanje tripsa. Za ove namene može se koristiti spinosad pri čemu se mora voditi računa o karenci.

Program zaštite breskve i nektarine

U tabeli 1 prikazan je orijentacioni program zaštite breskve i nektarine. U zavisnosti od meteoroloških uslova tokom vegetacije, ali i sorte ovaj broj tretiranja može biti za jedno do dva tretiranja manji ili veći.

Prvo tretiranje namenjeno je suzbijanju *T. deformans*, *S. carpophila* i smanjenu infekcionog potencijala od *Monilinia* spp. Ovo tretiranje se obavlja u jesen kada opadne 90% lišća sa preparatima na bazi jedinjenja bakra.

Tretiranje u fenofazi neposredno pre bubrenja pupoljaka vrši se za suzbijanje *T. deformans*. U ovoj fazi mogu se koristiti ciram, hlorotalonil ili delan.

Tabela 1. Orijentacioni program zaštite breskve i nektarine

Fenofaza	Bolesti/Štetočine	Pesticidi
Mirovanje vegetacije	Kovrdžavost lišća, štitaste i biljne vaši	Neorganska jedinjenja bakra + mineralno ulje
Neposredno pre pojave “zelene tačke”	Kovrdžavost lišća	Ciram ili hlorotalonil
Roze pupoljak	Pepelnica, vaši i trips	Krezoksim-metil + akrinatrin
Cvetanje	Sušenje grančica	Ciprodinil ili boskalid + piraklostrobin ili tiofanat-metil
Precvetavanje	Pepelnica, šupljikavost lista, biljne vaši	Triazol + mankozeb + hlorpirifos
15 dana nakon precvetavanja	Pepelnica, šupljikavost lista, breskvin smotavac	Triazol + kaptan + hlorantraniliprol
Sazrevanje ranih sorti	Breskvin smotavac, trulež plodova	Boskalid + spinosad
Sazrevanje poznijih sorti	Breskvin smotavac, trulež plodova, pepelnica	Piretoid + iprodion + kaptan + triazol
Pred berbu (poštovanje karence)	Breskvin smotavac, trulež plodova	Fludioksonil + spinosad

U fenofazi bubrenja pupoljaka do pojave mišijih ušiju treba obaviti tretiranje mineralnim uljima. Ovo tretiranje namenjeno je suzbijanju prezimljujućih formi štetočina (štitaste vaši, biljne vaši i grinje).

U fenofazi roze pupoljka izvodi se tretiranje za suzbijanja pepelnice. Od jedinjenja koriste se triazoli ili strobilurini. U ovoj fazi mogu se suzbiti trips i vaši, a od insekticda mogu se koristiti akrinatrin, neonikotinoidi ili hlorpirifos.

U fenofazi cvetanja vrši se suzbijanje *Monilinia* spp. prouzrokovača sušenja grančica. Za ove namene mogu se koristiti: tiofanat metil, boskalid, piraklostrobin, ciprodinil, tebukonazol, iprodion.

U fenofazi precvetavanja treba obaviti tretiranje za suzbijanje vašiju i tripsa ukoliko nije rađeno pre cvetanja, a od insekticida mogu se koristiti neonikotinoidi ili hlorpirifos. Od bolesti u ovoj fazi suzbijaju se pepelnica i šupljikavost lista. Za suzbijanje pepelnice mogu se koristi triazoli ili strobilurini, a za šupljikavost lista kaptan, mankozeb ili metiram metil

Sledeće tretiranje treba obaviti 15-20 dana kasnije u odnosu na prethodno. Nastavlja se sa suzbijanjem pepelnice i šupljikavosti lista istim jedinjenjima kao u prethodnom periodu. Od štetočina u ovom periodu suzbija se breskvin smotavac, pri čemu se mogu koristiti hlorantranilprol, hlorpirifos ili piretoridi.

Naredno tretiranje izvodi se 15-20 dana kasnije u odnosu na prethodno. Nastavlja se sa suzbijanjem pepelnice i šupljikavosti lista. U ovom periodu suzbiaju se i latentne infekcije od *Monilinia* spp., primenom fungicida: tiofanat metil, boskalid, piraklostrobin, ciprodinil, tebukonazol ili iprodion. Od štetočina u ovom

periodu suzbija se breskvin smotavac, primenom insekticida: hlorantranilprol, hlorpirifos ili piretoridi.

Poslednja tretiranja (jedno do dva) namenjena su suzbijanju truleži plodova jednim od prethodno navedenih fungicida. Od štetočina u ovom periodu suzbijaju se breskvin smotavac i trips i to nekim od insekticida iz grupe piretroida ili spinosadom. Kod poslednjeg tretiranja neophodno je poštovati karencu svakog pesticida koji se primenjuje.

Zaključak

Savremena proizvodnja breskve i nektarine nije moguća bez sprovođenja mera zaštite protiv prouzrokovača biljnih bolesti i štetočina tokom vegetacije. Redovna, pravilna i pravovremena primena pesticida, uz sprovođenje svih neophodnih agrotehničkih i pomotehničkih mera omogućiće optimalan prinos ovih kultura.

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Pest and Disease Control of Peach and Nectarine

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Summary

Peach and nectarine protection from plant diseases and pests is very important and represents prerequisite of high yields and good health of these cultures. Several diseases threaten to production of these fruit trees: peach leaf curl, fruit and brown rot, shot hole, powdery mildew. The most important pest species are: peach moth, green peach aphid, white peach scale and thrips.

The critical periods for control must be respected. The first application for *T. deformans*, *S. carpophila* and *Monilinia* spp. control should be carried out in autumn with copper compounds when 90% leaves were fallen. The application in phenophase immediately before bud swelling should be conducted for *T. deformans* control with ziram, chlorothalonil or delan. In phenophase of bud swelling until mouse-ear stage we should apply mineral oil for control of hibernating forms of pests (scales, aphids and mites). In phenophase when the most flowers with petals forming a hollow ball we should carry out powdery mildew control with triazoles or strobilurines. In this stage we control thrips and aphids with acrinathrin, neonicotinoids or chlorpyrifos. In flowering stage it should be conducted control of *Monilinia* spp. with tiophanat methyl, boscalid, pyraclostrobin, cyprodinil, tebuconazole or iprodione. In the end of flowering we control aphids, powdery mildew and shot hole. After this application of pesticide we must conduct another 2 to 3 treatments for pest and disease control.

Properly implemented peach and nectarine protection program in accordance with meteorological conditions, biology of pests and diseases and proper choice of pesticide products and their timely implementation provide high yields of these fruit trees.

Key words: peach, nectarine, diseases, pests, control.

Predavanje po pozivu

BAKTERIOZE BRESKVE I KAJSIJE

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Izvod. U radu su saopšteni podaci o ekonomski najznačajnijim fitopatogenim bakterijama, patogenima kajsije i breskve. Na osnovu dosadašnjih rezultata u nas, ali i sumiranjem rezultata drugih autora, breskvu i kajsiju parazitiraju fitopatogene bakterije rodova *Pseudomonas*, *Xanthomonas* i *Agrobacterium*. Najrasprostranjenija i ekonomski najštetnija u nas je *P. syringae,* koja je jedan od prouzrokovača izumiranja kajsije ali se u poslednje vreme sve češće pojavljuje i kao patogen breskve i nektarine. Široko je rasprostranjena i bakterija *A. tumefaciens*, prouzrokovač raka korena koštičavih voćaka. U radu su takođe opisane i dve karantinske bakterije *P.s*. pv. *persicae* i *Xanthomonas arboricola* pv. *pruni*, koje za sada u Srbiji nisu registrovane ali je poznavanje njihovih karakteristika veoma značajno za unapređenje proizvodnje breskve, nektarine i kajsije.

Ključne reči: breskva, kajsija, fitopatogene bakterije, detekcija, epidemiologija, suzbijanje.

Uvod

Fitopatogene bakterije paraziti breskve i kajsije, zbog sve veće rasprostranjenosti i šteta koje prouzrokuju, sve više privlače pažnju naučne i stručne javnosti. Ove vrste voćaka najčešće parazitiraju bakterije rodova *Pseudomonas*, *Xanthomonas* i *Agrobacterium*. Simptomi kojima se bolest ispoljava, kao i štete koje nastaju kao posledica infekcije, zavise od vrste bakterije, ekoloških uslova, osetljivosti sorte, primenjene agrotehnike, interakcije sa drugim organizmima i sl.

Cilj ovog saopštenja je da se pruže osnovne informacije o ekonomski najznačajnijim bakterijama parazitima breskve i kajsije, opišu njihove bakteriološke karakteristike, epidemiologija i ukaže na raspoložive mere njihovog suzbijanja.

Pseudomonas syringae

Patogen se odlikuje veoma širokim krugom domaćina, koji obuhvata brojne zeljaste i drvenaste biljke, te je zbog toga veoma rasprostranjena širom sveta. Obuhvata gram negativne bakterije štapićastog oblika, polarnog rasporeda cilija, koje stvaraju fluorescentni pigment, a glukozu metabolišu isključivo u aerobnim uslovima (oksidativno) (Arsenijević, 1997).

Simptomi koje bakterija prouzrokuje na stablima breskve i kajsije se ispoljavaju u u vidu sušenju grana , najčešće početkom vegetacije. Lišće na obolelim granama gubi turgor i vene; a usled nejednakog razvoja obolelog i zdravog tkiva dolazi do pucanja kore i obrazovanja rak rana. Uklanjanjem površinskog sloja kore uočava se nekroza provodnog sistema stabla voćke, ispoljena u vidu mrke boje i meke konzistencije obolelog tkiva. Pored ovog najčešće ispoljenog simptoma, često se uočava i nekroza debla koja obično rezultira izumiranjem čitavih stabala.

U periodu 2007-2009. godine, na području Smedereva zapažena je pojava nekroze pupoljaka mladih stabala breskve, veoma visokog intenziteta, što je prouzrokovalo sušenje čitavih stabala (Gavrilović et al., 2011). Tkivo oko pupoljaka nekrotira, što dovodi do sušenja listova i cvetova breskve.

Međutim, simptome slične navedenim na stablima breskve i kajsije mogu prouzrokovati i drugi fitopatogeni organizmi: gljive iz rodova *Leucostoma, Verticillium, Monilinia, Eutypa*, virusi i fitoplazme (Klement, 1977; Gavrilović, 2006; Duduk, 2011).

Zbog toga je u cilju pouzdane detekcije patogena neophodno pristupiti laboratorijskim ispitivanjima u cilju izolovanja bakterije i proučavanju njenih karakteristika.

Izolovanje bakterije je moguće praktično na svim hranljivim podlogama, ali se u ove svrhe najviše koriste, King-ova podloga B (KB) i mesopeptonska podloga obogaćena s 5 % saharoze (SNA) na kojima bakterija formoira karakteristične kolonije. Na prvoj stvaraju fluorescetni pigment, a na drugoj formiraju ispupčene klonije, sluzaste, sjajne i glatke (levan tip kolonija). Ovo su dve odlike *P. syringae*, veoma značajne za njenu identifikaciju (Lelliott and Stead, 1987; Arsenijević, 1997; Gavrilović, 2006). Bakterija prouzrokuje hipersenzibilnu reakciju duvana, međutim ne stvara oksidazu, arginin dehidrolazu i ne stvara pektolitičke enzime (LOPAT +---+) (Lelliott et al., 1966). Ova grupa testova omogućava detekciju bakterije do nivoa vrste. Međutim, koštičave voćke parazitiraju dva patogena varijeteta bakterije: *P.s*. pv. *syringae* i *P.s* pv. *morsprunorum.* Za njhovu diferencijaciju se koriste testovi patogenosti, biohemijski testovi i molekularne metode (PCR) korišćenjem prajmera za detekciju gena odgovornog za detekciju siringomicina (za pv. *syringae*) odnosno koronatina (pv. *morsprunorum*) (Liang et al., 1994; Sorensen et al., 1998; Cao et al., 2006; Ivanović, 2011; Gavrilović et al, 2011; Gašić et al., 2012).

Diferencijalni testovi patogenosti za pv. *syringae* i pv. *morsprunorum* prikazani su u tabeli 1. Na osnovu prikazanih podataka u ovoj tabeli, može se zaključiti da izuzev inokulisanih, nedozrelih plodova trešnje, na kojima prouzrokuje mrke površinske pege, sojevi *P.s.* pv. *morsprunorum*, negativno reaguju pri ostalim testovima patogenosti prikazanim u tabeli. Za razliku od njih, sojevi pv. *syringae* pozitivno reaguju pri pomenutim testovima patogenosti. Ovo su veoma značajne razlike između pv. *syringae* i pv. *morsprunorum* i imaju veliki značaj za njihovu detekciju (Burkowicz and Rudolph, 1994; Gavrilović, 2006; Bultreys and Kaluzna 2010, Gilbert et al., 2009; Gilbert et al., 2010; Kaluzna and Sobiczewski 2009; Kaluzna et al., 2010).

Tabela 1. Patogene odlike *P.s*. pv. *syringae* i *P.s.* pv. *morsprunorum*
Pathogenic characteristics of P.s. *pv.* syringae *and* P.s. *pv*. morsprunorum

Test	*P.s.*pv. *syringae*	*P.s.*pv. *morsprunorum*
HR duvana / *HR tobacco*	+	+
Patogenost na plodovima / *Pathogenicity on fruits*		
Trešnje* / *Sweet cherries*	++	+
Kruške / *Pears*	+	-
Limuna / *Lemon*	+	-
Inokulacija / *Inoculation*		
Kotiledona breskve / *Peach cotyledons*	+	-
Listova jorgovana / *Syringa lives*	+	-

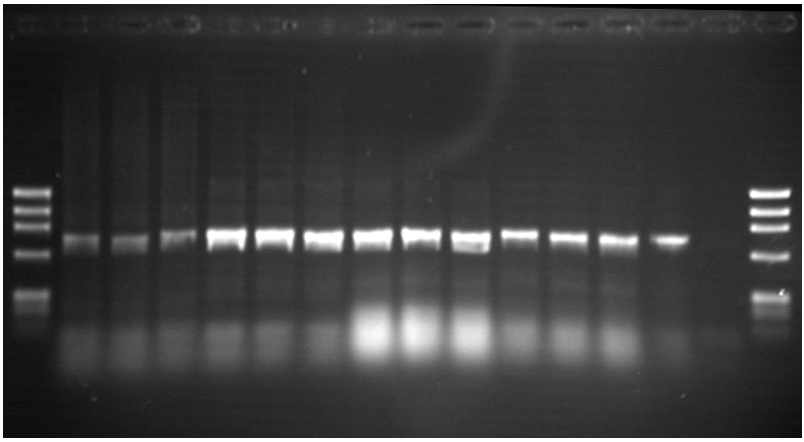
* + Površinske svetlo mrke pege oko mesta inokulacije
Surface light brown spots around the place of inoculation
++ Ulegnute nekroze crne boje oko mesta inokulacije
Depressed black necrosis around the place of inoculation

Za diferencijaciju patogenih varijeteta *P. syringe* veliki značaj imaju sledeći biohemijski testovi: hidroliza želatina i eskulina, aktivnost tirozinaze i metabolizam (korišćenje tartarata) (GATT). Sojevi pv. *syringae* hidrolizuju želatin i eskulin, ali ne stvaraju tirozinazu i ne metabolišu tartarate; suprotno, sojevi pv. *morsprunorum* ne hidrolizuju želatin i eskulin ali stvaraju tirozinazu i koriste tartarate usvojim metaboličkim procesima. Pored ovih testova za diferencijaciju patogenih varijeteta se koristi i test korišćenja DL laktata, koji metabolišu samo sojevi pv. *morsprunorum* (Lattore and Jones, 1979; Burkowicz and Rudolph, 1994; Gavrilović, 2006; Kaluzna et al., 2010)

Molekularna karakterizacija *P. syringae* uključuje primenu više tipova prajmera. Jedna od najpouzdanijih metoda je korišćenje seta prajmera za detekciju *syrB* gena, koji je genetski faktor stvaranja siringomicina. To je složeni makromolekul, uključen u proces patogeneze i ispoljavanje simptoma bolesti. Prisustvo ovog gena je potvrđeno u sojevima *P. syringae* izolovanim iz nekrozom zahvaćenih pupoljaka breskve na području Smedereva (sl.1) (Gavrilović et. al., 2011).

Produkcija siringomicina, cikličnog lipodepsinonapeptida, glavnog faktora virulencije bakterije *P. syringae* pv. *syringae* može biti detektovana korišćenjem PCR reakcije i specifičnih prajmera za *syrB* gen koji kodira ovaj metabolit (Sorensen et al., 1998). Pojava trake na gelu na poziciji od 752-bp kod svih ispitivanih izolata ukazuje na prisustvo *syrB* gena kod njih i samim tim potvrđuje da ispitivani izolati pripadaju vrsti *P. syringae* pv. *syringae*).

Primena BOX, REP i ERIC prajmera, ukazuje na diverzitet sojeva *P. syringae* pv. *syringae* poreklom sa različitih domaćina i lokaliteta, ali se ne mogu koristiti za pouzdanu detekciju bakterije (Ivanović, et al., 2009, Ivanović, 2011). Na osnovu raspoloživih podataka smatra se da kao patogen breskve i kajsije dominira *P.s*. pv. s*yringae,* dok pv. *morsprunorum* pretežno parazitira trešnju i šljivu (Arsenijević, 1980; Klement ет al., 1974; Cao et al, 2006; Gavrilović et al., 2008).



Slika 1. Prikaz rezultata gel elektroforeze, pojava traka na poziciji 752 bp
Results of the gel electrophoresis, the appearance of the bends on the position 752 bp

Epidemiološko ekološke odlike *P. syringae*

Bakterija se tokom perioda mirovanja održava u rak ranama obrazovanim na obolelim granama voćaka i u pupoljcima voćaka. S obzirom na širok krug domaćina, izvor inokuluma predstavljaju i ostale biljke koje bakterija parazitira. *P.syringae* se veoma često nalazi i kao epifit na površini listova i cvetova , pri čemu ne dolazi do ispljavanja simptoma bolesti. Ova, epifitna populacija ima veoma važnu ulogu u epidemiologiji bakterije i od velikog je značaja je u ostvarenju infekcije (Lattore and Jones 1979). Brojnost epifitne populacije zavisi od ekoloških uslova, vrste pa čak i sorte voćke. *P. syringae* je epifitno utvrđena i na korovskim biljkama u voćnjacima (Ross and Hatingh, 1986b). Za ostvarenje infekcije neophodan je period niskih tempereatura (ispod nule) u trajanju od nekoliko dana. Zbog toga su infekcije breskve i kajsije bakterijom *P. syringae* najčešće posle ekstremno niskih temperatura tokom zime, ili izraženih kolebanja ovog parametra (smena niskih i viših temperatura) (Cao et al., 2011).

Mere zaštite

Suzbijanje ove bakterije je otežano pre svega nepostojanjem baktericida koji bi sprečili razvoj i širenje bakterije. Preporučuje se primena preprata na bazi bakra u jesen radi zaštite ozleda nastalih posle opadanja lišća. Poželjno je obaviti dva tretiranja: kad počne opadanje i kada otpadne oko 2/3 lišća. Za preporuku je i prolećno tretiranje preparatima iz ove grupe, radi sprečavanja razvoja epifitne populacije koja je pri povoljnim uslovima može biti značajan izvor inokuluma za ostvarenje infekcije (Crosse, 1963; Latorre and Jones 1979; Ross and Hattingh, 1986a). Prolećno tretiranje se može obaviti do faze „mišjih ušiju“, ali i kasnije ukoliko se preparati primenjuju u nižim koncentracijama. Mehaničko uklanjanje

obolelih grana takođe je za preporuku, pri čemu takve operacije na breskvi treba izvoditi što kasnije u proleće (rezidba pred samo cvetanje) (Biggs, 1989). Mehaničko odstranjivanje obolelih grana kajsije obavljati još kasnije (tokom leta) (Klement et al., 1977). Povrede biljnog tkiva nastale prirodnim putem ili rezidbom su povoljna mesta za infekciju bakterijom (Klement, 1977). Za preporuku je i zaštita debla breskve i kajsije trakama bele boje, koje bi smanjile uticaj kolebanja zimskih temperatura kao i krečenje debala breskve i kajsije (Hinrichs- Berger, 2004). Pred zasnivanje zasada breskve, potrebno je uraditi analizu zemljišta na prisustvo nematoda, pošto je dokazano da postoji pozitivna korelacija između prisustva ovih organizama i intenziteta ostvarene infekcije (Ritchie and Clayton, 1982; Cao et al., 2006; Newton Mayer and Mendes Pereira, 2012).

Pseudomonas syringae pv. *persicae*

Bakterija parazitira breskvu i nektarinu, ali pri veštačkim inokulacijama i japansku šljivu (*Prunus salicina*). Prisustvo ove bakterije je potvrđeno u Francuskoj i na Novom Zelandu (Young 1988). U nas se nalazi na A1 Listi karantinskih patogena, što znači da njeno prisustvo u Srbiji nije potvrđeno (Gašić et al., 2012).

Simptomi bolesti se ispoljavaju u vidu pegavosti lišća, pri čemu nekrotični deo pega vremenom otpada i listu daje rešetav izgled. Slične simptome može prouzrokovati i fitopatogena gljiva *Wilsonomices carpophilus,* široko rasprostranjen patogen breskve i kajsije. Takođe, dolazi i do nekroze pupljaka breskve i okolnog tkiva, koje nekrotira i dobija mrko-zelenu boju. Bakterija se pri povoljnim uslovima veoma brzo razvija, zahvatajući mladare u celosti, ali i višegodišnje grane (Young 1988; Vigoroux, 1989). Stabla su naosetljivija do starosti 5-6 godina. Na plodovima breskve i nektearine se uočavaju mrke pege, praćene obilnim lučenjem smole, kao reakcije obolelog tkiva (Vigoroux, 1989)

Bakterija je štapićastog oblika,sa 2-3 polarne flagele, Gram negativna. Za razliku od patogenog varijeteta *P.s*. pv. *syringae* , ne fluorescira na King-podlozi B (KB), ali se razlike ispoljavaju i pri metabolizmu ugljenih hidrata i organskih kiselina.

Suzbijanje uključuje sadnju zdravog sadnog materijala, gajenje manje osetljivih sorata breskve i tretiranje stabala preparatima na bazi bakra u vreme opadanja lišća (Luisetti et al., 1976).

Xanthomonas arboricola pv. *pruni*

Bakterija je po prvi opisana na tlu Severne Amerike, gde u zasadima koštičavih (*Prunus* ssp) voćaka može naneti značajne štete. Među najosetljivije domaćine se ubrajaju breskva, nektarina i kajsija. Široko je rasprostranjena u SAD, Kanadi, Južnoj Americi, Aziji i Australiji (EPPO standards PM 7/64) (Gašić and Obradović, 2009)

Pošto je reč o karantinskom patogenu (A2 lista, EPPO), podaci o njenom eventualnom rasprostranjenju u Evropi ukazuju da je bakterija prisutna u Italiji, Bugarskoj, Sloveniji i Ukrajini (Gašić and Obradović, 2009). Bakterija se u Srbiji nalazi na A1 listi karantinskih organizama.

Simptomi bolesti se ispoljavaju na listovima, plodovima i mladarima breskve i kajsije. Na lišću se pojavljuju sitne pega okruglog ili nepravilnog oblika, žuto-zelene boje. Tkivo u okviru pege vremeno nekrotira i otpada, što takođe podseća na simptome koje prouzrokuje gljiva *W. carpohilum*. Tkivo lišća oko pega postaje hlorotično i kod osetljivih sorata može doći do defolijacije, kada i nastaju najveće štete. Na plodovima se uočavaju sitne nekrotične pege, koje se vremenom šire, a tkivo u okviru pega puca. Na osetljivijim sortama nektarine se pojavljuju crno-mrke ulegnute, krupnije nekroze, čije formiranje prati obilna produkcija smole. Procenat obolelih plodova se kreće od 25-75 %, što ukazuje da bakterija može naneti veoma značajne ekonomske štete (Arsenijević, 1997; Gašić i Obradović, 2009). Inficirani mladari nekrotiraju pri vrhu, dok je tkivo ispod nekrotičnog dela tamne boje i sadrži vitalne bakterijske ćelije (Gašić and Obradović, 2009). Bakterija sa obolelih listova i plodova vrši infekciju mladara na kojima se pojavljuju eliptične nekrotične pege, koje ne prouzrokuju veliku štetu, ali se bakterija u njima održava tokom perioda mirovanja (Jones and Sutton, 1996).

X. arboricola pv. *pruni* je Gram negativna bakterija, štapićastog oblika, koja pri izolaciji na hranljivim podlogama formira kolonije žute boje. One su posebno karakteristične na podlogama sa kvaščevim ekstraktom i kalcijum karbonatom, na kojim formire sluzaste, sjajne, blago ispupčene kolonije (Arsenijević 1997; Gašić and Obradović, 2009).

Patogenost bakterije se može pouzdano proveriti inokulacijom nesazrelih plodova japanske šljive, na kojima se posle pet dana od inokulacije pojavljuju vodenaste, svetlozelene pege, koje kasnije nekrotiraju i dobijaju tamnomrku boju (Gašić and Obradović, 2009). Za proveru patogenosti se se mogu koristiti i listovi osetljivih sorata breskve. Od biohemijskih odlika značajnih za detekciju bakterije izdvojili bi: pozitivan rezultat pri testovima hidrolize želatina i eskulina, razvoj na35°C i u podlozi s 2% NaCl, oksidativan metabolizam glukoze, korišćenje dekstrina, arabinoze, laktoze i sahroze; negativni rezultati su zabeleženi pri testovima stvaranja oksidaze, hidrolize skroba, aktivnosti ureaze, razvoja u podlozi sa 5% NaCl, kao i metabolizma laktoze, maltoze, rafinoze, sorbitola (Fahy and Persley, 1983; Schaad, 2001; Jami et al., 2005).

Molekularna analiza sojeva *X.a*. pv. *pruni* podrazumeva korišćenje specifičnih prajmera za ovu bakteriju, ali se u poslednje vreme sa uspehom koristi i rep-PCR metod korišćenjem REP, BOX i ERIC prajmera. Proučavani sojevi bakterije pri rep PCR testu identično reaguju kao i referentni soj *X.a*. pv. *pruni* , dok se primenom ERIC prajmera uočavaju izvesne razlike među sojevima, što može imati uticaja na epidemiologiu patogena i rezrade mera suzbijanja (Gašić and Obradović, 2009).

Suzbijanje podrazumeva pre svega korišćenje zdravog sadnog materijala. Za sprečavanje infekcije plodova breskve i kajsije se preporučuju 2-3 tretiranja

preparatima na bazi bakra od faze mišjih ušiju pa do precvetavanja. Utvrđena je i razlika između sorata, te bi strategiju uspešnog suzbijanja bakterije trebalo bazirati na gajenju otpornih sorata (Jones and Sutton, 1996).

Agrobacterium tumefaciens

Prouzrokuje „rak“ korena koštičavih i jabučastih voćaka. Na korenu obolelih stabala se formiraju tumori, različite veličine i strukture. Obično su okruglastog oblika i na početku njihovog razvoja tkivo im je, bledozelene boje i mekše su konzistencije. Kasnije dolazi do njihovog pucanja po površini, a samo tkivo tumora dobija tamnomrku boju. Simptomi bolesti su veoma karakteristični, lako prepoznatljivi, a patogen je veoma rasprostranjen u nas, kako na koštičavim tako i na jabučastim voćkama (Arsenijević, 1997).

Osnovni izvor zaraze bakterijom predstavljaju tumori koji ostaju u zemljištu i predstavljaju višegodišnji izvor inokuluma. Bakterija se odlikuje izrazitom vitalnošću i u zemljištu se održava veoma dugo. Infekcija se ostvaruje preko korenovih žilica i povreda koje nastaju prilikom izvođenja agrotehničkh mera u rastilu ili zasadu (Arsenijević, 1997). Daljim razvojem bakterija prouzrokuje proliferaciju tkiva, što se ispoljava stvaranjem tumoralnih tvorevina, a kasnije dospevanjem preko tumora u zemljištu služi kao izvor inokuluma za dalje infekcije.

Bakterija je kao i prethodno navedene Gram negativna, štapićastog oblika, amfilotrihog rasporeda cilija. Vrsta *A. tumefaciens* formira tzv. T plazmid koji prouzrokuje proliferaciju tkiva koja rezultira formiranjem tumora. Sojevi koji poseduju tzv. R plazmid, na korenu obolelih biljaka, utiču na stvaranje enormno velikog broja nefunkcionalnih korenovih žilica. Ova bolest se zove kosmatost korena i prouzrokuje je bakterija *A. rhizogenes* (Schaad, 2001).

Za izolovanje bakterije se koriste standardne podloge (NA, YDC), ali postoje i brojne selektivne podloge, na kojima se bakterija može izolovati iz biljnog materijala ali i iz zemljišta i vode (Schaad, 2001). S obzirom da se prilikom izolacije na hranljivim podlogama mogu pojaviti i saprofitne forme *Agrobactrium* ssp., potrebno je proveriti patogenost izolovanih sojeva. U te svrhe se uspešno primenjuje inokulacija mladih biljaka paradajza ili kriški mrkve, na kojima se nakon perioda inkubacije pojavljuje karakteristične tumoralne izrasline (Arsenijević 1997; Schaad et al., 2001; Milijašević et al., 2007). Sojevi *A. tumefaciens* stvaraju oksidazu, razvijaju se na 35°C, razvijaju se na 2% NaCl i metabolišu saharozu, i 3-ketolaktozni test je takođe pozitivan; negativni rezultati su utvrđeni pri testovima pektolitičke aktivnosti pri pH 4,5, metabolizma citrata i tartarata. Molekularna analiza (PCR) uključuje primenu, kako univerzalnih, tako i specifičnih prajmera za detekciju ove bakterije u biljnom materijalu, ali i zemljištu (Kuzmanović et al., 2011).

Suzbijanje bakterije podrazumeva pre svega korišćenje zdravog sadnog materijala. Prilikom vađenja sadnica odbaciti one sa vidnim prisustvom tumora. Nove zasade ne podizati na krčevinama starih, pošto je verovatnoća da je bakterija u

takvom zemljištu veoma velika. Ako je moguće zasade podizati na zemljištima gde su gajene strnine, jer biljke iz porodice *Poaceae* nisu domaćini bakterije. Bakterija ne prouzrokuje brzo uginjavanje stabala voćaka. Obolela stabla su fiziološki iscrpljena, kraći im je životni vek i period plodonošenja. Za suzbijanje su upotrebi i biološki preparati na bazi saprofitnih bakterija roda *Agrobacterium,* koji se u pojedinim zemljama sveta široko primenjuju. Njihova primena podrazumeva potapanje sadnica pre sadnje rastvor preparata ili zalivanje posle sadnje.

Zaključak

Breskva i kajsija su veoma osetljive prema fitopatogenim bakterijama. Ova grupa patogena prouzrokuje sušenje grana na kojima se obrazuju rak rane, pegavost lišća i plodova i rak korena. Bakterije paraziti kajsije i breskve pripadaju rodovima *Pseudomonas*, *Xanthomonas* i *Agrobacterium*, ali je u našim agroekološkim uslovima ekonomski najznačajnija i najrasprostranjenija bakterija *Pseudomonas syringae* pv. *syringae.* Suzbijanje pomenutih bakterija podrazumeva korišćenje zdravog sadnog materijala, mehaničko uklanjanje obolelih biljnih delova tokom vegetacionog perioda (pri višim temperaturama) i što kasnije obavljanje zimske rezidbe. Od hemijskih jedinjenja se preporučuje primena preparata na bazi bakra u jesen, u vreme opadanja lišća kao i u rano proleće. Za preporuku je zaštita debla ovih voćaka, kako bi se sprečio negativan uticaj ekstremno niskih temperature tokom zimskih meseci, kao i naglih promena vrednosti ovog ekološkog parametra tokom zime.

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Bacterial Diseases of Peach and Apricot

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Summary

Data about economically most important phytopathogenic bacteria, pathogens of peach and apricot are presented in this paper. Bacteria as pathogen of these fruit trees belong to genera *Pseudomonas, Xanthomonas* and *Agrobacterium*. Most widespread is *Pseudomonas syringae* which role in apricot decay is proved, but in recent years its occurrence on peach is also widespread throughout the world. *Agrobacterium tumefaciens* , causal agent of crown gall is also wide spread pathogen of apricot and peach transmitted by diseased plant material and rootstocks. Informations of two economically important quarantine bacteria *Pseudomonas syringae* pv. *persicae* and *Xanthomonas arboricola* pv. *pruni*, are also presented in this paper. Symptoms, epidemiology, characteristics of bacteria, methods for reliable detection, as well as available methods for pathogens control are described in manuscript.

Key words: peach, apricot, bacterial diseases, detection, epidemiology, control.

Original paper

EVALUATION OF APRICOT VARIETIES CREATED AND MAINTAINED AT SLOVAK COLLECTION OF GENETIC RESOURCES

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Abstract. The Slovak apricot breeding programme has been going on since 1964. In the range of this programme were registered 10 apricot varieties, 4 peaches and 2 rootstocks. The apricot varieties are ‘Vesna’, ‘Vegama’, ‘Velbora’, ‘Veharda’, ‘Velita’, ‘Barbora’, ‘Vesprima’, ‘Vestar’, ‘Vemina’ and ‘Veselka’. The most perspective varieties with resistance to PPV are ‘Veharda’ and ‘Vemina’. The condition of new fruit ideotype for fresh consumption (fresh fruit quality) meet mainly these varieties ‘Veselka’, ‘Vesna’ and ‘Vestar’.

The main breeding goals were: fruit quality, size, colour of skin and flesh, flesh firmness, resistance to frost and to PPV. Currently, activities with the breeding programme are over. The registered varieties are multiplied at nurseries, planted into orchards and they were included into fruit collection of the National Programme for Conservation Genetic Resources of the Slovak Republic.

During the years 2009-2012, 40 selected genotypes from fruit collection at the Gene Bank of the Slovak Republic at Piešťany were evaluated on the part of suitability for fruit growers.

The fruit quality was evaluated as a complex of characteristics consisting of the size, weight, skin colour, sugar content, firmness of flesh, etc. The maturity period was from the beginning of July to the middle of August. Kech Pchar was extremely late, with ripening at the end of September. Flower biology was studied on the other collection in the past. The evaluation consisted of valuation of flower bud density, flower composition, pollen germination and other parameters. Self-incompatible varieties were ‘Aurora’, ‘Cegledi Orias’, ‘Bergarouge’, ‘Ligeti Orias’ and ‘Vesna’.

This paper presents the results of vegetative and pomological characterisation of the selected apricot varieties created at the Slovak breeding programme and also other varieties included into collection of genetic resources.

Key words: apricot, breeding, genetic resources, flower biology, fruit quality.

Introduction

Apricots are grown in temperate and subtropical zones worldwide being the third economically most important stone fruit crops after peach and plum.

Apricot is in the *Rosaceae* family within the genus *Prunus* L., subgenus *Prunophora* Focke, and the section *Armeniaca* (Lam.) Koch. Depending on the classification system, the number of apricot species ranges from 3 to 12. Six distinct species are usually recognized: *P. brigantina* Vill., *P. holosericeae* Batal*, P. armeniaca* L., *P. mandshurica* (Maxim), *P. sibirica* L., Japanese apricot *P. mume* (Sieb.) Sieb. & Succ. Vavilov placed apricot in three centres of origin: the Chinese centre (Central and Western China), the Central Asiatic centre (Afghanistan, northwest India and Pakistan, Kashmir, Tajikistan, Uzbekistan, Xinjing province in China and western Tien-Shan), and the Near-Eastern centre (interior of Asia Minor) (Zhebentyayeva et al 2012).

Kostina (1946) divided the cultivated apricots according to their adaptability into four major ecogeographical groups: (1) the Central Asian group, (2) the Iran-Caucasian group, (3) the European group, and (4) the Dzhungar-Zailij group. Global growing areas are China, the Iran-Caucasian region, Central Asia, Europe and North America.

By comparison with other fruit species, apricot cultivation is characterized by interesting prospects either on the economical point of view or on the impact of landscape management in fragile areas. Strongly related with a clear phylogenetic structure, the wide genetic variability appeared more as a default than as a quality able to be valorised and, as most of fruit species a serious concern exists with the enlargement of pest and diseases pressure and with the required anticipation to face the problems (Bassi and Audergon, 2006).

Apricot is one of the few temperate fruit trees not affected by overproduction. Although acreage is steadily increasing worldwide, this crop is nevertheless challenged by many problems (Bassi, 1999).

In this context most of the countries developed applied research programmes to face punctual problems to be solved such as the enlargement of the period of production, the regularity of the production, the training of the orchard or the follow-up of the production after picking and the protection against pathogens. Breeding program of apricot has long tradition in Europe and achieved many very interesting results in particular countries (Burgos and Ledbeter 1993; Karayiannis and Mainou, 2001; Pennone 2001; Audergon et al. 2006a, 2006b, 2009; Krska et al., 2006; Mády et al., 2007; Badenes and Byrne, 2012).

Growing of apricot has a long tradition also in Slovakia regardless of fact that geographical and eco-climatic conditions of Slovakia are the northern boundary of apricot production in Europe. In these conditions, apricot orchards have limited longevity, flower buds are frequently injured during winter and spring by frost. Present situation in orchards and decreasing total area of apricot plantation is also consequence of strong influence of pathogens, especially virus, bacterial and fungal diseases. It is evident that apricot is a “risk” species for Slovak farmers.

Breeders have tried to overcome some of above mentioned factors in a long-termed program of hybridisation. The low geographic plasticity of the apricot species

means that a breeding program is necessary to generate cultivars, which are adapted to the specific condition of Slovak production area (Benedikova, 2004, 2006).

The major objectives in apricot breeding programs are resistance to sharka caused by *Plum Pox Virus*, brown rot caused by *Monilinia* spp., bacterial diseases caused by *Pseudomonas* spp. and *Xanthomonas arboricola* pv. *pruni* (Smith), Chlorotic Leaf Roll Phytoplasma, and Apricot Decline Syndrome. Among these, PPV is the most limiting factor in Europe and much work has to be invested in developing PPV-resistant apricot cultivars. In the areas where sharka disease occurs, it is a major constraint to stone fruit (*Prunus*) production. More than 100 million stone fruit trees were infected at past in Europe (Nemeth, 1994). Causal agent is plum pox virus (PPV), a potyvirus that has been widely studied (Cambra et al 2006 a, 2006b, Karayiannis et al 2008, Audergon et al., 2006a).

This paper presents the results of vegetative and pomological characterisation of the selected apricot varieties that were created at Slovak breeding programme and other varieties included into collection of genetic resources.

Materials and methods

The apricot breeding program in Slovakia was initiated in 1964 at the Fruit tree department of Research Institute of Plant Production Piestany, later continued on the Research Breeding Station Vesele. Principal breeding aimed at the development of late flowering apricot types with resistance to spring frost. High quality, early and late ripening and resistance to diseases were very important, in addition. Standard breeding techniques i.e. self-pollination, open pollination, crossing by emasculation and hand pollination has been employed. The most interesting selections were grafted on the standard registered seedling rootstocks M-VA-2 (*Prunus armeniaca)* at Slovakia. Subsequently the cultivars were planted in trials so that it was possible to observe their behaviour in comparison with the control cultivar ‘Hungarian Best’. Later apricot selection program continued in hybridisation oriented mainly on fruit quality and resistance to diseases (PPV, *Monilinia sp, Gnomonia erythrostoma).*

The Slovak origin cultivars from breeding program were included into new collection of genetic resources in National Program for Conservation Plant Genetic Resources for Food and Agriculture. This collection was founded as a field collection of Gene Bank of the Slovak Republic in Plant Production Research Centre Piestany at 2005. The trees of all the studied cultivars were grafted on the registered seedling rootstock M-VA-2 (*Prunus armeniaca).* They were grown in a collection plantation under drop irrigation, planting distance 6 x 5 m and as a free growing crown. Description of cultivars was under the Descriptor list (Guerriero and Watkins, 1984).

The trees in the collection were described for different criteria related to plant morphology, resistance to different diseases, capacity to adapt to different environments, production potential of the crop and product quality. Characteristic of these genotype were evaluated on the part of suitability for fruit growers. The fruit quality was evaluated like complex of characteristics consisting of the size, weight,

skin colour, sugar content, firmness of flesh etc. The evaluation consisted of valuation of flower bud density, flower composition, pollen germination and others.

Results and discussion

History of breeding program

I. Period 1964-1975 – the first hybridisation with mother cultivars like ‘Hungarian Best’, ‘Ananas’, ‘Rakovskeho’, ‘Urozajnyj’, ‘Julskij’ and local types of apricots. As father cultivars were used ‘Achrori’, ‘Arzami’, ‘Zard’, ‘Hindukush’ and Chinese white and yellow flesh local genotypes.

II. Period 1976-1987 – the hybridisation between promising hybrids and backcrossing. At this period also started reciprocal hybridisation (between perspective cultivars) from collection of genetic resources. Mother cultivars originated from central Asian hybrids and Chinese local genotypes. Also cultivars like ‘Veecot’, ‘Sunglo’, ‘Goldcot’, ‘Kech Pchar’ and ‘Hungarian Best’ were used. As father cultivars the breeders used mainly ‘Goldcot’, ‘NJA 44’, ‘Sunglo’, ‘Tirziu de Bucuresti’ and others. For the hybridisation best hybrids ‘VS 27/8’, ‘VS 9/83’, ‘VS 51/4’, ‘VS 25/38’, ‘VS 74/14’ and ‘VS 09/12’ were used. These hybrids were later (1999-2001) registered as cultivars. Father cultivars were ‘Veecot’, ‘Goldcot’, ‘Stark Early Orange’, ‘Henderson’, ‘Harlayne’, ‘Stella’, ‘Screara’ and others.

III. Period 1988-2006 – the hybridisation of promising hybrids, hybridisation in the frame of genetic resources collection and hybridisation oriented on the resistance to important diseases.

During the period of breeding more than 800 parent’s combination was realised and about 10.000 seedlings in orchards were obtained. Since 1964, when the breeding programme started, to now 10 of cultivars was registered in Slovakia. They are ‘Vesna’, ‘Vegama’, ‘Veharda’, ‘Velbora’, ‘Vemina’, ‘Velita’, ‘Vesprima’, ‘Barbora’, ‘Vestar’ and ‘Veselka’. The new assortment has a late blossoming, better quality of fruits and a prolonged maturation period of fruit. Frost hardiness was achieved through later beginning of flowering (‘Veharda’) or through prolongation of blossoming with gradual blooming (‘Vegama’), resistance to PPV M strain (‘Veharda’, ‘Vemina’), high fruit quality (‘Vesna’, ‘Vestar’ and ‘Veselka’) fruit transportability (‘Veharda’, ‘Vemina’).

The Central-Asian group is the oldest group with the richest variability. Most of the cultivars are self-incompatible; fruits are small to medium and ripen over a long period. Our results confirmed that in the breeding program the cultivars from this group were the source of higher frost hardiness, but their progeny had small size of fruits and lower flesh quality and self-incompatibility at the same time. The progeny of the local Chinese cultivars had an attractive appearance with red face, dark orange colour of flesh, high content of sugar, but shorter longevity. The progeny of the European group had the higher quality of fruits, orange colour of flesh, but

lower resistance to frost. The Iran-Caucasian group is mostly self-incompatible, produces larger fruit than the Central Asian group and shows lower chilling requirements.

Evaluation of some parent combination

Two groups of original cultivars were important for apricot breeding program in Slovakia: Central Asian group and European group. Other geographically distant types were used from China and from Hindu Kush mountains. Improving of selected genotypes and backcrossing has been done in second and third period.

‘Hungarian Best’ × mixture of Chinese local genotypes: Characters obtained in F1 generation were large fruit size, intensive dark orange colour of flesh, high content of sugar, worse separation of stone, very good health tatus of leaves and worse status of skeletal branches and limited longevity of trees.

‘Julskij’ × ‘Hungarian Best’: Characters in F1 generation: high frost tolerance of flower buds, late ripening, small size of fruit with pale orange colour of skin, worse taste of fruits.

‘Hungarian Best’ × ‘Achrori’, ‘Arzami’, ‘Zard’: Characters in F1 generation: good quality of fruits, white to pale orange colour of flesh , excellent health status of trees, no attack of fungi diseases, very healthy stem of trees, partial self-sterility of hybrids.

Evaluation of basic parent cultivars for frost resistance

‘Hungarian Best’: Very good for hybridisation, it gives to progeny important characters like size and taste of fruit, self-fertility. Hybrids had not higher frost tolerance than original cultivar.

‘Hindu Kush’: Local genotype originates from Hindu Kush mountains. They were mostly used as the father in breeding combination, with important expression of characters in progeny. Fruit have small size, later date of ripening, mealy consistency of flesh, high frost tolerance and good health status of trees.

Chinese local genotypes: Genotypes were used in mixture of pollen (yellow and orange flesh). In the F1 progeny expressively influenced good size of fruit, colour of flesh (white, dark yellow), and tolerance to fungal diseases. Trees have limited longevity, healthy status of skeletal branches was worse. Fruit flesh has high content of sugar, some hybrids were clingstones.

‘Julskij’: When it was used as a mother, the result was worse. In progeny undesirable characters as small size of fruits, worse taste, fibrous flash, susceptibility to fungi pathogens. Progeny has later time of blooming and high resistance to frost.

Cultivars most often used in the breeding program as donors of required properties were:

- disease resistance (‘SEO’, ‘Dacia’, and Chinese local genotypes);
- frost tolerance (the central Asian cultivars ‘Achrori’, ‘Arzami’, ‘Zard’);

- extended blossoming period (‘Ananasova’);
- extended ripening period (‘Ruzova skora’, ‘Kech Pchar’, ‘Vynoslivyj’, NJA hybrids)
- fruit quality (‘Hungarian Best’, ‘Bergeron’, ‘Hargrand’, Chinese local types ;

The perspective cultivars for fruit growers

‘Veselka’®

Origin: ‘Vesna’ × ‘Vegama’.

*Fruit***:** ripening very early (10th July), very large fruit, weight 65 g, shape spherical, firm fruit, good transportability, skin dark orange with attractive dark red face, flesh light orange, flavour very good. **General evaluation**: Dessert cultivar, very early ripening, spurs type growth, attractive large fruit and very good flavour. Trees has good level of resistance to *Gnomonia erythrostoma*.

‘Velita’®

Origin: ‘Hungarian Best’ × ‘Achrori’, ‘Arzami’, ‘Zard’.

*Fruit***:** ripening very early (7th July), large fruit, weight 56 g. Shape flat elongated, skin light orange with dark red face, firm flesh, light orange, good flavour, harmonic.

General evaluation: Very early cultivar with large attractive fruit and regular yields.

‘Vemina’®

Origin: ‘Rakovsky’ × ‘Achrori’, ‘Arzami’, ‘Zard’ (Central Asian cultivars)

Fruit: ripening middle, (27th July), large fruit, weight 50 g, shape spherical, very firm fruit, very good transportability, skin dark orange with attractive dark red face, high shine, flesh dark orange, flavour good, aromatic.

General evaluation: Universal apricot cultivar, mainly for processing, attractive appearance of fruit, very good flavour, resistance to PPV – M.

‘Vestar’®

Origin: ‘Hungarian Best’ × Chinese local types.

*Fruit***:** ripening end of July, very large fruit, weight 65 g, shape circular, colour of skin dark orange with attractive red face, flesh dark orange, flavour very good, harmonic.

General evaluation: Attractive dessert cultivar with low density of crown and very good transportability of fruits.

Cultivar evaluation

The studies were carried out in the period 2009-2012. All of pomological, phenological and economic characteristics were studied by the adopted standard

methods for variety testing. Phenological observations on the fruit ripening time showed that the fruits of ‘Vesna’ and ‘Veselka’ were the earliest, they ripen 15 till 20 days before control variety ‘Hungarian Best’ at Slovak climatic conditions, they practically opening the season of apricot ripening (Table 1). The fruits of ‘Veharda’ and ‘Vegama’ ripened 7 up to 10 days later than the fruits of ‘Hungarian Best’.

Table 1 Fruit characterisation of Slovak apricot varieties

Hybridisation year	Registration year	Cultivar	Blooming time[1]	Ripening time[1]	Fruit characteristics		
					Weight (g)	Diameter (mm)	Flesh colour[2]
1972	1999	VELITA	E	7.7. VE	56	49	Y
1979	2000	VESELKA	VE	10.7. E	65	50	DO
1964	1991	VESNA	VE	17.7. E	55	47	Y
1964	1999	VEMINA	E	27.7. M	50	48	O
1963	1991	VELBORA	M	30.7. M	58	50	O
1970	1997	VESTAR	E	30.7. M	65	51	O
1972	1997	BARBORA	M	1.8. M	56	49	O
1972	1996	VESPRIMA	L	4.8. M	55	45	DO
1964	1991	VEHARDA	VL	7.8. L	50	49	O
1968	1991	VEGAMA	L	12.8. L	49	50	DO
Control cultivar		HUNGARIAN BEST	E	30.7. M	55	48	O

[1]Blooming and ripening time: VE - very early, E - early, M - middle, L - late, VL - very late
[2]Flesh colour: Y – yellow, O – orange, DO – dark orange

The cultivar ‘Kech Pchar’, which was evaluated at the collection of genetic resources was the extremely late and ripened at the end of September.

Fruit setting was evaluated on 22 apricot cultivars from collection of genetic resources. The level of setting varied from 3, 0 up to 27, 0 %, the sterile cultivars achieved up to 5 % of fruit setting (‘Vesna’, ‘Oranzevo krasnyj’ and ‘Veecot’). The best level of fruit setting (20-27%) was observed on the cultivars ‘Velbora’, ‘Veharda’, ‘Velkopavlovicka’ and ‘Tilton’.

Slovak cultivars had weight from 49 up to 65 g and they ripened from 14 days before control variety Hungarian Best (30 July) until middle of August. Two cultivars had yellow coloured flesh, and three had dark orange flesh. Red fruit skins had ‘Veselka’, ‘Vesna’ and ‘Vestar’. Cultivar ‘Veselka’ had very large and dark red coloured fruits with good firmness and very good taste.

Conclusion

The paper presents analysis of major biometric fruit characteristics of apricot cultivars created at Slovak breeding programme and were register during 1991 till

2002 years. There are also presented some results from other experiments with cultivars included into collection of genetic resources.

Since the apricot breeding program was established in 1964, ten new apricot varieties have been registered: ‘Vesna’, ‘Vegama’, ‘Veharda’, and ‘Velbora’ in 1991, ‘Vesprima’ ‘Barbora’ and ‘Vestar’ in 1997, ‘Vemina’, and ‘Velita’ in 1999, and in 2000 was registered ‘Veselka’. ‘Veselka’ and ‘Vesna’ have high quality fruits. ‘Veharda’ and ‘Vemina’ are resistant to PPV. ‘Veharda’, ‘Vemina’, and ‘Vesprima’ are also very good for processing. For the planting of apricot orchards we can to recommend the Slovak cultivars ‘Vesna’ and from second breeding period cultivars ‘Veselka’, Vemina’, ‘Velita’ and ‘Vestar’.

From the collection of genetic resources very good fruit quality were interesting cultivars like ‘Ligeti Orias’, ‘Budapest’, ‘Cegledi Piroska’, ‘Bergeron’, ‘Orange Red’, ‘Hargrand’, ‘Aurora’ and ‘Harogem’. There are dessert cultivars with very good time of ripening and have attractive fruit appearance with very good taste of fruit.

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PROIZVODNJA KAJSIJE U SLOVENIJI - PROBLEMI I PERSPEKTIVE

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Izvod. Kajsija je u Sloveniji malo zastupljena vrsta voćaka. Intenzivni voćnjaci se nalaze na ukupnoj površini od 37 ha, pretežno na zapadu Slovenije (Vipavska dolina, Goriška Brda). Ukupni prinos iz svih (intenzivnih i ekstenzivnih) zasada kajsije u 2011. godini iznosio je tek 687 t. Visina prinosa u velikoj meri zavisi od godine. Zbog problema propadanja stabala preovladava ekstenzivna proizvodnja. Ova pojava je prouzrokovana mnogim bolestima i njihovim kombinovanim uticajima sa klimatskih činiocima. Najznačajnija karantinska bolest je šarka, prouzrokovana virusom *Plum pox virus* (PPV) i leptonekroza koštičavog voća, koju pouzrokuje fitoplazma - European stone fruit yellows (ESFY). U poslednjih 20 godina u Sloveniji je proučavano 25 sorti kajsije i 7 podloga. U testiranju na različitim lokalitetima se nalazi još 9 sorti i 2 podloge. Prema rezultatima dosadašnjih ispitivanja najbolju ocenu u pomološkim svojstvima dobile su sorte Aurora i Harcot, a najviši prinos je bio registrovan kod sorti Cafona i Giada. Po krupnoći i kvalitetu plodova, kao i prinosu mogu se istaći sorte Sabbatani i Goldrich. U proseku je u sedmoj godini rasta propalo 42-55% stabala. Među novijim sortama kao interesantna se pokazala sorta Pinkcot. Kod ispitivanja podloga, najmanje propadanje stabala (17%) je registrovano na podlozi Missour (sejanac breskve), a najveće na podlozi Barrier (100%). Prvi rezultati dobijeni za sortu Orange Red ukazuju na veći prinos ukoliko je kalemljena na podlozi Torinel, dok je kod sorte Bergeron veći prinos dobijen na podlozi Wavit. Perspektiva gajenja kajsije u Sloveniji se ogleda u potenciranju sorti tolerantnih na virus šarke i leptonekrozu koštičavog voća.

Ključne reči: kajsija, sorta, podloga, prinos, propadanje stabala.

Uvod

Proizvodnja kajsije u Sloveniji je malo zastupljena. Ona čini svega 1% od celokupne proizvodnje voća i 5% od intenzivne proizvodnje koštičavog voća. U 2011. godini ostvareni prinos kajsije je iznosio 687 t (SURS, 2011). U poređenju sa proizvodnjom kajsije u Evropi, proizvodnja ove vrste u Sloveniji je neznatna. Pored toga prinosi variraju iz godine u godinu. Više od polovine intenzivnih voćnjaka se

nalazi na Primorskom (zapadnom delu Slovenije), preciznije uz reku Vipavu sve do Goriških Brda. Do 1993. godine u Sloveniji su se sadile stare sorte kajsije, poznate kao: Ogrska, Debeli flokarji, Catarji. Danas u voćnjacima preovlađuju sorte: Aurora, Goldrich, San Castrese, Orange Red i Harcot, dok se Hargrand i Pisana koriste kao sorte za oprašivanje.

Kajsija je deficitarna vrsta voćaka. Potražnja za kajsijom na našem tržištu je veća od proizvodnje, zato postoji veliki interes za porastom njene proizvodnje. Nažalost postoje i fitosanitarni problemi koji gajenje kajsije ograničavaju, a u nekim delovima Slovenije ga i onemogućavaju. U poslednih 20 godina primećujemo porast propadanja stabla, zato se proizvođači često ne odlučuju za obnavljanje voćnjaka. Dosadašnje propadanje voćaka je uglavnom prouzrokovano sa prisustvom različitih karantinskih bolesti, kao što su: leptonekroze koštičavog voća (Ambrožič-Turk et al., 2008), šarka (Viršček-Marn et al., 2004) i prisustvo različitih bakterioza, apopleksije. Kajsija je voćka domaćin ekonomski štetnim virusima. Među njima, u Evropi su najraširenji: *Plum pox virus* (PPV), *Apple chlorotic leafspot virus (ACLSV)*, *Prune dwarf virus* (PDV), *Prunus necrotic leafspot viru*s (PNRSV) i *Apple mosaic virus* (ApMV*)*. Šarka, prouzrokovana PPV, je ekonomski najznačajnija virusna bolest kajsija, zato je PPV svrstan među karantinske bolesti i nalazi se na listi II.A.2 Direktive 2000/29/ES, što znači, da kod voćaka iz roda *Prunus* ne sme biti prisutan na sadnicama spremnim za sadnju. Koštičave voćke iz roda *Prunus* ugrožava i opasna bolest hlorotičnog savijanja lista koštičavog voća ili leptonekroza koštičavog voća, prouzrokovana fitoplazmom - European stone fruit yellows (ESFY). Transfer između biljaka domaćina je *Cacopsylla pruni* Scopoli (Carraro et al*.,* 1998), a može se prenositi i vegetativnim razmnožavanjem. Kajsiju ugrožavaju i razne bakterioze, kao npr. *Pseudomonas syringae* pv. *morsprunorum* i *Xanthomonas arboricola* pv. *pruni*, apopleksija itd. U 2011. godini je zbog problema vezanih za propadanje stabala kajsije i razmnožavanje, započeo projekat pod nazivom: „Rešavanje stalno prisutnih karantinskih bolesti kod voćaka roda *Prunu*s spp. u cilju održavanja proizvodnje“. Projekat je trogodišnji i vrši se u okvirima Ciljnog istraživačkog programa (CRP) „Obezbedimo sebi hranu za sutra“. Cilj projekta je ustanoviti osetljivost na karantinske bolesti u proizvodnji već raširenih i novih sorti kajsije u odnosu na podloge i lokaciju. Potrebno je postaviti platformu iz koje ćemo pronaći rešenje za postojeće probleme u korist povećavanja proizvodnje kajsije.

Voćarski centar Bilje (u nastavku SC Bilje), u okviru Kmetijsko gozdarskega zavoda Nova Gorica, ispituje koštičave voćke, zato je i na kajsiji napravljeno nekoliko istraživanja. Najviše je bilo istraživanja kod traženja novih sorti i podloga primernih za naše klimatske uslove (Fajt et al., 2011). Takođe, u Voćarskom centru Maribor (u nastavku SC Maribor), Kmetijski gozdarski zavod Maribor, bile su posađene različite nove sorte kajsije na podlogama Torinel i Wavit sa ciljem pronalaženja pogodne sorte i podloge, koje će u severoistočnom delu Slovenije imati dobre proizvodne karakteristike.

U ovom radu želimo da predstavimo dosadašnje rezultate stručnog rada na polju proučavanja kajsije u Sloveniji, ali u isto vreme želimo i upozoriti na probleme koji se javljaju u njenoj proizvodnji.

Materijal i metode

Istraživanja na zapadu Slovenije. Tokom 1995/96. godine u SC Bilje je zasnovana kolekcija novijih sorti kajsije: Aurora, Pellechiella, Orange Red, Pisana, Antonio Errani, Cafona, Perla, Sabbatani, Bella d'Imola, Giada, Laycot, Palummella, Tomcot, Harcot, Martina Bassi, Hargrand, Bobcot, Tardif de Bordaneil, Icapi 28, Icapi 31/3 i Goldrich (standard). U SC Bilje je 1997. godine postavljen ogled sa sortom San Castrese, koja je kalemljena na podlogama Barrier, Torinel, Isthara, Mariana GF 8/1, Missour, *P. pumila* i Myrabolan B (standard). Po već poznatom lošem iskustvu sa gajenjem kajsije na lakim zemljištima u Biljensko-Orehoveljskom polju (nadmorska visina 55 m), oba voćnjaka su podignuta na brdskoj lokaciji Stara gora (nad. visina 174 m, teško zemljište) severna strana terena, sa ciljem da bi u proleće odgodili rani početak vegetacije i time izbegli ili smanjili uticaj mraza. U okviru ogleda sa sortama i podlogama praćeni su parametri porasta (jednogodišnji prirast i obim debla) i rodnosti (vreme sazrevanja, prinos po stablu, kvalitet plodova), kao i propadanje sadnica. Sorte su praćene do 2002. godine, a podloge do 2004. godine. Analiza sadržaja suve materije u plodovima (% Brixa) je urađena 2003. godine. Sadnice su bile posađene u 4 ponavljanja (po 5 sadnica/ponavljanju kod ispitivanja sorti, a kod podloga po 12 sadnica /ponavljanju).

U proleće 2008. godine je u SC Bilje posađena nova kolekcija sorti i postavljen nov ogled sa podlogama. Na lokaciji Stara gora posađeno je 10 sorti na podlozi Myrabolan 29 C: Ninfa, Pinkcot, Sylvercot, Kioto, Bora, Bergeron, Tardicot, Farbaly, Fardao, Goldrich (standard) i u okviru ogleda sa podlogama korišćene su tri podloge (Wavit, Torinel i Mirabolana 29 C -standardna podloga) na koje su kalemljene sorte Orange Red i Bergeron. U oba eksperimenta bilo je posađeno po 10 sadnica za ispitivanu sortu, odnosno kombinaciju sorta/podloga. Sadnice su posađene na terasama, na rastojanju od 3 m. Merenja se još uvek izvode u oba eksperimenta.

Istraživanja na severoistoku Slovenije. U SC Maribor su 2007. godine posađene sledeće sorte kajsije kalemljene na podlozi Wavit: Bergeron, Pinkcot, Sylvercot, Kioto, Mađarska najbolja, Goldrich i Orange Red (standardna sorta). Sorte Bergeron, Orange Red i Mađarska najbolja bile su posađene još i na podlozi Torinel. Stabla su od početka cvetanja do berbe bila prekrivena sa polietilenskom folijom, sa ciljem smanjenja štetnog uticaja bolesti, posebno monilije. I ova istraživanja su još u toku.

Porast (bujnost stabla) smo pratili preko porasta obima debla na 20 cm iznad kalemljenog mesta uz pomoć formule $p = \pi * r^2$ (p = površina debla, π (pi) = 3,14, r = poluprečnik debla). Rodnost stabala je praćena preko prinosa (kg) po sadnici, prosečne mase ploda, i spoljašnjih (obojenost, oblik) i unutrašnjih (obojenost mesa,

sazrevanje, odvajanje mesa od koštice, tekstura mesa, sočnost mesa, aroma, ukus) karakteristika ploda.

Uz pomoć projekta CRP je, sa uzimanjem uzoraka korena, jednogodišnjih grana i plodova kajsije na različitim lokacijama, omogućeno i ispitivanje kontaminiranosti različitih sorti sa ESFY i PPV, kao i određivanje potencijalnih uzroka kolapsa stabala.

Rezultati i diskusija

Lokacije proizvodnje kajsije u Sloveniji, površine, prinos i uzgojni oblik

Kajsija se uglavnom intenzivno proizvodi u zapadnom delu Slovenije (Vipavska dolina, Goriška Brda), dok u ostalim delovima Slovenije proizvodnja je uglavnom ekstenzivna. Poslednji statistički podaci (SURS, 2011), koji obuhvataju sve intenzivne zasade kajsije, pokazuju da su ukupne površine pod ovom vrstom oko 37 ha, a da se u ekstenzivnoj proizvodnji nalazi 21.229 stabala. Procentualno učešće zemljišta pod intenzivnim voćnjacima kajsije je u 2011. godini iznosilo 5% u odnosu na ostala zemljišta pod intenzivnim zasadima koštičavog voća. To ujedno potvrđuje malu proizvodnju kajsije u Sloveniji. Ukupan prinos iz intenzivnih i ekstenzivnih zasada kajsije u 2011. godini je bio 687 t. Taj prinos iz godine u godinu varira. Poznato je, da većina sorti kajsije alternativno rađa i da često budu izložene štetnom dejstvu prolećnog mraza. Najveći razlozi za taku malu proizvodnju leže u fitosanitarnim problemima te voćke, koji nastupaju odmah nakon sadnje, što rezultira i čestim podsađivanjem kajsije. Najviše raširenu uzgojni oblici su piramida i kotlasta kruna.

Sorte: cvetanje, sazrevanje, rodnost, kvalitet plodova

U poslednjih 20 godina ispitano je 25 sorti, a u istraživanju se nalazi još 9 sorti. Za ove sorte dajemo tek preliminarne rezultate.

U tabeli 1. su prikazani rezultati istraživanja 21 sorte kajsije, koji uključuju podatke o prosečnom prirastu stabla (u cm) za period 1995/96 – 2001., prosečnoj masi ploda (u g) za period 1997 – 2001., kumulativnom prosečnom prinosu (u kg/stablo) za period 1998 – 2002., opštem utisku o sorti i o procentualnom učešću propalih stabala za period 1995/96 – 2001., za SC Bilje. Fenološka osmatranja su izvedena u periodu 1997 – 2001. godina. Rani početak cvetanja imaju sorte Aurora, Giada, Goldrich, Martina Bassi i Icapi 31/3, a kasni Perla, Bella d'Imola, Harcot i Hargrand. Najranije vreme zrenja u svim godina ispitivanja imala je sorta Aurora (početak juna), a zatim sorte Orange Red, Antoino Errani, Perla, Giada, Tomcot, Goldrich, Martina Bassi i Icapi 31/3 (druga polovina juna), dok su ostale sorte sazrevale početkom jula. Najveći prirast stabla pokazale su sorte Martina Bassi, Giada, Icapi 31/3 i Cafona (prirast stabla iznad 40 cm), a najmanji sorte Icapi 28, Hargrand, Bella d'Imola i Antonio Errani (prirast stabla ispod 25 cm). Najveći

ukupni prinos po stablu postigle su sorte Martina Bassi i Cafona (iznad 80 kg), dok su sorte Sabbatani, Laycot, Goldrich, Giada, Palummella bile u rangu srednje rodnih (50-70 kg), a sve ostale sorte pokazale su lošiju rodnost (Fajt et al., 2011). Najkrupniji plodovi (60 - 65 g) registrovani su kod sorti Goldrich i Sabbatani, sa visokim prosečnim prinosom po stablu i kod sorti Icapi 28 i Harcot, sa niskim prosečnim prinosom po stablu. Opšti utisak o sorti označen kao „odličan“ dobile su sorte Aurora i Harcot.

Tabela 1. Prosečni prirast stabla, prosečna masa ploda, kumulativni prinos, opšti utisak o sorti i deo propalih stabala na lokaciji SC Bilje

Average trunk cross sectional area (TCSA), average fruit weight, cumulative yield per tree, general estimation, and share of dead trees on location SC Bilje

Sorta *Variety*	Prirast debla *Trunk increment* (cm)	Masa ploda *Fruit weight* (g)	Kumulativni prinos po stablu *Cumulative yield per tree* (kg)	Opšti utisak o sorti *General estimation*	Propala stabla *Dead trees* (%)
Aurora	31,8	48,3	19,7	odličan	20
Orange Red	40,0	46,8	31,0	dobar	58
Antonio Errani	25,0	38,4	8,8	dobar	60
Perla	28,0	42,5	14,7	vrlo dobar	43
Bella d’Imola	24,1	49,8	21,1	dobar	60
Giada	42,6	48,7	50,8	dobar	40
Goldrich (Sungiant)	34,7	62,0	41,7	vrlo dobar	40
Palummella	38,0	46,0	33,6	vrlo dobar	20
Harcot	30,8	61,8	23,2	odličan	60
Hargrand	23,9	56,5	19,0	dobar	75
Pellecchiella	31,6	48,2	17,5	vrlo dobar	20
Pisana	26,7	48,4	15,6	dobar	100
Cafona	40,5	48,8	57,2	vrlo dobar	20
Sabbatani	26,4	62,7	43,2	dobar	20
Laycot	31,3	51,3	31,4	vrlo dobar	60
Tomcot	38,1	43,7	27,1	vrlo dobar	40
Martina Bassi	44,4	50,8	38,8	dobar	20
Icapi 31/3	41,5	39,9	46,1	vrlo dobar	0
Tardif de Bordaneil	26,3	37,0	13,0	dobar	100
Bobcot	23,3	32,2	1,3	vrlo dobar	40
Icapi 28	21,1	62,9	12,5	vrlo dobar	60

Tabela 2. pokazuje prve rezultate ispitivanja sorti, koje se prate od 2008. godine. Najranije cvetanje je registrovano kod sorte Ninfa, slede sorte Goldrich, Bora, Pinkcot i Sylvercot, a najkasnije vreme cvetanja su imale sorte Bergeron, Tardicot i Fardao. Početkom juna je počelo zrenje plodova sorte Ninfa, sredinom juna sorti Bora, Pinkcot, Sylvercot i Kioto, a krajem juna su sazrevali plodovi sorte Goldrich. Kod sorti Bergeron i Tardicot je početak zrenja registrovan sredinom jula,

dok su najpoznije vreme zrenja (sredinom avgusta) imale sorte Fardao i Farbaly. Rodnost (kumulativni prinos po stablu za 2011. i 2012. godinu) bila je najveća kod sorti Goldrich (19,7 kg) i Pinkcot (19,4 kg), a najmanja kod sorti Fardao (4,7 kg) i Tardicot (3,8 kg). Prosečna masa plodova u obe proučavane godine bila je najveća kod sorte Goldrich (63,2 g), a najmanja kod sorte Ninfa (36,2 g). Pomološke osobine bile su u obe ispitivane godine ocenjene odlično kod sorte Goldrich. Do sada je najviše stabala propalo kod sorte Kioto (60%), Fardao (30%), Farbaly (30%) i Bergeron (30%), a najmanje kod sorti Goldrich i Ninfa.
U SI delu Slovenije su se od novijih sorti po prinosima (prosečni prinos po stablu) u periodu 2009 – 2011. godina najbolje pokazale sorte Pinkcot (4,56 kg) i Kioto (4,02 kg), a najslabija bila je sorta Goldrich (0,73 kg). Najveću masu ploda imala je sorta Sylvercot (86,19 g), a odmah iza nje sorta Goldrich (86,02 g).

Tabela 2. Prosečni prinos po stablu za 2011. i 2012. godinu, prosečna masa plodova i udeo propalih stabala kod različitih sorti kajsije, posađenih 2008. godine u SC Bilje
Yield per tree from 2011 to 2012, average fruit weight and ratio of dead trees of different apricot cultivars planted in 2008 at Fruit Growing Centre Bilje

Sorta *Variety*	Prinos (kg po stablu) *Yield per tree (kg)*		Masa ploda *Fruit weight* (g)	Propala stabla *Dead trees* (%)
	2011	2012		
Fardao	2,0	2,7	43,3	30
Farbaly	3,6	4,2	50,9	30
Tardicot	2,2	1,6	43,5	10
Kioto	3,6	3,0	37,6	60
Bergeron	6,8	4,6	48,0	30
Goldrich	10,0	9,7	63,2	0
Bora	8,1	2,0	54,3	10
Ninfa	6,8	10,8	36,2	0
Pinkcot	10,2	9,2	60,5	10
Sylvercot	8,0	7,4	51,5	10

Podloge

Podloge Barrier, Torinel, Isthara, Mariana GF 8/1, Missour, *P. pumila* i Myrabolan B (standard) nisu uticale na vreme zrenja, ali su uticale na istovremenost sazrevanja plodova (jedna berba samo kod podloga Barrier i Myrabolan B, a kod ostalih podloga višekratna berba plodova, tabela 3). Prema rezultatima dobijenim za obim debla (2003), kao pokazateljem veličine rasta, uočava se najveća bujnost stabla kod sorte San Castrese na podlozi Missour (121,1 cm^2), a najmanja na podlozi Barrier (32,8 cm^2). Prinos je praćen od 1999. do 2003. godine, a prosečna masa plodova od 2000. do 2003. godine. Najveći kumulativan prinos po stablu imala je podloga *P. pumila* (59,60 kg), sledi podloga Missour sa 40,9 kg/stablo. Najveći plodovi kod sorte San Castrese su dobijeni na podlozi Missour (40,0 g), a zatim na

podlozi *P. pumila* (38,3 g). Najmanji plodovi bili su kod podloge GF 8/1 (34,2 g) i Barrier (33,9 g). Najveći sadržaj rastvorljive suve materije zabeležen je kod podloge *P. pumila* (14,3%), a najmanji kod podloge Myrabolan B (12,5%). Tokom osam godina rasta propale su sve sadnice (100%) na podlozi Barrier, 42% sadnica je propalo na podlozi Myrabolan B i *P. pumila.* Najmanji udeo propalih sadnica (17%) bio je na podlozi Missour.

Tabela 3. Presek stabla, prosečni prinos po stablu, prosečna masa ploda, sadržaj rastvorljive suve materije u plodovima sorte San Castrese na različitim podlogama i udeo propalih stabala u SC Bilje

Trunk cross sectional area (TCSA), average yield per tree, average fruit weight, soluble solids and share of dead trees for cultivar San Castrese on different rootstocks in SC Bilje

Podloga *Rootstock*	Presek debla *TCSA* (cm^2)	Prinos po stablu *Yield per tree* (kg)	Masa ploda *Fruit weight* (g)	Rastvorljiva suva materija *Soluble solids* (%)	Propala stabla *Dead trees* (%)
Myrabolan B	36,5	3,8	35,1	14,3	42
Barrier	32,8	3,3	33,9	-	100
Torinel	70,7	7,4	35,6	13,6	33
GF 8/1	43,2	2,8	34,2	14,2	27
Ishtara	63,3	6,1	36,7	13,1	33
Missour	121,1	8,2	40,0	13,1	17
P. pumila	79,0	11,2	38,3	12,5	40

Delimični rezime rezultata ispitivanja podloga za kajsiju, ogled koji je bio posađen 2008. godine, prikazuje tabela 4.

Tabela 4. Prosečna masa plodova sorti Orange red i Bergeron na različitim podlogama, prosečni prinos po stablu u 2011. i 2012. godini, i udeo propalih stabala u SC Bilje

Average fruit weight of cultivars Orange Red and Bergeron on different roostocks, yield per tree for 2011 and 2012 and (%) of dead trees in SC Bilje

Sorta *Variety*	Podloga *Rootstock*	Masa ploda *Fruit weight 2011* (g)	Prinos *Yield 2011* (kg)	Prinos *Yield 2012* (kg)	Propala stabla *Dead trees* (%)
Orange Red	Mirabolan 29 C	48,9	5,9	6,6	20
	Wavit	44,2	7,1	7,3	30
	Torinel	45,6	10,3	5,9	0
Bergeron	Mirabolan 29 C	43,7	1,6	2,5	50
	Wavit	39,8	2,6	3,4	20
	Torinel	25,6	1,6	3,9	70

Kumulativni prinos (za godini 2011 i 2012) bio je kod sorte Orange Red najveći na podlozi Torinel (16,2 kg), a kod sorte Bergeron na podlozi Wavit (6,0 kg).

Kod obe sorte bio je najmanji na podlozi Myrabolan 29 C (12,5 kg Orangered, 4,1 kg Bergeron). Podloge nisu uticale na prosečnu masu plodova, ukus plodova bio je kod obe sorte najbolji na podlozi Myrabolan 29C. Do sada su na podlozi Myrabolan 29C propadla 2 stabla i na podlozi Wavit 3 stabla sorte Orange Red. Na podlozi Myrabolan 29C je do sada propalo 5 stabla, na podlozi Wavit su propala 2 stabla i na podlozi Torinel propalo je 7 stabala sorte Bergeron.

Propadanje stabala i njihovi uzroci. Propadanje kajsija u Sloveniji prouzrokuju mnogobrojne bolesti, njihova međusobna aktivnost i uticaj klimatskih uslova. Pored toga, najznačajnije karantinske bolesti su šarka koja je uzrokovana sa *Plum pox virus* (PPV) i leptonekroza koštičavog voća, koja je uzrokovana fitoplazmom - European stone fruit yellows (ESFY).

PPV. U Sloveniji je od 1998. godine pokrenuta redovna sistemska kontrola PPV (Virščeк Marn et al., 2004; Virščeк-Marn et al., 2006). Od 2000. godine su sistemske kontrole PPV orijentisane na proizvodnju sadnog materijala, kontrolu buffer (zaštićenih) zona i ugroženih područja, a pored toga obavezno je testiranje sadnica, matičnih sadnica i biljaka domaćina. Posebna pažnja se posvećuje testiranju sadnog materijala, koji služi za razmnožavanje (plemke) koštičavog voća, kada se uvozi ili na ulazu u Sloveniju. U slučaju identifikacije infekcije sprovodi se akcija eradikacije. Šarka je u Sloveniji raširena u svim proizvodnim područjima koštičavog voća i ne može se iskoreniti, zato je za održavanje proizvodnje najbitnije gajenje tolerantnih i otpornih sorti kajsije. Izolati PPV su jako varijabilni i svrstavaju se u 7 grupa. Izolati iz različitih grupa se razlikuju po patogenosti, biljkama domaćinima, mogućnosti i efikasnosti prenosa sa vašima i prisutnosti na različitim geografskim područijma. Zato podaci o otpornosti i osetljivosti sorti jako variraju među različitim autorima iz različitih zemalja. Osetljivost ili otpornost pojedinih sorti potrebno je ispitati u našim proizvodnim područjima. U kontekstu CRP projekta smo, na osnovu pregleda literature, iskustava istraživača i uz pomoć stručnih radnika poljoprivredne struke, izradili metod vrednovanja imuniteta otpornosti ili tolerantnosti sorti koštičavog voća protiv PPV u Sloveniji (Virščeк-Marn et al., 2012). U kontekstu projekta takođe se radi na determinaciji i razvrstavanju izolata u grupe. Kod kajsije smo pronašli izolate iz grupe PPV-M i PPV-D.

ESFY. U Sloveniji je praćenje ove bolesti potvrdilo prisustvo na područjima gde se gaje koštičave voćke (Mehle et al., 2007). Poznato je da su biljke domaćini ESFY takođe divlje vrste iz roda *Prunus* (Carraro i Osler, 2003), koje su na našim područjima raspostranjene i predstavljaju važan izvor za širenje infekcije. Zbog toga je za obezbeđenje zdravog matičnog materijala 2007. godine u SC Bilje postavljen mrežanik za gajenje zdravih matičnih biljka koštičavog voća u zaštićenim uslovima (Ambrožič-Turk et al., 2008; Fajt et al., 2009). Kajsija je na infekciju sa fitoplazmom ESFY jako osetljiva vrsta voćaka, koja pokazuje izrazite simptome bolesti i kolaps sadnica, a najviše se to primećiuje kod osetljivih sorti. U Sloveniji se na nekim područjima nalaze domaći, lokalni tipovi autohtonih sorti kajsije sa kvalitetnim plodovima, koje su uspele preživeti do danas. Ustanovili smo, da stabla lokalne sorte kajsije Debeli flokarji, uz utvrđeno prisustvo infekcije sa fitoplazmom ESFY,

opstaje, dobro se održava i rađa. Postoji interes za širenjem te sorte, ali postoji takođe i interes za povećavanjem voćnjaka i širenjem kajsije, uz uslov da se u budućnosti obezbedi zdrav materijal za sadnju sa primerenom tehnologijom proizvodnje, što će smanjiti alternativnu rodnost. U konceptu navedenog CRP projekta smo pripremili pravce za praćenje tolerantnosti različitih sorti i tipova kajsije na infekciju fitoplazmom ESFY. Sa time želimo voćare upozoriti da odabiraju tolerantnije sorte za gajenje i na taj način utičemo na povećanje interesa za proizvodnjom kajsije u Sloveniji.

Zaključak

U Sloveniji je u poslednjih 20 godina ispitano 7 različitih podloga i 25 sorti kajsije. Dve podloge i devet novijih sorti još su u istraživanju. U kontekstu projekta CRP testiranja se izvode na infekcije sa fitoplazmom ESFY, PPV i druge karantinske bolesti, kako kod starih tako i kod novijih sorti kajsije. Od lokalnih sorti kajsije jedna pokazuje znake tolerantnosti na ESFY. Sa uputstvima za procenu tolerantnosti različitih sorti i tipova kajsije na infekciju sa ESFY i PPV, želimo voćare upozoriti da je važan odabir tolerantnijih sorti i tipova kajsije. U područijma sa velikim infekcionim potencijalom virusa šarke i fitoplazme, možemo sa sadnjom tolerantnijih sorti kajsije omogućiti veću proizvodnju ove jako osetljive vrste koštičavih voćaka.

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APRICOT PRODUCTION IN SLOVENIA - PROBLEMS AND PROSPECTS

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Summary

In Slovenia, apricot is one of the least representative fruit species. According to recent statistical data, we have only 37 ha of intensive orchards, which represent 1% of total fruit intensive orchards, and only 5% of stone fruit orchards. The greatest part of intensive orchards lays in the upper Vipava Valley and in Goriška Brda (Primorska region in Slovenia). We produce apricot mostly in an extensive way. In 2011, the yield from intensive and extensive orchards reached 687 t and it varies from year to year. Till 1993, in Slovenia we planted almost old local and autochthonous varieties such as Debeli flokarji and Catarji and broadly well known variety Ogrska, while nowadays we usually plant Aurora, Goldrich, San Castrese, Orange Red, Harcot, as well as Hargrand and Pisana as good pollination varieties.

Apricot is a deficit fruit species in Slovenia. It is mightily search on market, but its production does not cover even our own needs. There is an interest for apricot production, but apricot as fruit species has many phytosanitary problems, which in many cases provoke tree mortality. For this reason, many fruit growers are not able to produce apricots in great quantities. In a way, they almost avoid to put large intensive apricot orchards. Nowadays cognitions for a great part of tree mortality are quarantine diseases as stone fruit leptonecrosis, which cause European stone fruit yellows phytoplasmas (ESFY) and sharka, which is caused by the *Plum pox virus* (PPV). Apoplexy and some dangerous bacteriosis like *Pseudomonas syringae* pv. *morsprunorum* and *Xanthomonas arboricola* pv. *pruni* are also problematical diseases. In 2011 we began the project in which we try to handle the most problematical quarantine diseases on stone fruits, including apricot species. The aim of the project is to establish sensitivity on quarantine diseases of already developed varieties in productive orchards and also in rather new apricot varieties in dependence on rootstocks and locations – the scope is to find good solutions in order to establish more intensive apricot orchards.

There are many new varieties and rootstocks on the market, so we have tested many varieties and rootstocks in Fruit Growing Centre Bilje in the west, and in Fruit Growing Centre of Maribor in the east part of Slovenia. We have found out that the best varieties are Aurora and Harcot as they have been evaluated as varieties for very good general pomological characteristics, while the best varieties for a good yield are Cafona and Giada. The best fruit size, internal quality and productivity were recognized in Sabbatani and Goldrich. In all varieties, after 7 th leaf, we have noticed an average of 42-55% tree mortality. The first promising results of tested new varieties gave Pinkcot. Amongst the rootstocks tested in the past, good results were noticed with the rootstock Missour (peach seedling), with tree mortality rate only in 17% in front of Barrier, which died totally (100%).The preliminary testing gave us promising results of Orange Red on the rootstock Torinel, and Bergeron on rootstock Wavit. We think that the good solution would be planting great apricot intensive orchards so as to choose and plant tolerant or resistant apricot varieties on problematical quarantine diseases.

Key words: apricot, variety, rootstock, yield, apoplexy.

Original paper

CURRENT STATUS AND POSSIBILITIES OF SOLVING POOR STATE OF PEACH CULTIVATION IN CONDITIONS OF THE CZECH REPUBLIC

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Abstract. Peach production in the Czech Republic is currently in decline. The major problem is the surplus of old orchards with a limited range of varieties, absence of young orchards, health condition of the trees, and the market environment where the import of foreign fruits is supported. This situation can be solved by the introduction of modern, reliable varieties, which can extend the peach season and meet the requirements regarding the market needs.

The degree of PPV occurrence was monitored in a young peach orchard during 2010–2011. The percentage of infected trees in as well as the intensity of PPV symptoms in two peach varieties „Royal Glory“ and „Symphony“ grafted on seven different rootstocks of *Prunus* species after the natural infection was evaluated.

This paper presents some examples of prospective varieties, lists different pomological groups of prospective varieties, and classifies the varieties in terms of their resistance to plum pox virus (PPV) and late spring and winter frosts. Finally, training systems and fruit-breeding programme in the Czech Republic are briefly characterised.

Key words: PPV, pomology, frost resistance, rootstocks.

Introduction

In recent years, the development of peach production in the Czech Republic has not been very favourable. This is mainly a result of the declining interest of the growers attributed to low purchase prices, which are dictated by retail chains in the country and support mainly the import of foreign fruit, old peach varieties, prevailingly over-mature commercial plantations and spreading plum pox virus (PPV).

Due to the reasons mentioned above, the area of peach plantations in the Czech Republic has been decreasing for several years now. In the past ten years, it was reduced by 50% to 731 ha in 2011. Reduction of surface and thereby production of peaches is going on in most post-communist countries, Slovenia has around 52%

of aged peach orchards and plantations are also decimated diseases such as PVV and ESFY, (Bavcon-Kralj et al.2009). The import of fruit to the Czech Republic, on the other hand, has been rising, and it has grown by 15%, compared with the last year. In 2010, 12,903 tons of peaches and nectarines were imported to the Czech Republic. The total harvest in the same year was 1,717 tons, which is about 13% of the total amount of imported peaches. These figures evidence that 87% of peaches and nectarines sold in the home market to the consumers are not from home producers but come mostly from Spain, Italy and Greece, from where the market is supplied with imported fruit 5 months per year, naturally also during our harvest season, which results in poor sale of fruit from home producers.

In recent years, the plum pox virus (PPV) has been spreading heavily in the commercial plantations and also premature tree mortality has been recorded. For these reasons, the growers are reluctant to start new peach and nectarine plantations. In 2011, new peach plantations accounted for only 1.3% total peach orchards, juvenile plantations 2.2%, plantations in their high production age 35.5% and the share of over-mature plantations was 61% of the total peach growing area.

Finding a source of immunity or resistance within genus *Prunus persica* L., or in the wide gene pool in various geographical groups seems impossibly, the strategy to breed PPV resistant peaches gets even more complicated. *Prunus davidiana* (Carriére) Franch represents the only source of resistance from related species, and it is used in INRA Avignon breeding program (Rubio et al., 2010).

As Polák et al. (1998) reports, no immune or even resistant variety was identified from 34 naturally infected varieties. However, varieties Envoy and Favorita Morettini 3 were recommended for the conditions of the Czech Republic where PPV infection is widely spread. Other varieties such as Candor, Flamencrest, Harcrest, Harmony, Maycrest, Spring Lady, Friestina and Velvet were classified as medium resistant.

In other work Polák et al. (2003) identified the following peach varieties as medium resistant to PPV after PPV-D inoculation (Flame Prince, Cotender, Newhaven, Ruby Prince, Sun Prince, Jefferson, Camden a Jersey Queen), and as tolerant varieties Loring, Blaze Prince, June Prince and Legend.

The rootstock effect on PPV spread in peach varieties has not been studied yet. The aim of this study is to assess the presence and intensity of PPV symptoms in natural environment in young peach orchards.

The efforts of Czech growers and breeders could improve this unfortunate situation, which affects not only peach growing within the fruit growing sector but also processing industry and other sectors. The interest of producers for growing fruit from Czech peach plantations must be restored and quality fruit comparable with imported fruit should be promoted.

Similar problems can be found in most Central European countries, where peach production was once highly developed. The present situation must be solved on both political and expert levels. The article deals with the expert aspects of the issue.

Materials and methods

The most significant areas of peach growing in the Czech Republic are situated in the South Moravian Region (south-east part of the Czech Republic), mainly in the areas surrounding the towns of Břeclav, Hodonín and Znojmo. According to Quitts classification of climate regions (1971) these areas belongs to the warm region (the warmest in the Czech Republic) with the average annual temperature of 9°C, the average number of summer days in range of 60-70 days, the number of days with the temperature of at least 10°C in range of 170-180 days, with 100-110 frost days, the precipitation reaching on average 300 to 350 mm during the vegetation period, or 200 to 300 mm in winter time. As for soil types, the areas with peach growing comprise mainly of chernozem and degraded chernozem on loess or alluvial soil.

The Lednice area, where a plantation of gene pool collection of peach trees is situated, can also be classified as a warm region from the climatic point of view, with its average annual temperature of 9-10°C (80-year average), long term average precipitation of 442 mm (80-year average), and Langs rain factor of 52.5(i.e. area is classified as dry). The soil type is loamy soil of alluvial or degraded chernozem type. The altitude of the area is 170 m asl.

Between the years 2010 and 2011 the PPV (*Plum pox virus*) symptoms were evaluated in peach rootstock orchard on flowers, leaves and fruits of peach trees (*Prunus persica* L.). The symptoms were evaluated in two varieties grafted on different rootstocks – variety Royal Glory on 7 rootstocks: GF 677 (148 pcs), Lesiberian (62 pcs), Ishtara (68 pcs), Pumiselect (47 pcs), St. Julien A (13 pcs), MRS 2/5 (72 pcs) and Julior (92 pcs) and variety Symphony on 6 rootstocks: GF 677 (120 pcs), Lesiberian (82 pcs), Ishtara (61 pcs), Pumiselect (31 pcs), MRS 2/5 (43 pcs) a Julior (75 pcs). A total of 13 variety/rootstock combinations were included in the study (altogether 914 trees). The planting was set up in 2004. Trees were planted with 5 x 1.5 m spacing.

The obtained data were subjected to statistical analysis using the software Statistica, ANOVA multi-factor analysis.

Results and discussion

The evaluation of the intensity of PPV symptoms

The overall grade average was calculated concerning the intensity of PPV symptoms on flowers, leaves and fruits in each combination. The intensity of PPV symptoms was more frequent in ‘Symphony’ (1.64 points) while ‘Royal Glory’ showed less frequent symptoms (1.45 points). On the basis of this research it was discovered that the rootstock Julior can significantly affect the peach trees susceptibility to PPV (1.84 points). Other very susceptible rootstocks are as follows:

Ishtara (1.71 points), MRS 2/5 (1.61 points), Pumiselect (1.51 points), GF 677 (1.49 points). As for both varieties, rootstock Lesiberian reached on average the lowest values (1.31 points). On the other hand, St. Julien A (1.11 points) proved as the least susceptible rootstock to PPV pathogen from the evaluated collection but only combination with variety Royal Glory was evaluated.

Generally, the PPV symptoms were present mostly on flowers and least on fruits. Low correlation dependence was proved between symptoms on flowers and symptoms on leaves (r = 0.10515) as well as between symptoms on flowers and fruits (r = 0.10102). Low correlation was also proved in comparison of symptoms on leaves and fruits (r = 0.20878).

Table 1. Definition of significant differences in the intensity of PPV symptoms on flowers, leaves and fruits among the individual combinations compared to the control combination ‘Royal Glory’/GF 677, graded by points

Control variety/rootstock	Rootstock	Symptoms/flowers average ± SD	Symptoms/leaves average ± SD	Symptoms/fruits average ± SD
Royal Glory/GF 677	GF 677	2.27 ± 0.06 a	1.57 ± 0.07 a	0.51 ± 0.07 a
Royal Glory/GF 677	Lesiberian	2.10 ± 0.09 a	1.05 ± 0.11 a	0.76 ± 0.11 a
Royal Glory/GF 677	Ishtara	1.84 ± 0.09 a	1.76 ± 0.10 a	0.93 ± 0.11 a
Royal Glory/GF 677	Pumiselect	1.52 ± 0.10 a	1.29 ± 0.11 a	0.57 ± 0.13 a
Royal Glory/GF 677	St. Julien A	1.83 ± 0.22 a	0.83 ± 0.24 a	0.69 ± 0.24 a
Royal Glory/GF 677	Julior	2.21 ± 0.09 b	2.01 ± 0.08 a	1.11 ± 0.09 b
Royal Glory/GF 677	MRS 2/5	2.45 ±0.09 b	1.68 ± 0.10 a	1.28 ± 0.10 b
Average		2.03	1.46	0.84

Table 2. Definition of significant differences in the intensity of PPV symptoms on flowers, leaves and fruits among the individual combinations compared to the control combination ‘Symphony’/GF 677, graded by points

Control variety/rootstock	Rootstock	Symptoms/flowers average ± SD	Symptoms/leaves average ± SD	Symptoms/fruits average ± SD
Symphony/GF 677	GF 677	1.94 ± 0.07 a	1.44 ± 0.07 a	1.11 ± 0.08 a
Symphony/GF 677	Lesiberian	1.36 ± 0.08 a	1.93 ± 0.09 a	0.57 ± 0.10 a
Symphony/GF 677	Ishtara	2.48 ± 0.09 a	1.78 ± 0.10 a	1.33 ± 0.11 a
Symphony/GF 677	Pumiselect	1.94 ± 0.13 a	1.88 ± 0.14 a	1.74 ± 0.16 a
Symphony/GF 677	Julior	2.11 ± 0.09 a	2.07 ± 0.09 b	1.59 ± 0.10 a
Symphony/GF 677	MRS 2/5	1.28 ± 0.11 a	1.60 ± 0.13 a	1.30 ± 0.13 a
Average		1.85	1.78	1.27

Selection of suitable varieties according to the current market needs

The varieties of peaches and nectarines are characterised by large diversity in terms of long ripening period as well as the pomological characteristics of fruits, with yellow-flesh, white-flesh, and red-flesh, free stone or clingstone types. A flat shaped

varieties, also called “Peento”, are very popular in the south of Italy or in Asia.Varieties without anthocyanins, originally from Italy (“ice peach”), Californian series of Royal variety characterised by very hard flesh consistency and very low acid content, which gives the fruit an excellent sweet taste can also be popular with certain customers preferring these qualities.

Extension of ripening time. Low flesh firmness of early varieties is a factor limiting their marketing. The Czech production plantations mostly include Favorita Morettini, Redwin, Sunbrite and Sunhaven. The ripening time of described varieties is in range of the Redhaven (RH) variety. Suitable alternative varieties are for instance the following.

Maycrest. Californian variety with its origin in a bud mutation of the Springcrest variety, which is of particular interest today due to its certain tolerance to PPV, showing no apparent strong symptoms. Ripening time is 28 days before Redhaven. Thanks to its average weight of 120g, excellent taste, yellow flesh of medium firmness and attractive appearance it still meets the current market demands.

Spring Lady. Very attractive fruit appearance, average weight of 150 g. Yellow basic colour of fruit, deep red blush covering nearly the entire fruit. Flesh of medium firmness, inseparable from stone, very good taste. Average ripening time is 16 days before RH variety, the period from the end of blooming to the start of ripening being 78 days.

Spring Belle. A very attractive fruit appearance, yellow basic colour, deep red blush covering nearly 95% of fruit. Medium flesh firmness, excellent taste, semi-free stone. Average fruit weight of 140 g. Average ripening time is 14 days before RH variety, the period from the end of blooming to the start of ripening being 80 days.

For the ripening period of several days before and after the Redhaven variety the following varieties are prospective:

Ruby Prince. Very attractive fruits, its advantage is the firm consistence of the yellow flesh. Average fruit weight of 110 g. Ripening time is 10 days before Redhaven. The stone in full ripeness is moderately well separable from flesh. Very good taste, reliable production of quality fruit is conditioned by fruit thinning.

Royal Glory. Average fruit weight of 135 g. Very good taste, smooth fruit skin pubescence. Ripenig time is 8 days before Redhaven. The fruits are characterised, also in other newer varieties, by a prevailingly sweet taste and reduced acid content. A disadvantage is its sensitivity to plum pox virus (PPV).

Fidelia. A yellow-flesh peach variety with fine skin hairiness and ripening time 12 days after RH. Average fruit weight of 150 g. Its white-cream flesh is firm and easily separable from stone. Its deep red blush covers nearly the entire fruit. Very attractive fruits of excellent taste, compared with other white-flesh varieties.

Varieties with later ripening do not show good basic colour and blush, which results in lower marketable attractiveness. Examples of the prospective varieties include the following:

Symphonie. A highly productive variety with firm flesh consistence and very good taste. A potential replacement of Cresthaven variety for intensive cultivation.

Ripening time is 20 days after Redhaven. Its major disadvantage is a very high sensitivity to PPV manifested mainly in the fruit appearance and therefore can only be grown in areas with low occurrence of PPV.

Sweet Dream. Heavy and regular production of large sized fruit. Fruit with firm flesh, good handling and shipping quality. Attractive red skin. Preliminary results showed no PPV symptoms in this variety. The average ripening time is 30 days after Redhaven.

Tardibelle. The ripening time is 30 days after Redhaven. A yellow-flesh, very attractive peach variety. It is distinguished by high flesh firmness and excellent taste quality. It seems to be an ideal variety for harvest in the first decade in September.

Prospective varieties from the nectarine group are the following:

Neve. The ripening phase starts on average 5 days before the Redhaven variety. The average fruit weight is 175 g, oval fruit shape. The basic fruit colour is green-cream, the blush colour is purple red covering more than 75% of the surface. The green-white flesh is of firm consistence and excellent taste, the rock is poorly separable from the flesh.

Super Queen (*Caldesi 2000*). Its ripening period starts five days before RH. A nectarine with a very attractive fruit appearance, average fruit weight is 160 g. The green-white flesh is firm, aromatic, with a very good taste. It is a variety with a reliable and high yield.

August Queen (*Caldesi 2010*). The ripening starts 26 days after Redhaven, on average. The average fruit weight is 174 g, the fruit is symmetrical and elongated round shaped. The basic fruit colour is green-cream; the deep red blush covers nearly 80% of fruit surface. The light cream flesh has very firm consistence and is easily separable from the stone. It has a very good taste with well balanced sweet and sour flavours.

Venus and *Orion*. Orion starts ripening about 30 and Venus about 35 days after RH. Average fruit weight of 200 g. These are yellow-flesh varieties with easily separable stone and firm flesh consistence. High attractiveness, good fruit taste quality, and late ripening time are their advantages for their potentially successful growing.

Frost resistance. The varieties that maintained high fruit production value of 7 and more (out of max. 9)in the years with spring frost are the following – Redhaven, Royal Jim, Harken, Crimson Gold, Early Crest, Neve, Krymčanin, Sovetskij, Fidelia, Cresthaven, Fayette, Veteran, Nectared 306, Harrow Diamond, Michellini, Guglielmina, Andross, Envoy, and Flamingo.

Varieties tolerant to PPV. The peach tree varieties with medium resistance to PPV are Envoy, Maycrest, Loring, Blaze Prince, June Prince, Legend, Favorita Morettini 3, Harmony, Candor, Spring Lady and Velvet.

Based on personal communication (Buzrla, 2012), the varieties with medium resistance to PPV include Red Moon, Plus Plus, Sweet Dream or hybrid Buz.114, kept in a private fruit farm in Moravský Žižkov, where the issues of breeding and

selection are also tested in practice.As the tolerant cultivars he found hybrid Buz.84,Alix,Cloe and Royal Mayestic.

Selection, assessment of training systems and rootstocks

One of the major training systems in the Czech Republic is open vase and recently also modified leader. The comparison of phenological and biological characteristics revealed no significant differences in the start and abundance of blooming, production or fruit quality.

The advantage of open vase, particularly in our geographical conditions, is better utilisation of sunlight and lower height which enables that all cultivation operations (pruning, fruit thinning, harvesting) can be done from the ground. On the other hand, a disadvantage of modified leaders is more demanding harvesting and pruning as ladders must be used when working on the upper parts which results in higher labour costs and lower interest of pickers in this kind of harvesting. In countries with more developed fruit growing this type of harvest is better paid than in the Czech Republic.

The French rootstock Ishtara can be identified as a very promising rootstock considering the crown structure, productive tree parts, pruning demands, fruit quality and stability, preliminary decline of trees and resistance to PPV. The peach-almond hybrid GF 677, which is regarded as the most frequently used rootstock worldwide, shows overproduction in vigorous varieties requiring fruit thinning. When using this rootstock for a modified leader, the growth balance in the apical part of the crown must be maintained. Pumiselect and Fire rootstocks showed the highest percentage of preliminary decline in the experimental plantation.

Conclusion

The current adverse situation can be improved by new prospective varieties suitable for commercial growing providing new characteristics for both the producers and consumers.

These prospective varieties should be characterised by certain resistance to PPV, profitable production of quality and balanced fruit of good taste properties, frost-resistance and a range of potential use of the fruit, either for direct consumption or for industrial processing.

The assortment can be complemented with white-flesh peach and nectarine varieties, flat varieties or the wide range of cling varieties.

Important factors are also restoration or expansion of the processing industry structure, support of “from the farm” sale or sale in the tourist centres within the respective areas, support of peach growing regions with local sale, etc. The sale through the network of supermarkets is not really feasible for the growers due to the

purchase price regulation. Often the price offered to the producers is under the profitability level and peach growers cannot compete with the price of imported fruit.

The fruit-breeding programme and evaluation of hybrids is solved at the Faculty of Horticulture in Lednice, Department of Fruit-Growing. The joint collaboration with private breeder Mr. Josef Buzrla from Moravsky Žižkov has begun. The breeding program is focused on the fruit quality, medium late ripening period, attractiveness and selection and promotion of hybrids and varieties with higher tolerance or medium resistance to PPV.

Acknowledgement

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Original paper

‘SPASENA’ – A NEW CANNING PEACH CULTIVAR

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Abstract. The cultivar ‘Spasena’ was obtained by conventional breeding methods, selected in F_3 hybrid generation, which was developed at the Fruit-Growing Institute in Plovdiv. It was officially recognized in February 2012.

The tree is moderate in growth. The crown is optimally garnished with moderately vigorous mixed shoots. The internodes are short and the flower buds are most often grouped by two in a node. Flowers are bell-shaped, 26.9 mm in diameter. The petals are dark pink. The leaf blade is 140.5 x 35.4 mm in size and the leaf petiole is 7.8 mm long. The cultivar is self-fertile. It starts bearing fruits in a short period – as early as the second vegetation season, showing very good and regular fertility. It needs optimally balanced pruning and, in some years, fruit thinning should be carried out.

Fruits ripen at the same time, shortly after mid-August. They are large, their mean weight is 164.3 g and their size is 65.00 x 67.0 x 66.6 mm. The shape is spherical; the sides are slightly asymmetric, bulging. The fruit skin is creamy yellow as a basic colour, mottled with carmine red blush covering up to 50% of the fruit surface. Fruit flesh is bright yellow, dense in texture, tender, crispy, homogeneous, moderately juicy, sweet, with a slight acidity and a pronounced fine aroma, preserved in the compote.

The stone is small, with a mean weight of 7.2 g, representing 4.59% share of the total fruit weight, clingstone.

‘Spasena’ is a typical canning cultivar, suitable to be processed into best quality compotes.

Key words: *Prunus persica*, peach, breeding, new cultivar.

Introduction

At the end of the last century and the beginning of the present millennium a great dynamics of the peach cultivars was observed in all the countries with a favourable climate for its growing. It was dictated by the increasing supply of new cultivars and the comparatively shorter lifespan of the peach plantations. A large number of new cultivars mainly of the group of the dessert peaches and nectarines have been developed in the USA, Italy, France and in other countries, the best solved breeding problems referring to extending the period of fruit ripening (Giauque and Hilaire, 2002; Bellini et al., 2005; Sansavini et al., 2006).

Considering the fact that peach is grown in both hemispheres and taking into account the increased international trade, fresh fruits are supplied almost throughout

the year. That has led to a great decrease in the consumption of peach compotes. On its side, it caused a reduced demand of canning cultivars and most of the European and American programmes directed their efforts towards the establishment of new dessert peach and nectarine cultivars. The group of canning (clingstone) cultivars has always been the smallest one compared to the group of the dessert peaches and nectarines. The majority of the clingstone peach cultivars were created in the USA and Italy, followed by France and Spain, mainly in the 70s of the last century when the breeding programmes were most active in that direction. A smaller number of those cultivars were established in the 60s and 80s. In the 90s an abrupt drop in the development of cultivars with a firm texture of the fruit flesh was observed.

Peach breeding activities in Bulgaria started in the middle of 20th century when the range of available cultivars was still quite limited (Velkov, 1970). In the 60s, the genetic resources were rapidly enriched by introducing some new cultivars from abroad. At the same time clingstone cultivars established in the USA and Italy were imported and over 60 peach cultivars of that group were studied at the experimental plantations of the research institutions. That situation and the fast spread of the canning peach cultivars in the industrial plantations have provided the impetus for the development of the breeding programmes, in which the creation of cultivars for the canning industry in Bulgaria was set as one of the major aims.

In the 60s and 70s of the last century five peach cultivars were established in Bulgaria, suitable for industrial processing. The first one was ‘Oktomvriiska 2’ developed by Prof. Velkov and officially recognized in 1970. The cultivars ‘Tundzha 1’ and ‘Tundzha 2’ were created by Prof. Grigorov. Assoc. Prof. Dabov was the author of the cultivars ‘Stoyka’ and ‘Malo Konare’ that are resistant to powdery mildew (Velkov, 1970; Velkov and Tsanev, 1974; Petrov and Grigorov, 1981; Grigorov, 1982; Grigorov and Bozhikova, 1985; Dabov, 1985; Iliev et al., 1985; Zhivondov, 2009).

A new peach breeding programme started in Bulgaria in 1989 at the Fruit-Growing Institute in Plovdiv (Zhivondov, 1994; Zhivondov and Bozhkova, 2009). It is still running nowadays and it is continuously updated. One of the aims of the programme is the development of peach cultivars with a firm texture of the fruit flesh for the needs of the processing industry.

The aim of the paper was to present the pomological characteristics of the new industrial peach cultivar ‘Spasena’.

Material and methods

The new peach cultivar ‘Spasena’, the fruits of which are intended for industrial processing, was officially recognized in February 2012. It was created by conventional breeding methods, selected from F_3 generation hybrids. The first generation hybrids (F_1) were created by pollination of ‘J.H. Hale’ cultivar with pollen from the local cultivar ‘Dupnishka’. One hybrid was selected and it was pollinated once again with pollen of ‘J.H. Hale’ cultivar. One hybrid was selected from the

second hybrid generation (F_2) and a third hybrid generation (F_3) was obtained from it by open pollination. After a selection of the hybrids in F_3 generation, the new cultivar ‘Spasena’ was obtained (Figure 1).

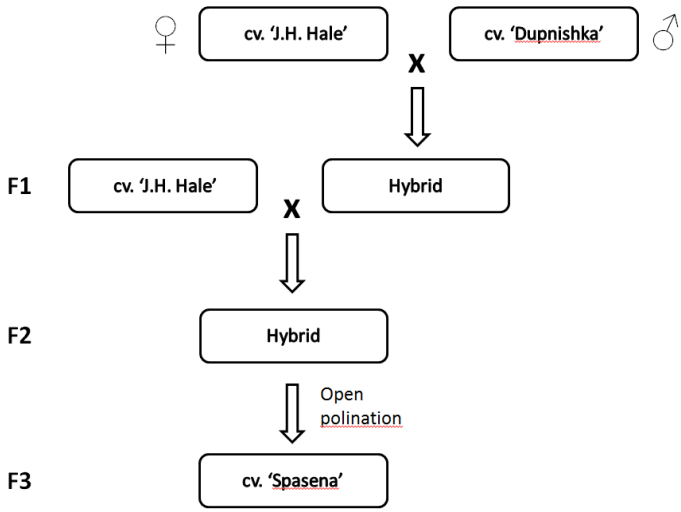

Figure 1. Genetic origin of the peach cultivar Spasena

The pomological studies at the final stages were carried out in the period 2009 – 2012, after propagating the cultivar on GF-677 rootstock. The trees were grown in a collection plantation at a planting distance 5 x 3 m on black fallow, under irrigation. The trees were trained to a free-growing crown. The results obtained were compared with the industrial cultivars ‘Baby Gold 9, ‘Catherine’ and ‘Fortuna’, grown under the same conditions.

Results and discussion

The tree of ‘Spasena’ cultivar is moderate in growth. The crown is of an upright habit, medium dense, well-garnished with moderately vigorous mixed shoots. The internodes are short and the flower buds are most often grouped by two in a node with a leaf bud in-between. Flowers are bell-shaped, 26.9 mm in diameter. The petals are dark pink, separate. Flowering is medium late. The cultivar is self-fertile. The leaves are large, the average size of the leaf blade is 140.5 x 35.4 mm and the leaf petiole is 7.8 mm long.

The fruits of ‘Spasena’ cultivar ripen uniformly, shortly after mid-August, immediately after those of ‘Fortuna’ cultivar and quite before those of ‘Baby Gold 9’ (Fig. 2).

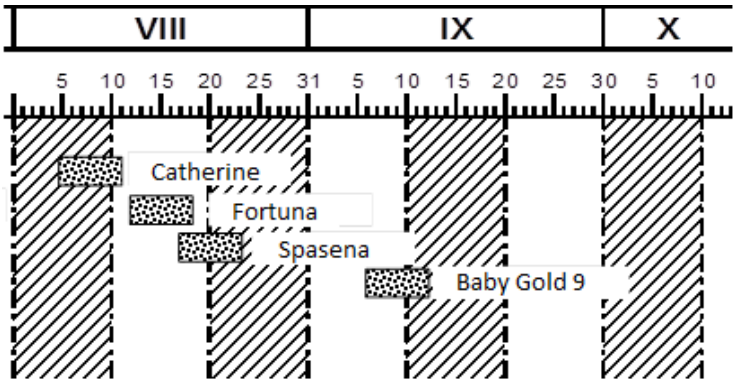

Figure 2. Phenogram of ripening

Fruits are large, their mean weight is 164.3 g and their size is 65.00 x 67.0 x 66.6 mm (Tabl. 1). The shape is almost spherical; the sides are slightly asymmetric, bulging. The fruit skin is creamy yellow as a basic colour, mottled with carmine red blush covering up to 50% of the fruit surface. It is slightly fuzzy and not detaching from the fruit flesh. The latter is bright yellow in colour, without any blush, dense and firm in texture, homogeneous, tender, crispy, moderately juicy and sweet, with a slight acidity and a pronounced fine aroma, preserved in the compote.

Table 1. Biometric parameters of fruit and yields of clingstone peach cultivars (2009 – 2012)

Cultivar	Fruit size (mm)			Fruit Weight (g)	Yields	
	Height	Width	Thickness		kg/tree	t/ha
Spasena	65.01 ab	67.04 a	66.60 a	164.32 a	42.50 a	28.31 a
Catherine	61.68 b	67.88 a	67.32 a	160.00 a	41.50 a	27.64 a
Fortuna	60.58 b	66.50 a	66.35 a	151.81 a	40.75 a	27.14 a
Baby Gold 9	67.60 a	66.37 a	66.81 a	171.65 a	43.25 a	28.80 a
LSD	4.69	5.12	4.34	36.15	2.67	1.78

The stone is small with a mean size of 36.87 x 18.33 x 26.62 mm and a mean weight of 7.2 g, representing only 4.59% relative share of the total fruit weight (Table 2). The cultivar is clingstone, even the stone is firmly attached to the flesh that is typical of all the industrial type cultivars.

The new cultivar ‘Spasena’ starts bearing fruits in a short period – as early as the second vegetation season. Thanks to its good frost resistance, it shows regular and abundant fertility. Yields are slightly lower than those of ‘Baby Gold 9’ and slightly higher than those of ‘Fortuna’ and ‘Catherine’ (Table 1). The tree of that cultivar produces too many mixed shoots and it requires stronger pruning and sometimes fruit thinning, too. Fruits are comparatively equal in size and the size is optimal for industrial processing – 160-170 g in weight and 65-70 mm in diameter. The compotes produced from them are of best quality. The stone is small, almost the

same as that of ‘Fortuna’ cultivar, which also makes it easier to detach the flesh by mechanical means and the waste is smaller in volume. Thanks to the firm texture of the flesh, the fruits are suitable for mechanical harvesting.

Table 2. Biometric parameters of stone of clingstone peach cultivars (2009 – 2012)

Cultivar	Size (mm)			Mass (g)	Share in the fruit weight (%)
	Height	Width	Thickness		
Spasena	36.87 a	18.33 ab	26.62 a	7.20 ab	4.59 a
Catherine	31.69 b	18.94 ab	25.05 a	6.46 b	4.02 a
Fortuna	33.03 b	20.46 a	24.05 a	7.18 ab	4.76 a
Baby Gold 9	38.51 a	17.37 b	26.23 a	8.39 a	4.91 a
LSD	3.27	2.98	3.89	1.37	1.27

‘Spasena’ cultivar shows a high level of resistance to the disease powdery mildew (*Sphaerotheca pannosa* (Wallr.: Fr.) Lev. *var. persica*) and peach leaf curl (*Taphrina deformans* (Fuskel) Tulasne).

Conclusion

The new industrial peach cultivar ‘Spasena’ has quite good pomological, economic and technological characteristics. Best quality compotes could be produced from its fruits. The cultivar deserves to be grown in the new commercial peach orchards.

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Originalni naučni rad

KARAKTERISTIKE HIBRIDA BRESKVE IZ KOMBINACIJE UKRŠTANJA FLAMINIA × HALE TARDIVA SPADONI

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Izvod. U radu su prikazani trogodišnji rezultati ispitivanja osam hibrida breskve dobijenih iz kombinacije ukrštanja Flaminia x Hale Tardiva Spadoni. Hibridi su upoređivani sa standardnom sortom Summerset. Kod ispitivanih hibrida i standardne sorte proučavani su vreme sazrevanja, osobine ploda (masa, dužina, širina i debljina), osobine koštice (masa, dužina, širina i debljina) i hemijske osobine ploda (sadržaj rastvorljivih suvih materija, ukupnih kiselina, ukupnih šećera, invertnih šećera i saharoze). Za proučavane osobine ispitivani hibridi ispoljili su sličnost ili značajne razlike u odnosu na standard. Polovina hibrida sazrevala je pre, a polovina posle standardne sorte. Masa ploda ispitivanih hibrida varirala je od 116,39 g (hibrid FH6) do 166,87 g (hibrid FH3), masa koštice od 8,83 g (hibrid FH8) do 15,22 g (hibrid FH7), sadržaj rastvorljivih suvih materija od 13,03% (hibrid FH5) do 17,33% (hibrid FH7), a sadržaj ukupnih kiselina od 0,51% (hibrid FH8) do 0,83% (hibrid FH7). Kao najperspektivniji u pogledu poznog vremena sazrevanja i kvaliteta ploda izdvojen je hibrid FH3, koji je interesantan kao kandidat za priznavanje kao nova sorta breskve ili za dalji oplemenjivački rad.

Ključne reči: *Prunus persica*, hibridi, selekcija, plod, koštica, hemijske osobine.

Uvod

U strukturi voćarstva Srbije, po broju stabala, breskva se nalazi na petom mestu, iza šljive, jabuke, kruške i višnje (Nikolić et al., 2012). Breskve su veoma kvalitetno, cenjeno i rentabilno voće. Kao stono voće breskva se u Srbiji bere i koristi od kraja maja do kraja septembra. Njeni plodovi upotrebljavaju se i za proizvodnju sokova, kompota džemova, marmelada, bebi kaša, kao i za sušenje i smrzavanje (Mišić, 2002).

U povoljnim prirodnim uslovima i pri korišćenju savremenih sistema gajenja, breskva rano prorodi (u drugoj godini), a u punoj rodnosti može da postigne visoke prinose (30, 40 i više t/ha). Već u trećoj godini vrednost prinosa kod breskve može pokriti troškove proizvodnje (Ognjanov et al., 1993).

Danas se u proizvodnim zasadima Srbije gaje uglavnom sorte srednjeg i srednjepoznog vremena sazrevanja kao što su Redhaven, Glohaven, Suncrest, Cresthaven i Fayette. Imajući u vidu povoljne uslove za gajenje ove kulture u mnogim oblastima naše zemlje sortiment breskve bi trebalo proširiti sortama ranijeg i kasnijeg vremena sazrevanja, od vremena sazrevanja navedenih sorti. Pored toga promene u sortimentu treba usmeriti i u pravcu izbora sorti koje poseduju adekvatne biološke osobine i koje bi trebalo da u kombinaciji sa intenzivnijom tehnologijom gajenja unaprede ukupnu proizvodnju i kvalitet plodova (Nikolić et al., 2012).

Za razliku od ostalih vrsta voćaka, sortiment breskve je vrlo dinamičan. U svetu danas postoji više od 6000 sorti breskve. Planska hibridizacija je najznačajniji metod za stvaranje novih, boljih sorti breskve, jer omogućuje rekombinaciju gena. Ovom metodom stvoreno je više od 50% sorti kije se danas nalaze u proizvodnji. Oplemenjivanje breskve veoma je razvijeno u SAD-u, Italiji, Francuskoj, Kini i drugim zemljama. U Srbiji je do sada oplemenjivačkim radom stvoreno osam novih sorti breskve.

Uspeh u oplemenjivanju breskve zavisi od iskustva selekcionara, postavljenih ciljeva i izbora roditelja za hibridizaciju, kao i od izbora standardnih sorti prema kojima se ceni vrednost hibrida. Tako su sa različitih aspekata osobine perspektivnih hibrida breskve ispitivali Kapetanović et al. (1976), Mišić i Todorović (1983), Ogašanović i Plazinić (1986), Smole (1992), Rakonjac et al. (1998), Čolić et al. (2000) i Ogašanović et al. (2000).

Na Poljoprivrednom fakultetu, Univerziteta u Beogradu, već duži niz godina veoma intenzivno se radi na stvaranju novih sorti breskve. Metodom planske hibridizacije dobijen je do sada značajan fond hibrida F_1 generacije različitog vremena sazrevanja i kvaliteta ploda.

Cilj ovog rada bio je proučavanje hibrida F_1 generacije iz kombinacije ukrštanja Flaminia x Hale Tardiva Spadoni, radi izdvajanja najperspektivnijih za priznavanje ili dalji oplemenjivački rad, u pogledu poznog vremena sazrevanja i kvaliteta ploda.

Materijal i metode

Proučavano je osam hibrida breskve dobijenih iz kombinacije ukrštanja Flaminia x Hale Tardiva Spadoni. Ove dve sorte su korišćene za hibridizaciju radi rekombinovanja njihovih osobina i dobijanja hibrida koji će pored poznog vremena sazrevanja imati krupne i atraktivne plodove namenjene za svežu potrošnju. Proučavani hibridi su označeni šiframa: FH1; FH2; FH3; FH4; FH5; FH6; FH7; FH8. Zasad ispitivanih hibrida podignut je 2006. godine na oglednom dobru “Radmilovac” Poljoprivrednog fakulteta, Univerziteta u Beogradu. Uzgojni oblik je vretenast žbun, a razmak sadnje 4,5 x 2,0 m. U toku izvođenja ogleda u zasadu su primenjivane standardne agrotehničke mere.

Sve osobine ispitivanih hibrida upoređivane sa standardnom sortom Summerset. Tokom trogodišnjeg perioda istraživanja (2010-2012) kod izdvojenih hibrida i standardne sorte proučavani su vreme sazrevanja, osobine ploda (masa, dužina, širina i debljina), osobine koštice (masa, dužina, širina i debljina) i hemijske osobine ploda (sadržaj rastvorljivih suvih materija, sadržaj ukupnih kiselina, sadržaj ukupnih šećera, sadržaj invertnih šećera i sadržaj saharoze).

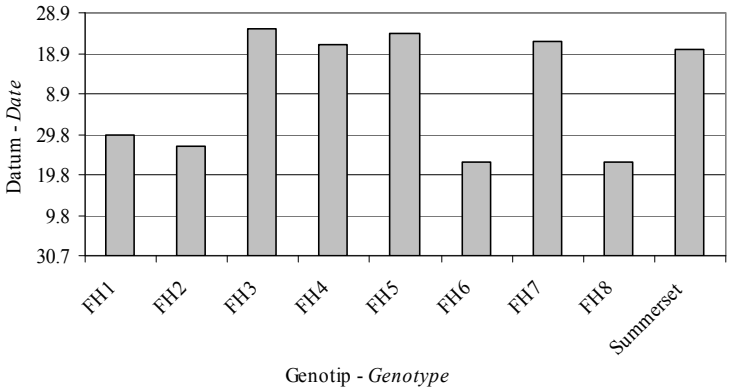
Kao vreme sazrevanja ploda uzet je datum početka berbe. Masa ploda i masa koštice mereni su na vagi, a dimenzije ploda i koštice digitalnim šublerom. Za sve osobine ploda i koštice korišćen je uzorak od 30 plodova, odnosno 30 koštica.

Sadržaj rastvorljivih suvih materija određivan je digitalnim refraktometrom (Atago, Pocket PAL-1), a sadržaj ukupnih kiselina titracijom sa 0,1N NaOH uz prisustvo fenolftaleina kao indikatora. Sadržaj ukupnih i invertnih šećera određeni su Luff Schoorl metodom (Egan et al., 1981), a sadržaj saharoze računskim putem kao razlika ukupnih i invertnih šećera pomnožena koeficijentom 0,95.

Dobijeni rezultati prikazani su na nivou prosečnih vrednosti. Značajnost razlika između proučavanih hibrida i standardne sorte za osobine ploda i koštice utvrđena je na osnovu rezultata dvofaktorijalne analize varijanse, a za hemijske osobine ploda na osnovu rezultata monoktorijalne analize varijanse. Pojedinačno testiranje izvršeno je primenom Dunnett-ovog testa za verovatnoće P=0,05 i P=0,01. Analiza podataka obavljena je korišćenjem statističkog softverskog paketa ‘Statistica’ (StatSoft, Inc., Tulsa, Oklahoma, USA).

Rezultati i diskusija

Podaci prikazani u grafikonu 1. pokazuju da je od ukupno osam ispitivanih hibrida polovina imala ranije, a polovina poznije vreme sazrevanja od standard sorte, koja je sazrevala 19. septembra. Najranije vreme sazrevanja utvrđeno je kod hibrida FH6 (21. avgust), a najkasnije kod hibrida FH3 (24. septembar).



Grafikon 1. Vreme sazrevanja ispitivanih hibrida i standardne sorte (prosek 2010-2012)
Ripening time of investigated hybrids and standard cultivar (average 2010-2012)

Ninkovski (1982) navodi da se u beogradskom voćarskom području kao kasne sorte breskve podrazumevaju one čije je sazrevanje plodova posle 25. avgusta, a pre 20. septembra. Prema ovoj klasifikaciji dva od osam ispitivanih hibrida u našem radu mogu se svrstati u kategoriju poznog vremena sazrevanja, a četiri u kategoriju veoma poznog vremena sazrevanja.

Masa ploda je jedna od najznačajnijih pomoloških osobina koja u znatnoj meri utiče na prinos. Nasleđuje se poligenski, što znači da u njenom razvoju pored genetičkih faktora u velikoj meri utiču i faktori spoljašnje sredine. Rezultati analize varijanse za masu ploda u našem radu pokazali su upravo vrlo značajne razlike kako između ispitivanih genotipova, tako i između godina istraživanja (Tabela 1). Veoma značajne razlike utvrđene su i za interakciju genotip x godina. Slični rezultati dobijeni su i za dužinu, širinu i debljinu ploda.

Tabela 1. Osobine ploda ispitivanih hibrida i standardne sorte (prosek 2010-2012)
Fruit properties of investigated hybrids and standard cultivar (average 2010-2012)

Genotip *Genotype*		Masa ploda (g) *Fruit weight (g)*	Dužina ploda (mm) *Fruit length (mm)*	Širina ploda (mm) *Fruit width (mm)*	Debljina ploda (mm) *Fruit thickness (mm)*
FH1		132,83	62,13	62,53	61,41
FH2		155,21	63,48	65,28	64,97
FH3		166,87	67,18	67,80	66,92
FH4		123,66*[1]	60,11*	60,47	59,86
FH5		135,03	59,50**	60,37	62,80
FH6		116,39*	57,66**	57,84*	57,21**
FH7		127,99	61,00*	60,53	59,51*
FH8		142,47	60,40*	64,23	63,19
Summerset		155,03	65,54	64,61	65,27
F-test	Genotip/*Genotype*	9,953**	16,332**	10,006**	10,148**
	Godina/*Year*	15,007**	3,955*	13,384**	14,697**
	Genotip x Godina *Genotype x Year*	6,523**	6,043**	4,802**	4,857**
	$D_{0,05}$	30,969	4,396	5,758	5,762
	$D_{0,01}$	39,392	5,592	7,323	7,329

[1] Proseci označeni * ili ** se značajno ili veoma značajno razlikuju od standarda prema Dunnett-ovom testu za P=0,05 i P=0,01

*The averages marked with * or ** significantly or very significantly differ from the standard according to Dunnett's test for P=0.05 and P=0.01*

Najmanju masu, dužinu, širinu i debljinu ploda imao je hibrid FH6 (116,39 g; 57,66 mm; 57,84 mm; 57,21 mm), a najveću hibrid FH3 (166,87 g; 67,18 mm; 67,80 mm; 66,92 mm). Značajno odstupanje u odnosu na standard za masu ploda pokazali su hibridi FH4 i FH6. Za dužinu ploda značajno odstupanje od standardne sorte

utvrđeno je kod hibrida FH4, FH7 i FH8, a veoma značajno kod hibrida FH5 i FH6. Za širinu ploda značajno odstupanje od standarda ustanovljeno je jedino za hibrid FH6. Ovaj hibrid pokazao je i veoma značajno odstupanje za debljinu ploda. Značajno odstupanje od standardne sorte u pogledu debljine ploda dobijeno je i kod hibrida FH7.

Pri stvaranju novih sorti breskve koštica treba da bude relativno sitna, bez šiljatog vrha, da ne puca i da se od mesa lako odvaja. Što je koštica sitnija njeno učešće u masi ploda je manje, pa se postiže povoljniji randman ploda. Masa koštice ispitivanih hibrida varirala je u intervalu od 8,83 g (hibrid FH8) do 15,22 g (hibrid FH7). Metodom analize varijanse za ovu osobinu utvrđene su veoma značajne razlike između ispitivanih genotipova, dok su za godine istraživanja i interakciju genotip x godina utvrđene značajne razlike (Tabela 2).

Tabela 2. Osobine koštice ispitivanih hibrida i standardne sorte (prosek 2010-2012)
Stone properties of investigated hybrids and standard cultivar (average 2010-2012)

Genotip *Genotype*		Masa koštice (g) *Stone weight (g)*	Dužina koštice (mm) *Stone length (mm)*	Širina koštice (mm) *Stone width (mm)*	Debljina koštice (mm) *Stone thickness (mm)*
FH1		10,09	38,68	27,88	20,40
FH2		13,94*	43,01	27,15	19,28
FH3		12,05	38,89	31,32**	22,57**
FH4		9,70	37,71	28,15	21,29
FH5		9,86	37,54	27,49	20,71
FH6		11,00	36,37	26,07	19,54
FH7		15,22**	40,73	29,30	21,83*
FH8		8,83	36,76	26,92	18,37
Summerset		10,82	40,01	28,09	19,95
F-test	Genotip/*Genotype*	20,553**	2,556*	17,685**	20,107**
	Godina/*Year*	3,547*	5,523**	0,922^{ns}	11,628**
	Genotip x Godina *Genotype x Year*	2,033*	1,585^{ns}	3,524**	6,544**
	$D_{0,05}$	2,715	7,738	2,122	1,725
	$D_{0,01}$	3,454	9,842	2,698	2,194

[1] Proseci označeni * ili ** se značajno ili veoma značajno razlikuju od standarda prema Dunnett-ovom testu za P=0,05 i P=0,01

The averages marked with * or ** significantly or very significantly differ from the standard according to Dunnett's test for P=0.05 and P=0.01

^{ns} nije značajno - *not significant*

Veoma značajno odstupanje od standarda za masu koštice utvrđeno je kod hibrida FH7, a značajno kod hibrida FH2. Sa druge strane za dužinu koštice rezultati analize varijanse pokazali su veoma značajno odstupanje između godina ispitivanja,

a značajno između proučavanih genotipova. Hibrid FH6 imao je najmanju (36,37 mm), a hibrid FH2 najveću (43,01 mm) dužinu koštice. Iako su ispoljene razlike među proučavanim genotipovima u pogledu ove osobine bile značajne, pojedinačnim testiranjem nisu ustanovljena značajna odstupanja ispitivanih hibrida u odnosu na standard. Za širinu i debljinu koštice veoma značajne razlike utvrđene su za proučavane genotipove i interakciju genotip x godina. Razlike između godina ispitivanja nisu bile značajne za širinu koštice, a za debljinu koštice su bile veoma značajne. Inače, najmanju širinu koštice imao je hibrid FH6 (26,07 mm), a najmanju debljinu koštice imao je hibrid FH8 (18,37 mm). Najveća širina i debljina koštice utvrđena je kod hibrida FH3 (31,32 mm; 22,57 mm). Za obe ove osobine hibrid FH3 pokazao je veoma značajno odstupanje od standarda. Pored njega značajno odstupanje od strandardne sorte za debljinu koštice utvrđeno je i kod hibrida FH7.

Plod breskve sadrži znatne količine biološki značajnih hemijskih materija (suve materije, šećeri, kiseline, pektini, vitamini, proteini, lipidi, mineralne materije i dr.) koje ga uz dobar ukus i aromu čine pogodnim za potrošnju u svežem stanju i različite vidove prerade. Iz tabele 3 može se videti da je najveći sadržaj rastvorljivih suvih materija, ukupnih kiselina, ukupnih i invertnih šećera imao hibrid FH7 (17,33%; 0,83%; 13,24%; 7,17%). Najmanji sadržaj rastvorljivih suvih materija i ukupnih šećera utvrđen je kod hibrida FH5 (13,03%; 10,70%), a sadržaj ukupnih kiselina i invertnih šećera kod hibrida FH8 (0,51%; 5,55%). Sadržaj saharoze varirao je u intervalu od 4,91% (hibrid FH2) do 6,07% (hibrid FH1).

Tabela 3. Hemijske osobine ploda ispitivanih hibrida i standardne sorte (prosek 2010-2012).
Chemical fruit properties of investigated hybrids and standard cultivar (average 2010-2012)

Genotip *Genotype*	Rastvorljive suve materije *Soluble solids* (%)	Ukupne kiseline *Total acids* (%)	Ukupni šećeri *Total sugars* (%)	Invertni šećeri *Invert sugars* (%)	Saharoza *Sucrose* (%)
FH1	15,60	0,64	12,34	5,95	6,07
FH2	14,20	0,62	10,85	5,68	4,91
FH3	15,80	0,80	12,38	6,10	5,92
FH4	16,33	0,75	12,67	6,42	5,94
FH5	13,03	0,68	10,70	5,75	5,02
FH6	14,00	0,58	11,13	5,57	5,28
FH7	17,33	0,83	13,24	7,17	5,76
FH8	14,20	0,51	11,27	5,55	5,50
Summerset	16,47	0,69	12,57	6,46	5,81
F-test Genotip/*Genotype*	$0,879^{ns}$	$1,296^{ns}$	$0,739^{ns}$	$0,590^{ns}$	$0,786^{ns}$

^{ns} nije značajno - *not significant*

Smole (1992) navodi da i pored toga što je varijabilnost kvaliteta ploda genetički kontrolisana, u određenoj meri ona je i ekološki uslovljena. Rezultati analize varijanse u našem radu pokazali su da ne postoje značajne razlike između ispitivanih genotipova u pogledu proučavanih hemijskih osobina ploda. Ovakvom rezultatu najverovatnije je doprinelo nepostojanje značajnijih razlika među hibridima po pojedinim godinama koje su u ovom slučaju uzete kao ponavljanja.

S obzirom da Mišić i Todorović (1983) navode da je cilj oplemenjivanja breskve pored ostalog stvaranje, srednje poznih i poznih, samooplodnih i rodnih sorti sa kvalitetnim plodovima, selekcija perspektivnih hibrida u našem radu izvršena je upravo na osnovu ovih osobina. Kao najperspektivniji u tom pogledu izdvojen je hibrid FH3, koji je interesantan kao kandidat za priznavanje kao nova sorta breskve ili za dalji oplemenjivački rad.

Hibrid FH3 je na prvom mestu izdvojen na osnovu vremena sazrevanja, jer je od svih proučavanih hibrida najpoznije sazrevao (24 septembra). Pored toga on je imao i najveću masu ploda (166,87 g) i skladan odnos šećera i kiselina (12,38%; 0,80%). Osnovna boja pokožice ovog hibrida je žuta sa veoma izraženim dopunskim crvenilom i retkim maljama. Mezokarp je žute boje i lako se odvaja od koštice (kalanka). Priznavanjem ovog hibrida za novu sortu znatno bi se produžila sezona potrošnje breskve u svežem stanju.

Zaključak

Za proučavane osobine ispitivani hibridi ispoljili su sličnost ili značajne razlike u odnosu na standard.

Poznije vreme sazrevanja od sorte standard utvrđeno je kod četiri, a veća masa ploda kod dva ispitivana hibrida.

Sadržaj rastvorljivih suvih materija i sadržaj ukupnih kiselina u odnosu na standard, bili su takođe veći kod četiri odnosno kod tri ispitivana hibrida.

Kao najperspektivniji u pogledu poznog vremena sazrevanja i kvaliteta ploda izdvojen je hibrid FH3, koji je interesantan kao kandidat za priznavanje kao nova sorta breskve ili za dalji oplemenjivački rad.

Hibridizaciju breskve i selekciju perspektivnih hibrida različitog vremena sazrevanja i namene treba dalje nastaviti u cilju poboljšanja njenog sortimenta.

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Characteristics of Peach Hybrids from the Crossing Combination Flaminia × Hale Tardiva Spadoni

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Summary

Characteristics of eight hybrids obtained from the crossing combination Flaminia x Hale Tardiva Spadoni during a three year period of research (2010-2012), are shown in this paper. Hybrids were compared with a standard cultivar Summerset. In the examined hybrids and standard cultivar the following characteristics were studied: ripening time, fruit properties (weight, length, width, and thickness), stone properties (weight, length, width, and thickness), and chemical characteristics of the fruit (contents of soluble solids, total acids, total sugars, inverted sugars, and sucrose). In relation to the observed traits, the examined hybrids had similarities or significant differences compared to the standard. Half of the hybrids matured before and half after the standard cultivar. Fruit weight of the examined hybrids varied from 116.39 g (hybrid FH6) to 166.87 g (hybrid FH3), stone weight from 8.83 g (hybrid FH8) to 15.22 g (hybrid FH7), soluble solids content from 13.03% (hybrid FH5) to 17.33% (hybrid FH7), and total acid content from 0.51% (hybrid FH8) to 0.83% (hybrid FH7). Hybrid FH3 distinguished as the most promising in terms of late fruit ripening, and fruit quality, which is interesting for recognizing as a new peach cultivar or for the further breeding work.

Key words: *Prunus persica*, hybrids, selection, fruit, stone, chemical properties.

Originalni naučni rad

BIOLOŠKE OSOBINE SREDNJE RANIH SORTI KAJSIJE U BEOGRADSKOM PODUNAVLJU

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Izvod. U periodu od četiri godine (2009-2012) na području Beograda proučavane su karakteristike 14 novointrodukovanih sorti kajsije srednje ranog vremena zrenja, uporedo sa sortom Mađarska najbolja, koja je uzeta kao standard. Većina ispitivanih sorti je cvetala 1-2 dana pre standard sorte, dok je vreme zrenja bilo 3-9 dana ranije. Statistički značajno veći prinos po stablu u odnosu na kontrolu imalo je osam sorti: Sylred, Palava, Sundrop, Pinkcot, Harcot, Dacia, Forum i Orangered. Značajno veću masu ploda imalo je pet sorti: Neptun, Goldrich, Robada, Sylred i Dacia, dok je manju masu ploda imala samo sorta Sundrop. Većina introdukovanih sorti je imala bolji izgled ploda. Kvalitet ploda kod većine sorti je bio na nivou kontrole ili nešto lošiji, sa izuzetkom sorti Forum, Orangered, Goldrich i Legolda, koje su imale bolji kvalitet ploda. Najbolje rezultate među proučavanim sortama su dale Goldrich i Sylred, koje se mogu preporučiti za gajenje kao pretežno stone sorte. Pored njih, mogu se preporučiti i sorte Orangered, Harcot, Neptun, Dacia i Pinkcot (za potrošnju u svežem stanju ili za preradu), kao i sorta Forum (samo za preradu).

Ključne reči: *Prunus armeniaca*, vreme cvetanja, vreme zrenja, prinos, kvalitet ploda.

Uvod

Prosečna proizvodnja kajsije u Srbiji u periodu 2007-2011. godine iznosila je 26.400 t (Republički zavod za statistiku Srbije). Bez obzira na veliku upotrebnu vrednost plodova, proizvodnja kajsije u našoj zemlji se relativno sporo povećava. Ograničavajući faktori za veće gajenje su neredovna rodnost zbog osetljivosti na pozne prolećne mrazeve i pojava iznenadnog sušenja stabala (apopleksije). Pored toga, sortiment kajsije u Srbiji karakteriše se malim brojem sorti i kratkim periodom sazrevanja. Glavna sezona potrošnje je u prvoj polovini jula, od početka zrenja sorte Mađarska najbolja, do desetak dana posle toga. Posebno je izražen nedostatak ranih sorti, koje sazrevaju u toku juna meseca i koje se odlikuju dobrim kvalitetom ploda.

Fideghelli i Della Strada (2010) navode da je u periodu 1980-2007. godine u svetu stvoreno 545 novih sorti kajsije. One se odlikuju poboljšanim osobinama, kao što su: bolja adaptivnost na različite ekološke uslove, duži raspon sazrevanja, veća otpornost na prouzrokovače bolesti, veća rodnost i bolji kvalitet ploda. Introdukcija novih sorti i njihovo proučavanje u našim agroekološkim uslovima omogućava proširenje izbora sorti za gajenje, a time i unapređenje proizvodnje kajsije.

Milatović et al. (2000) su proučavali osobine 10 sorti kajsije ranog vremena zrenja u beogradskom voćarskom području, a najbolje osobine je pokazala kanadska sorta Harkot. Plazinić et al. (2005) su u uslovima Čačka proučavali osobine 10 čeških sorti i selekcija kajsije. Među njima je bila i sorta Lebona, za koju ističu da ima dobar ukus i visok sadržaj suve materije, ali srednju rodnost i krupnoću ploda.

Cilj ovog rada je bio proučavanje 14 introdukovanih sorti kajsije srednje ranog vremena zrenja uporedo sa osobinama sorte Mađarska najbolja. Sorte koje pokažu najbolje rezultate će biti preporučene za gajenje u beogradskom području, kao i u drugim rejonima sa sličnim agroekološkim uslovima.

Materijal i metode

Istraživanja su obavljena u kolekcionom zasadu kajsije na Oglednom dobru ”Radmilovac” Poljoprivrednog fakulteta iz Beograda u periodu od četiri godine (2009-2012). Ogledni zasad je podignut 2007. godine, podloga je sejanac džanarike, a razmak sadnje 4,5 x 3 m. Sorte su u zasadu zastupljene sa po pet stabala.

Ispitivanjem je obuhvaćeno 14 sorti kajsije srednje ranog vremena zrenja. Četiri sorte potiču iz Republike Češke (Lebona, Legolda, Lerosa i Palava), tri potiču iz SAD (Orangered, Goldrich i Robada), po dve sorte potiču iz Francuske (Sylred i Pinkcot), Rumunije (Neptun i Dacia) i Kanade (Harcot i Sundrop), a jedna sorta je poreklom iz Ukrajine (Forum). Kao kontrola je uzeta sorta Mađarska najbolja.

Cvetanje je praćeno prema preporukama Međunarodne radne grupe za polinaciju: početak cvetanja – kada se otvori 10% cvetova, puno cvetanje – kada se otvori 80% cvetova, a kraj cvetanja – kada otpadne 90% kruničnih listića (Wertheim, 1996). Za vreme zrenja uzeti su datumi početka berbe. Osobine ploda određivane su na uzorku od 25 plodova po sorti. Indeks oblika ploda izračunat je po formuli: dužina^2 / širina x debljina. Rastvorljive suve materije određivane su refraktometrom, a ukupne kiseline (izražene kao jabučna kiselina) titracijom sa 0,1N NaOH. Organoleptičke osobine ploda (izgled i ukus) ocenjivao je petočlani žiri, poentiranjem sa ocenama od 1 do 5.

Dobijeni podaci za prinos i masu ploda su obrađeni statistički metodom analize varijanse. Značajnost razlika između srednjih vrednosti utvrđena je pomoću Dankanovog testa višestrukih intervala za verovatnoću 0,05.

Rezultati i diskusija

Od fenoloških osobina kod sorti kajsije proučavani su vreme cvetanja i vreme zrenja, a dobijeni rezultati su prikazani u tabeli 1.

Prosečno vreme cvetanja ispitivanih sorti kajsije je bilo krajem marta i početkom aprila. Cvetanje je počelo najranije kod sorti Goldrich, Lerosa i Sundrop (27. mart), a najkasnije kod sorti Harcot, Neptun, Dacia i Forum (29. mart). Većina introdukovanih sorti kajsije je cvetala 1-2 dana pre Mađarske najbolje. Između godina ispitivanja nisu zabeležene velike razlike u vremenu cvetanja. Cvetanje je bilo

najranije 2012. godine, kada je prosečan datum početka cvetanja za sve sorte bio 23. mart, a najkasnije 2009. godine, kada je prosečan datum početka cvetanja bio 2. april.

Tabela 1. Fenološke osobine sorti kajsije (prosek, 2009-2012. god.)
Phenological properties of apricot cultivars (average, 2009-2012)

Sorta *Cultivar*	Cvetanje / *Flowering*				Datum berbe *Date of harvest*	Broj dana u odnosu na kontrolu *N° of days comparing to control*
	Početak *Start*	Puno *Full*	Kraj *End*	Trajanje *Duration*		
Legolda	28.03.	30.03.	04.04.	6,8	24.06.	-9
Orangered	28.03.	30.03.	04.04.	6,5	24.06.	-9
Lebona	28.03.	29.03.	03.04.	6,0	25.06.	-8
Sylred	28.03.	30.03.	04.04.	7,3	26.06.	-7
Harcot	29.03.	30.03.	04.04.	6,3	26.06.	-7
Neptun	29.03.	31.03.	05.04.	7,5	27.06.	-6
Dacia	29.03.	30.03.	04.04.	6,0	27.06.	-6
Pinkcot	28.03.	30.03.	04.04.	7,5	28.06.	-5
Palava	28.03.	30.03.	04.04.	6,8	28.06.	-5
Lerosa	27.03.	29.03.	03.04.	7,0	28.06.	-5
Sundrop	27.03.	29.03.	03.04.	6,8	29.06.	-4
Forum	29.03.	31.03.	06.04.	7,3	29.06.	-4
Robada	28.03.	29.03.	03.04.	6,3	29.06.	-4
Goldrich	27.03.	29.03.	03.04.	6,8	30.06.	-3
Mađarska najbolja (kontrola / *control*)	29.03.	31.03.	04.04.	5,5	03.07.	0

Sve novointrodukovane sorte su imale duže trajanje cvetanja u odnosu na standard sortu (Mađarska najbolja sa 5,5 dana). Ono je iznosilo prosečno za sve sorte 6,7 dana, sa variranjem od 6,0 dana kod sorti Lebona i Dacia do 7,5 dana kod sorti Neptun i Pinkcot.

Naši podaci o trajanju cvetanja u skladu su sa navodima Soltész-a (1996) da cvetanje kajsije prosečno traje od 6 do 15 dana. U odnosu na rezultate Milatovića (2005) za period od deset godina (1995-2004) u istom lokalitetu, trajanje cvetanja sorti kajsije je bilo kraće u proseku za tri dana. Dobijene razlike se mogu objasniti višim temperaturama u fenofazi cvetanja u periodu ispitivanja.

Prosečno vreme zrenja je bilo od 24. juna kod sorti Legolda i Orangered do 30. juna kod sorti Robada i Goldrič. U odnosu na standard sortu (Mađarska najbolja) zrenje je bilo za 3-9 dana ranije. Između godina ispitivanja nisu zabeležene velike razlike u vremenu zrenja. Zrenje je bilo najranije u 2012. i 2009. godini, a najkasnije u 2010. godini. Prosečna razlika u vremenu zrenja između ove dve godine je bila 9,1 dana, a po sortama je varirala od 8 do11 dana.

Prosečno vreme zrenja sorte Mađarska najbolja u periodu 2009-2012. godine je bilo za tri dana ranije u odnosu na devetogodišnji prosek (1995-2003) za ovu sortu u istom lokalitetu (Milatović et al., 2005). To ukazuje na veoma toplo vreme u periodu april - jun u periodu ispitivanja (2009-2012. godina). Naši podaci o vremenu zrenja za češke sorte u skladu su sa podacima koje navode Vachůn et al. (1999) i Plazinić et al. (2005).

Prosečan prinos po stablu ispitivanih sorti kajsije je bio od 4,9 kg kod sorte Robada do 15,6 kg kod sorte Sylred (Tabela 2). Ovi podaci se odnose na prinos u periodu početne rodnosti, kada je starost stabala bila između tri i šest godina. Ranim stupanjem u rod i visokom početnom rodnošću odlikuju se sorte Sylred, Pinkcot i Palava. Sa druge strane, kasnije stupanje u rod i niži početni prinosi zabeleženi su kod sorte Forum. U poređenju sa kontrolnom sortom, značajno veći prinos je ostvaren kod osam sorti: Sylred, Palava, Sundrop, Pinkcot, Harcot, Dacia, Forum i Orangered.

Tabela 2. Prinos sorti kajsije (kg po stablu)
Yield of apricot cultivars (kg per tree)

Sorta *Cultivar*	Godine / *Years*				Prosečno *Average*
	2009.	2010.	2011.	2012.	
Legolda	0,8	7,3	18,5	0,2	6,7 cde
Orangered	1,4	9,7	25,9	2,3	9,8 bcd
Lebona	1,1	13,3	12,7	5,1	8,0 bcde
Sylred	3,7	18,9	33,3	6,7	15,6 a
Harcot	1,2	6,4	15,5	16,4	9,9 bcd
Neptun	1,8	6,1	13,0	5,7	6,6 cde
Dacia	2,0	4,2	23,7	9,4	9,9 bcd
Pinkcot	3,3	14,9	20,1	6,2	11,1 abc
Palava	2,9	14,7	30,1	0,8	12,1 ab
Lerosa	1,1	9,4	19,4	2,2	8,0 bcde
Sundrop	1,5	12,6	24,7	7,2	11,5 abc
Forum	0,5	3,4	13,3	22,6	9,9 bcd
Robada	0,9	8,2	9,2	1,2	4,9 de
Goldrich	1,7	12,5	15,0	5,8	8,7 bcde
Mađarska najbolja (kontrola / *control*)	0,3	2,1	10,8	2,0	3,8 e

* Mean values followed by the same letter within a column do not differ significantly according to Duncan’s test at P=0.05

Kod svih sorti najviši prinos je ostvaren u 2011. godini. Rekordno visok prinos u ovoj godini ostvarila je sorta Sylred – 33,3 kg po stablu ili 24,6 t/ha. U 2012. godini većina sorti je ostvarila nizak prinos usled pojave zimskog mraza (-20,7°C od 9. februara), kao i poznog prolećnog mraza (-2,4°C od 10. aprila). Sorte koje su u

ovoj godini dale visok rod su Forum (22,6 kg po stablu) i Harcot (16,4 kg po stablu) i one se mogu smatrati otpornim na mrazeve.

Dobijeni rezultati o prinosu su u skladu sa rezultatima Vachůn-a (2002), koji je proučavao rodnost kod 24 sorte kajsije u periodu od šest godina i utvrdio variranje prosečnog prinosa od 3-20 kg po stablu.

Prosečna masa ploda je bila od 39,0 g kod sorte Sundrop do 71,4 g kod sorte Neptun (Tabela 3). U odnosu na standard sortu statistički značajno veću masu ploda imalo je pet sorti: Neptun, Goldrich, Robada, Sylred i Dacia, dok je manju masu ploda imala samo sorta Sundrop. Kod većine sorti najmanja masa ploda je ostvarena u 2011. godini, u kojoj je zabeležena i najveća rodnost, dok je najveća masa ploda dobijena u 2012. i 2009. godini, u kojima su prinosi bili niži.

Masa koštice je varirala od 2,1 g (Lerosa) do 4,1 g (Goldrich), a njeno učešće u masi ploda je bilo od 4,5% (Sylred i Neptun) do 8,4% (Palava). Sorte sa krupnijim plodom imale su relativno sitniju košticu, tj. povoljniji randman mesa.

Tabela 3. Osobine ploda sorti kajsije (prosek, 2009-2012. god.)
Fruit properties of apricot cultivars (average, 2009-2012)

Sorta *Cultivar*	Masa ploda *Fruit weight* (g)	Masa koštice *Stone weight* (g)	Udeo koštice *Stone share* (%)	Dimenzije ploda *Fruit dimensions* (cm)			Indeks oblika *Shape index*
				Dužina *Lenght*	Širina *Width*	Debljina *Thickness*	
Legolda	48,9 de	2,8	5,7	4,5	4,4	4,2	1,11
Orangered	42,6 ef	2,4	5,7	4,5	4,1	3,9	1,26
Lebona	46,4 de	3,1	6,7	4,2	4,2	4,0	1,07
Sylred	59,1 c	2,7	4,5	4,7	4,6	4,5	1,05
Harcot	43,9 def	3,3	7,5	4,5	4,0	4,0	1,24
Neptun	71,4 a	3,2	4,5	5,1	5,1	4,6	1,09
Dacia	57,6 c	3,0	5,1	4,7	4,6	4,4	1,09
Pinkcot	50,0 d	2,8	5,5	4,5	4,3	4,2	1,09
Palava	48,4 de	4,0	8,4	4,4	4,4	4,2	1,04
Lerosa	46,7 de	2,1	4,6	4,5	4,3	4,2	1,13
Sundrop	39,0 f	2,8	7,2	4,3	4,1	3,9	1,15
Forum	42,4 ef	2,9	6,8	4,3	4,2	3,9	1,13
Robada	63,9 bc	2,9	4,6	5,1	4,8	4,6	1,17
Goldrich	66,5 ab	4,1	6,1	5,3	4,9	4,7	1,21
M. najbolja (kontrola)	47,4 de	3,5	7.4	4,6	4,6	4,4	1,05

* Mean values followed by the same letter within a column do not differ significantly according to Duncan’s test at P=0.05

Dimenzije ploda su bile u korelaciji sa masom ploda. Dužina ploda je varirala od 4,2-5,3 cm, širina od 4,0-5,1 cm, a debljina 3,9-4,7 cm. Na osnovu dimenzija je izračunat indeks oblika ploda, čije su vrednosti bile od 1,04 kod sorte Palava do 1,26 kod sorte Orangered.

Rezultati ispitivanja pomoloških osobina ploda u skladu su sa literaturnim podacima za pojedine sorte (Vachůn et al., 1999; Plazinić et al., 2005; Jakubowski i Grzyb, 2006).

Sadžaj rastvorljive suve materije u plodu ispitivanih sorti kajsije je varirao od 13,5% kod sorte Sundrop do 16,9% kod sorte Harcot (Tabela 4). Većina introdukovanih sorti imala je niži sadržaj suve materije u odnosu na standard (Mađarska najbolja sa 16,2%). Veći sadržaj imale su samo sorte Harcot, Lebona i Neptun.

Najviši sadržaj rastvorljive suve materije kod većine sorti je bio u 2009. godini. Razlog za to je mala količina padavina u periodu april-maj u ovoj godini.

Tabela 4. Parametri kvaliteta ploda sorti kajsije (prosek, 2009-2012. god.)
Fruit quality properties of apricot cultivars (average, 2009-2012)

Sorta *Cultivar*	Rastvorljive suve materije *Soluble solids* (%)	Ukupne kiseline *Total acids* (%)	RSM/UK[1] *SS/TA*	Senzoričke ocene *Sensory evaluation* (*1-5*)	
				Izgled *Appearance*	Ukus *Taste*
Legolda	13,6	1,57	8,7	3,6	4,3
Orangered	14,1	0,91	15,5	4,3	4,4
Lebona	16,6	1,25	13,3	3,6	4,1
Sylred	13,6	1,36	10,0	4,7	4,0
Harcot	16,9	1,42	11,9	4,0	4,1
Neptun	16,6	1,65	10,1	4,3	4,2
Dacia	14,8	1,45	10,2	4,0	4,2
Pinkcot	14,0	1,12	12,5	4,2	3,7
Palava	13,9	1,40	9,9	3,8	3,8
Lerosa	14,1	1,71	8,2	3,7	3,9
Sundrop	13,5	1,72	7,9	3,3	3,8
Forum	15,9	1,05	15,2	3,5	4,6
Robada	14,0	1,44	9,7	4,3	3,8
Goldrich	14,4	1,56	9,2	4,8	4,4
M. najbolja (kontrola)	16,2	1,42	11,4	3,5	4,1

RSM/UK[1] – Odnos rastvorljive suve materije / ukupne kiseline
SS/TA – Ratio of soluble solids / total acids

Sadržaj ukupnih kiselina u plodu je varirao od 0,91% kod sorte Orangered do 1,72% kod sorte Sundrop. Odnos sadržaja rastvorljive suve materije (koju najvećim delom čine šećeri) i kiselina ukazuje na slast ploda. Ovaj odnos je kod većine ispitivanih sorti bio niži u odnosu na standard. Veći odnos imale su četiri sorte: Orangered, Forum, Pinkcot i Harcot.

Naši rezultati o sadržaju rastvorljive suve materije i kiselina su bili u granicama koje navode drugi autori (Ninkovski, 1984; Badenes et al., 1998; Gurrieri et al., 2001; Drogoudi et al., 2008; Ruiz i Egea, 2008).

Većina ispitivanih sorti kajsije je dobila bolje ocene za izgled ploda u odnosu na standard sortu (Mađarska najbolja), sa izuzetkom sorti Sundrop i Forum. Po atraktivnom izgledu ploda posebno se ističu sorte Goldrich i Sylred. Ukus mesa većine introdukovanih sorti je ocenjen na nivou kontrole ili nešto lošije. Bolje ocene za ukus dobile su sorte Forum, Orangered, Goldrich i Legolda.

Zaključak

Na osnovu četvorogodišnjih ispitivanja novointrodukovanih sorti kajsije srednje ranog vremena zrenja u beogradskom području mogu se izvesti sledeći zaključci:

- Početak cvetanja introdukovanih sorti kajsije je bio 1-2 dana pre Mađarske najbolje, sa izuzetkom sorti Harcot, Dacia, Neptun i Forum, koje su cvetale istovremeno sa kontrolom.
- Prosečno vreme zrenja je bilo od 24-30. juna, odnosno 3-9 dana pre Mađarske najbolje.
- U poređenju sa kontrolnom sortom, statistički značajno veći prinos je ostvaren kod osam sorti: Sylred, Palava, Sundrop, Pinkcot, Harcot, Dacia, Forum i Orangered.
- Statistički značajno veću masu ploda u odnosu na sortu Mađarska najbolja imalo je pet sorti: Neptun, Goldrich, Robada, Sylred i Dacia, dok je manju masu ploda imala samo sorta Sundrop.
- Sadržaj rastvorljive suve materije je varirao od 13,5% (Sundrop) do 16,9% (Harcot). Kod većine sorti on je bio niži u odnosu na kontrolu, sa izuzetkom sorti Harcot, Lebona i Neptun.
- Sadržaj ukupnih kiselina je imao vrednosti od 0,91% (Orangered) do 1,72% (Sundrop). Po visokom indeksu slasti ističu se sorte Orangered i Forum.
- Većina introdukovanih sorti kajsije je imala bolji izgled ploda u odnosu na standard sortu, dok su bolje ocene za ukus dobile sorte Forum, Orangered, Goldrich i Legolda.
- Najbolje rezultate među proučavanim sortama su dale Goldrich i Sylred, koje se mogu preporučiti za gajenje kao pretežno stone sorte. Pored njih, mogu se preporučiti i sorte Orangered, Harcot, Neptun, Dacia i Pinkcot (za potrošnju u svežem stanju ili za preradu), kao i sorta Forum (samo za preradu).

Zahvalnica

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Biological Characteristics of Medium-Early Cultivars of Apricot in the Region of Belgrade

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Summary

Apricot cultivar assortment in Serbia is characterized by small number of cultivars and a short period of maturing. Most apricot fruits are harvested in the season of cultivar ‘Hungarian Best’ or at a short time (about ten days) afterwards. There is particularly a lack of early-maturing cultivars of high quality fruit. The aim of this study was the evaluation of 14 introduced apricot cultivars of medium-early maturing time in order to recommend best of them for growing in Belgrade area.

Study was carried out at the Experimental station “Radmilovac” of the Faculty of Agriculture in Belgrade over a period of four years (2009-2012). The experimental orchard was established in 2007, the rootstock was Myrobalan seedling, and tree spacing was 4.5 x 3 m. Control cultivar for comparison was ‘Hungarian Best’ (‘Magyar Kajszi’), which is the most grown apricot cultivar in Serbia.

Introduced cultivars began to flower one to two days before the ‘Hungarian Best’, with the exception of four cultivars (‘Harcot’, ‘Neptun’, ‘Dacia’, and ‘Forum’), that began to flower at the same time as the control cultivar. Average maturing time was from June, 24 (‘Legolda’ and ‘Orangered’) to June, 30 (‘Goldrich’), or 9 to 3 days before the ‘Hungarian Best’. Compared with the control cultivar, significantly higher yield was achieved in eight cultivars: ‘Sylred’, ‘Palava’, ‘Sundrop’, ‘Pinkcot’, ‘Harcot’, ‘Dacia’, ‘Forum’, and ‘Orangered’. Significantly higher fruit weight had five varieties: ‘Neptun’, ‘Goldrich’, ‘Robada’, ‘Sylred’, and ‘Dacia’, while smaller fruit weight had only ‘Sundrop’. Most of the introduced cultivars got higher scores for fruit appearance than ‘Hungarian Best’. Scores for fruit quality in most varieties was at the level of control or slightly lower, with the exception of cultivars ‘Forum’, ‘Orangered’, ‘Legolda’, and ‘Goldrich’, which got higher scores for fruit quality.

Among studied apricot cultivars, the best results were shown by ‘Goldrich’ and ‘Sylred’, which can be recommended for growing, predominantly for fresh consumption. In addition, the following cultivars can also be recommended for this region: ‘Orangered’, ‘Harcot’, ‘Neptun’, ‘Dacia’, and ‘Pinkcot’ (for fresh consumption or processing), and ‘Forum’ (only for processing).

Key words: *Prunus armeniaca*, time of flowering, time of maturing, yield, fruit quality.

Originalni naučni rad

PROUČAVANJE POZNIH SORTI NEKTARINE U GUSTOJ SADNJI

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Izvod. Ispitivan je uticaj guste sadnje na osobine pet poznih sorti nektarine: Venus, Vinčanka (klon sorte Stark Redgold kasnijeg vremena zrenja), Orion, Morsiani 51 i Vega. Sejanci vinogradske breskve su posađeni na rastojanju 3,5 x 1m (2800 stabala/ha). Kalemljenje je obavljeno na stalnom mestu na visini od 50 cm. U oglednom zasadu je primenjen novi uzgojni oblik, nazvan kosa vođica, koji se karakteriše time da je centralna vođica povijena pod uglom od 25° u odnosu na zamišljenu vertikalu. Ispitivani su parametri bujnosti, prinos, masa i organoleptičke osobine ploda u trogodišnjem periodu. U trećoj godini rodnosti sorte Venus, Vinčanka i Orion su postigle visoke prinose. Manji razmak sadnje je ispoljio negativan uticaj na masu ploda sorti Vega i Max 7, dok su plodovi ostalih sorata bili u kategoriji krupnih plodova. Sistem guste sadnje nije ispoljio negativan efekat na organoleptičke osobine plodova ispitivanih sorata.

Ključne reči: nektarina, gusta sadnja, rodnost, masa ploda.

Uvod

Breskva je jedna od najznačajnijih kontinentalnih vrsta voćaka i po proizvodnji se nalazi na trećem mestu u svetu, iza jabuke i kruške. U svetskim razmerama naša zemlja spada u male proizvođače, ali je breskva za Srbiju privredno značajna voćka (Mišić, 2002). Jedan od osnovnih preduslova za postizanje redovnih i visokih prinosa breskve i nektarine je uvođenje novih sistema gajenja, a u okviru njih i uzgojnih oblika uz primenu specifične agrotehnike i pomotehnike. Intenziviranje voćarske proizvodnje se postiže i povećanjem gustine sadnje radi ostvarenja ranijeg stupanja u punu rodnost, olakšanog izvođenja agro i pomotehničkih mera i postizanja većih prinosa. Ispitivanjem proizvodnje breskve i nektarine u gustoj sadnji se bavilo više autora (Ninkovski, 1986; Loreti and Pisani, 1992; Costa and Testolin, 1996).

Pri podizanju novih zasada uvek se postavlja pitanje izbora sorte, podloge, uzgojnog oblika i razmaka sadnje voćaka, koji će u datim uslovima omogućiti najbolje proizvodne, a time i ekonomske rezultate (Gvozdenović, 1996, Veličković i Radivojević, 1998). Raznolikost velikog broja gajenih sorti breskve i nektarine, daje mogućnost izbora onih, koje bi u sistemu guste sadnje postigle dobre proizvodne rezultate (Zec, 2010).

Cilj ovog rada je ispitivanje biološko-proizvodnih osobina poznih sorti nektarine u uslovima guste sadnje.

Materijal i metode

Istraživanja su obavljena u ogledno–proizvodnom zasadu Instituta PKB Agroekonomik u Padinskoj Skeli, na površini od 1 hektara. Podizanje zasada u sistemu gustog sklopa je obavljeno sadnjom kontejnerskih sejanaca vinogradske breskve na rastojanju 3,5 x 1 m (2800 st/ha). Zasad je formiran okuliranjem podloge na stalnom mestu na visini od 50 cm. Primenjen je uzgojni oblik kosa vođica (kosa kordunica) koji se karakteriše time da je centralna vođica povijena pod uglom od 25° u odnosu na zamišljenu vertikalu. Povijanje je obavljeno vezivanjem vođice za deblo susednog stabla. Planirana visina stabala je bila 2,8 m i većina stabala je dostigla zadatu visinu u drugoj godini formiranja zasada. Tokom ispitivanja svake godine je primenjivana zimska rezidba (kraj februara) i letnja rezidba (kraj juna).

Ogled je postavljen po potpuno slučajnom planu. U ogledu su tokom tri godine praćene sorte nektarine Venus, Vinčanka (pozni klon sorte Stark Redgold), Orion, Morsiani 51 i Vega. Ispitivani su sledeći pokazatelji: bujnost, prinos, masa ploda, organoleptički parametri ploda. Bujnost je definisana merenjem prečnika debla epibiota, visine stabla i širine krune. Prinos po stablu i masa ploda su utvrđeni merenjem svih plodova sa stabla. Organoleptičke osobine je ocenjivala grupa potrošača. Statistička obrada podataka je vršena u programu SPSS for Windows Release 7.5, standardna verzija u paketu ANOVA.

Rezultati i diskusija

Najveću prosečnu vrednost prečnika debla (osnovni parametar bujnosti stable breskve) su imala stabla Vinčanke (48,3 mm) a najmanju stabla sorti Orion i Vega (41,3 mm). Stabla sorti Vinčanka i Venus u gustoj sadnji su imala statistički vrlo značajno veću srednju vrednost prečnika debla od ostalih sorti (tabela 1). Nejednake vrednosti prečnika debla, ispitivanih sorti nektarine se mogu pripisati uticaju genotipa. Stabla nektarina Venus i Vinčanka su imale značajno veću širinu krune, dok su stabla Venusa imala značajno veću visinu od ostalih sorti u ogledu. Razlike u visini stabla i širini krune mogu biti rezultat uticaja genotipa.

Na osnovu ispitivanja 22 sorte breskve sa istim razmakom sadnje Rakonjac (2002) navodi da postoje statistički veoma značajne, genetički uslovljene razlike, u visini stabla i obimu debla, što je u skladu sa dobijenim rezultatima. Mićić (2008) opisuje sortu Venus kao bujnu a Orion kao sortu umerene bujnosti. Štampar (2009) navodi da su nektarine Stark Red Gold (čiji je klon Vinčanka, koja je ispitivana u ovom radu) i Orion srednje bujnosti. Dobijeni rezultati su u skladu sa literaturnim navodima.

Tabela 1. Parametri bujnosti stabala sorti nektarine u gustoj sadnji (3,5 x 1 m)
Parameters of tree vigor of nectarine cultivars in high density planting

Sorta *Cultivar*	Prečnik debla epibiota *Trunk diameter* (mm)				Visina stabla *Tree hight* (cm)				Širina krune *Crown width* (cm)			
	2009	2010	2011	Mx	2009	2010	2011	Mx	2009	2010	2011	Mx
Vinčanka	39	49	57	48,3	176	220	269	222	121	165	173	153
Venus	38	47	53	46,0	179	232	270	227	124	169	183	159
Orion	35	42	47	41,3	173	210	258	214	120	166	174	153
Morsiani	37	43	49	43,0	175	218	267	220	122	167	175	155
Vega	35	42	47	41,3	169	207	256	211	119	167	175	154
Mx	36,8	44,6	49,6	43,6	174,4	217,4	264	218,8	121,2	166,8	176	154,8
CV (%)	4,8	7,2	8,7		2,1	4,5	2,6		1,6	0,9	2,7	
Godine	LSD	0,05		2,0				5,2				2,4
Years	LSD	0,01		2,9				7,5				3,6
Sorte	LSD	0,05		2,5				6,7				3,2
Cultivars	LSD	0,01		3,7				9,7				4,6

U trećoj godini praćenja ogleda, stupanjem zasada u punu rodnost, ostvareni su i optimalni prinosi kod sorata Venus, Vinčanka i Orion (28, 27 i 26 t/ha). Upoređujući sorte nektarine u gustoj sadnji (tabela 2) najveći prosečni prinos (15.733 kg/ha) i najveću prosečnu masu ploda (149 g) je imala sorta Venus. Kod nektarine Morsiani 51 je zabeležen najmanji prosečan prinos (10.920 kg/ha), dok su plodovi sorte Vega imali najmanju prosečnu masu ploda (117 g). Sorte Venus,Vinčanka i Orion su imale statistički značajno veću srednju vrednost prinosa od ostalih sorata u gustoj sadnji. Masa ploda nektarina Venus, Orion, Vinčanka i Morsiani 51 se nije značajno razlikovala. Plodovi sorte Vega su imali značajno manju masu od ostalih sorti nektarine u ogledu.

Tabela 2. Prosečan prinos i masa ploda sorti nektarine u gustoj sadnji
Yield and fruit weight of nectarine cultivars in high density planting

Sorta *Cultivar*	Prinos / *Yield* (kg/ha)				Masa ploda / *Fruit weight* (g)			
	2009	2010	2011	Mx	2009	2010	2011	Mx
Vinčanka	5.040	14.280	27.440	15.586	133	141	157	144
Venus	5.480	13.440	28.280	15.733	137	141	170	149
Orion	5.750	13.860	26.040	15.216	142	139	156	146
Morsiani 51	4.760	9.240	18.760	10.920	143	127	146	139
Vega	4.560	8.120	20.160	10.946	112	114	124	117
Mx	5.118	11.788	24.136	13.680	133,4	132,4	150,6	138,8
CV (%)	9,6	24,4	18,1		9,4	8,9	11,3	
Godina	LSD	0,05	3.034					9,7
Year	LSD	0,01	4.415					14,1
Sorta	LSD	0,05	3.920					12,5
Cultivar	LSD	0,01	5.703					18,3

Dobijeni rezultati ukazuju da su pojedine sorte postigle odlične rezultate u gustoj sadnji, dok su neke sorte imale osrednji prinos i masu ploda. Kod gajenja nektarine u gustoj sadnji, došle su do izražaja sortne specifičnosti. Sorte Vinčanka, Orion i Venus su se bolje prilagodile gustoj sadnji i ostvarile bolje proizvodne rezultate.

Prinos i masa ploda su bili pod veoma značajnim uticajem spoljašnje sredine (godine), što je bilo ispoljeno i zbog rastuće rodnosti mladog zasada. Vrednosti koeficijenta varijacije pokazuju da su prinos i masa ploda ispitivanih sorti u gustoj sadnji umereno varirali. Zec et al. (2009) navode da se sorta Orion ističe po odličnim proizvodnim rezultatima u Beogradskom regionu.

Najveću ocenu za ukus ploda (tabela 3) ispitivanih sorti nektarina u gustoj sadnji su imale Vinčanka i Vega (3,93), dok je najslabije ocenjen ukus nektarine Venus (3,56). Conte et al. (1994) navode da je sorta Venus osrednjeg ukusa. Plodovi nektarine Morsiani 51 su dobili najveću prosečnu ocenu za boju i atraktivnost (4,33 i 4,56), dok je najniže ocene za boju i atraktivnost plodova u gustoj sadnji imala nektarina Vega (3,43 i 3,46). Nenadović-Mratinić et al. (1998) su ispitivali kvalitet nektarina srednje poznog zrenja u standardnom razmaku sadnje i navode da su prosečne ocene ukusa bile od 3,2 do 4, a boje od 3,5 do 4,5. Nektarine u gustoj sadnji su imale slične prosečne ocene ukusa i boje.Visoke ocene boje i atraktivnosti ploda u gustoj sadnji je dobila i sorta Orion koju Sansavini et al. (2006) ističu kao najzastupljeniju sortu nektarine u oblasti Emilia- Romanja, jer je karakterišu dobra rodnost i obojenost plodova.

Tabela 3. Ocene organoleptičkih svojstava plodova sorti nektarine u gustoj sadnji
Sensory evaluation of nectarine cultivars in high density planting

Sorta *Cultivar*	Ukus ploda *Fruit taste*				Boja ploda *Fruit colour*				Atraktivnost plodova *Fruit atractivness*			
	2009	2010	2011	Mx	2009	2010	2011	Mx	2009	2010	2011	Mx
Vinčanka	3,9	4,0	3,9	3,93	4,0	3,8	3,7	3,83	3,9	3,8	3,9	3,86
Venus	3,7	3,4	3,6	3,56	4,1	4,1	3,9	4,03	4,1	4,1	4,2	4,13
Orion	3,7	3,8	3,9	3,80	4,2	4,1	4,0	4,10	4,2	4,0	4,2	4,13
Morsiani 51	3,4	3,3	3,6	3,43	4,5	4,4	4,1	4,33	4,7	4,5	4,5	4,56
Vega	4,0	3,8	4,0	3,93	3,5	3,2	3,6	3,43	3,4	3,6	3,4	3,46
Mx	3,74	36,6	3,80	3,73	4,06	3,92	3,86	3,94	4,06	4,00	4,04	4,03
Godina	LSD	0,05		N.S.				N.S.				N.S.
Year	LSD	0,01		N.S.				N.S.				N.S.
Sorta	LSD	0,05		0,21				0,27				0,19
Cultivar	LSD	0,01		0,30				0,40				0,29

NS – nije značajno / *Non significant*

Rezultati LSD testa su pokazali da je postojalo značajno variranje ispitivanih sorti u pogledu ocena ukusa, boje i atraktivnosti. Razlike u ukusu i boji su očekivane jer predstavljaju sortno obeležje, dok je atraktivnost subjektivna ocena.

Ukus, boja i atraktivnost plodova ispitivanih sorti nisu značajno varirale po godinama ispitivanja, što se može objasniti istom tehnologijom gajenja tokom trajanja ogleda.

Sve ispitivane nektarine osim sorte Vega su imale visoke ocene boje i atraktivnosti ploda, što predstavlja pozitivan rezultat obzirom da se radi o zasadu guste sadnje.

Zaključak

Ispitivane sorte nektarine su pokazale različitu bujnost stabala u sistemu guste sadnje. Ispoljene razlike su nastale pod uticajem različite genetske osnove analiziranih sorti.

Na osnovu dobijenog prinosa i mase ploda, sorte se mogu podeliti u dve grupe. U prvu grupu spadaju sorte Venus, Vinčanka i Orion koje su postigle visok prinos i vrlo dobru masu ploda. Sorte druge grupe Morsiani 51 i Vega su imale osrednji prinos i masu ploda. Sorte prve grupe su se dobro prilagodile uslovima guste sadnje što je rezultat sortne specifičnosti. Primenjeni razmak sadnje nije negativno uticao na organoleptičke osobine većine ispitivanih sorata.

U početnim godinama rodnosti postignuti su dobri rezultati u gajenju većine isptivanih sorti nektarine u gustoj sadnji. Da bi primenjeni sistem gajenja sa uzgojnim oblikom kosa vođica mogao sa sigurnošću da se preporuči, neophodno je pratiti ispitivane sorte u dužem vremenskom periodu.

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The Influence of High Density Planting on the Properties of Late Maturing Nectarine Cultivars

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Summary

The influence of high density planting on the properties of five nectarine cultivars: Venus, Vinčanka (clone of Stark Redgold with later ripening), Orion, Morsiani 51, and Vega, was studied. In high density planting, seedlings of vineyard peach were planted at 3.5 x 1m (2800 trees ha^{-1}) and grafted at the height of 50 cm above ground level. The trees were trained as the Sloping Leader. That is new training system characterized by central leader bended at an angle of 25° with respect to an imaginary vertical axis. The following characteristics were studied: tree vigour, yield, fruit weight, and sensory properties for three consecutive years. A small row spacing had negative influence on yield and fruit weight of nectarine cultivars Morsiani 51 and Vega. High-density planting system did not show negative effects on fruit sensory characteristics.

Based on obtained results, studied cultivars can be divided into two groups. The first group consists of cultivars Venus, Orion, and Vinčanka that are suitable for this system of high density planting. The second group consists of cultivars Vega and Morsiani 51, that are less suitable for this system. Further long-term study is required to obtain more reliable conclusions.

Key words: nectarine, high density planting, yield, fruit weight.

Originalni naučni rad

NEKI POKAZATELJI USPEŠNOSTI GAJENJA KAJSIJE (*PRUNUS ARMENIACA* L.) U POLUGUSTOJ SADNJI

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Izvod. U radu su prikazane karakteristike rasta, rodnosti i kvaliteta ploda pet sorti kajsije kalemljenih na džanarici, gajenih na plitkom, peskovitom i kiselom zemljištu sa 600 stabala ha^{-1} u oblasti Čačka od 2008 do 2012. godine. Sorta *per se* (genotip) se ponašala kao najznačajniji faktor koji je uticao na ispitivane osobine kajsije. Sve sorte su imale umeren rast stabala, rani početak rodnosti, dobar prinos i fizičke osobine ploda, osim Biljane i Aleksandra, koje su ispoljile tendenciju bujnijeg rasta stabla i niže prinose. Najmanju bujnost stabla i najbolji prinos imale su sorte Harkot i Roksana. Najveću masu ploda imale su Roksana i Vera, a najveći randman mezokarpa Aleksandar i Roksana. Najveću čvrstinu mezokarpa imale su sorte Biljana i Vera. Najveći sadržaj ukupnih fenola je registrovan u plodu Harkota, ukupnih flavonoida u plodu Aleksandra, a najveći antioksidativni potencijal imao je plod Roksane. Generalno, sve sorte na podlozi džanarike sa 600 stabla ha^{-1} su imale dobru sposobnost adaptacije na plitko, peskovito i kiselo zemljišta i dobre fizičke i hemijske atribute ploda, a takođe imaju dobar potencijal kao komercijalno voće za svežu potrošnju i preradu u sličnim uslovima.

Ključne reči: antioksidativni kapacitet ploda, bujnost stabla, kajsija, masa ploda i koštice, prinos, polugusta sadnja.

Uvod

Kajsija (*Prunus armeniaca* L.) je veoma važna i rado gajena voćna vrsta širom sveta gde za to postoje povoljni agroekološki uslovi. Osnovni razlog gajenja ove vrste ogleda se u širokoj upotrebnoj vrednosti ploda koji se koristi kao svež, prerađen u niz proizvoda, duboko smrznut ili pak osušen (Ruiz i Egea, 2008). U 2010. godini, ukupna proizvodnja i površine u svetu su porasle u odnosu na prethodne godine i iznosili su 3.442.045 t, odnosno 491.903 ha (FAOSTAT, 2012). Najviše se gaji u mediteranskim zemljama, a u poslednje vreme visok rast proizvodnje je zabeležen u zemljama centralne Azije (Iran, Uzbekistan, Pakistan), dok je proizvodnja u Turskoj, kao najvećem svetskom proizvođaču, opala u pomenutoj godini za preko 100.000 t u odnosu na prethodne. Sorte kajsije koje se gaje u pomenutim oblastima pripadaju vrsti *P. armeniaca* L. i evropskoj (Gurrieri et al., 2001), odnosno iransko-kavkaskoj ekološko-geografskoj grupi sorti (Asma i Ozturk, 2005). One su dobro prilagođene

lokalnim uslovima sredine, ali se veoma teško prilagođavaju novim, posebno pri prenošenju iz jedne u drugu geografsku oblast (Badenes et al., 1998).

U Srbiji, proizvodnja kajsije je značajno varirala iz godine u godinu. Primera radi, u 2002. godini iznosila je svega 13.409 t, u 2004. 40.754 t, a u 2010. oko 23.000 t (FAOSTAT, 2012). Pretpostavlja se da 2012. godine zbog niskih zimskih temperatura u februaru, rodne i sušne prethodne, tj. 2011. godine, nije prešla 15.000 t (lična komunikacija). Područje oko grada Čačka je poznato po proizvodnji kajsije i godišnje se u njemu u tzv. rodnim godinama proizvede oko 3.500 t plodova. U ovom području, kajsija je voćka od velikog ekonomskog i socijalnog značaja. Međutim, i u ovom području je izraženo variranje proizvodnje (Milošević et al., 2010) koje je izazvano brojnim ograničavajućim činiocima kao što su: izmrzavanje cvetnih pupoljaka tokom zimskog mirovanja (Szabo et al., 1995), izmrzavanje cvetova zbog prolećnih mrazeva (Milatović et al., 2006), iznenadno (prevremeno) sušenje stabala (Petrovic i Milosevic, 1999), virus šarke (Bassi et al., 1993) i odsustvo savremenog tehnološkog koncepta, bolje rečeno, lutanja u tehnologiji gajenja (Milosevic et al., 2011). Dominantna sorta u ovom području, posebno u starijim zasadima, je Mađarska najbolja i niz lokalnih genotipova (Milošević et al., 2010), a tek se u novije vreme u zasadima šire inostrane i domaće sorte, pre svih Roksana, kao i sorte i selekcije stvorene na Poljoprivrednom fakultetu u Novom Sadu (neobjavljeni podaci autora). Međutim, izostankom moderne tehnologije gajenja koja podrazumeva primenu svih agro- i pomotehničkih mera, posebno rezidbe, proizvodni rezultati su veoma ograničeni sa dominacijom plodova slabijeg kvaliteta.

Kvalitet ploda je osnova za prihvatanje sorti kajsije od potrošača, uzimajući u obzir veliku konkurenciju na tržištu posmatranu kroz prisustvo brojnih sorti drugog voća i ostalih namirnica. Inače, kvalitet ploda je definisan kao spoj fizičkih i hemijskih osobina koje daju dobar izgled i prihvatljivost u smislu potrošačkog proizvoda (Kramer i Twigg, 1966), dok drugi autori navode da kvalitet ploda obuhvata senzorne osobine (izgled, tekstura, ukus i aroma), hranljivu vrednost, sadržaj hemijskih jedinjenja, mehaničke i funkcionalne osobine (Abbot, 1999). Potrošači svežih plodova vole lepe i aromatične kajsije, dok su ostali parametri, kao što su krupnoća, otpornost na manipulaciju i dobro čuvanje, posebno značajni za industrijsku preradu (Ruiz i Egea, 2008).

Izgled, čvrstina i ukus ploda su najvažniji osobine na tržištima sveže kajsije. Pored ovih osobina, u novije vreme, povećana je tražnja za voćem sa visokom količinom fitohemikalija i velikim antioksidativnim kapacitetetom, zbog zdravstvenog aspekta. Zajedno sa ostalim antioksidativnim komponentama, polifenoli i flavonoidi prisutni u voću i povrću igraju glavnu ulogu u prevenciji nekih bolesti, zbog svoje sposobnosti da sakupljaju slobodne radikale u biološkom sistemu (Halliwell, 1996). Plodovi sorti kajsije sadrže različite količine fenolnih jedinjenja, flavonoida i imaju značajan antioksidativni potencijal (Dragović-Uzelac et al., 2007; Schmitzer et al., 2011).

Brojni faktori utiču na bujnost stabla, prinos i kvalitet ploda kajsije. Među njima, glavni su: genetičko poreklo sorti (Badenes et al., 1998; Gurrieri et al., 2001;

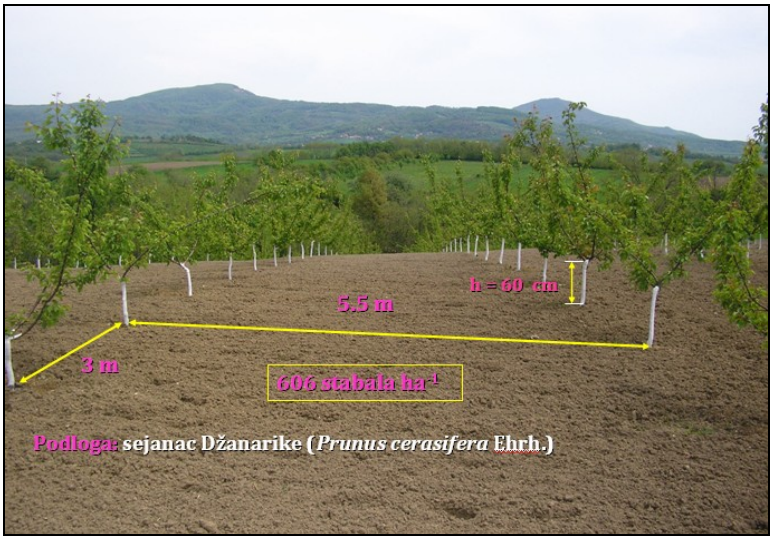
Asma i Ozturk, 2005; Ruiz i Egea, 2008), podloge (Son i Küden, 2003; Hernadez et al., 2010), klimatski i zemljišni uslovi (Audergon et al., 1991; Kalyoncu et al., 2009; Hegedűs et al., 2010), ali i način gajenja i mere nege zasada (Southwick i Yeager, 1999; Milosevic et al., 2011).

Iz ovih razloga, osnovni cilj našeg rada se sastoji u oceni bujnosti stabla, karakteristika rodnosti i najznačajnijih fizičkih i hemijskih osobina ploda dve inostrane (Harkot, Roksana) i tri domaće sorte (Aleksandar, Biljana, Vera) gajenih u tzv. polugustoj sadnji (600 stabala ha^{-1}) u ekološkim uslovima Čačka.

Materijal i metode rada

Biljni materijal, procedura ogleda, zemljišni i klimatski uslovi

Ogled je postavljen u selu Prislonica (43°53’ N; 20°21’ E, 340 m iznad mora) nedaleko od Čačka. Ispitivanja su obavljena u periodu od sadnje (proleće 2008) do 2012. godine (Slike 1-3). Ispitivanjima su obuhvaćene sorte Aleksandar, Biljana, Vera, Harkot i Roksana koje su kalemljene na sejancima džanarike (*P. cerasifera* Ehrh.) na visini od 60 cm od površine zemlje. Razmak sadnje je 5.5 m × 3.0 m, što odgovara gustini sadnje od 607 stabala ha^{-1}.



Slika 1. Zasad kajsije u kojem su vršena ispitivanja (T. Milošević, original)
The apricot orchard used for investigations (T. Milosevic, original)

Uzgojni oblik je vaza sa tri ramene grane. Svaka sorta u zasadu je zastupljena sa po 6 stabala u četiri ponavljanja. Tokom ispitivanja primenjivane su standardne mere nege zasada, izuzev navodnjavanja, Posebna pažnja je posvećena primeni rane letnje rezidbe u cilju kontrole bujnosti, stimulisanja pojave prevremenih rodnih

grančica, a time i kasnijeg cvetanja narednog proleća. Ona doprinosi izbegavanju rizika od eventualnog pospešivanja iznenadnog sušenja stabala, ukoliko bi rezidba bila primenjena u drugim terminima, posebno u periodu mirovanja.

Slika 2. Puno cvetanje u 2012. godini (T. Milošević, original)
Picture 2. Full blooming in 2012 (T. Milosevic, original)

Slika 3. Zrenje ploda u 2012. godini (T. Milošević, original)
Picture 3. Fruit ripening in 2012 (T. Milosevic, original)

Hemijska analiza zemljišta, obavljena pre sadnje, je pokazala da ono ima peskovito-ilovastu teksturu u dubini od 0-40 cm, srednje do slabo je obezbeđeno organskom materijom i ukupnim N (1,62% i 0,14%), dok je sadržaj dostupnog P, K, Ca i Mg iznosio 77,7 mg kg^{-1}, 182,6 mg kg^{-1}, 0.39%, odnosno 6,2 mg kg^{-1}. Zemljišni pH u 0,01 mol l^{-1} KCl je imao veoma nisku vrednost i iznosio je 4,86.

Klima je umereno-kontinentalna, sa umerenim do jakim zimama, toplim i srednje suvim do suvim letima. Lokalna količina padavina se kreće između 450 i 690 mm sa najvećom koncentracijom u pozno leto i u jesen, od čega u vegetaciji padne oko 400 mm. Srednja godišnja temperatura za višegodišnji period (1965-2010. godina) iznosi 11,3ºC, a vegetaciona 17,0ºC. Oštećenja od niskih zimskih temperatura u ferbruaru 2012. godine nisu registrovana u ovom zasadu (podaci nisu prikazani). Međutim, nedostak padavina u 2011. i 2012. godini, mogao je uticati na neke rezultate.

Merenja bujnosti i rodnosti stabla, mase i čvrstine ploda

Radi utvrđivanja bujnosti stabla, meren je prečnik debla (cm) pomoću mernog instrumenta Starrett 727 (Athol, MA, USA) na 20 cm od površine zemlje za svaku sortu na kraju svih vegetacija i na osnovu toga je izračunata površina poprečnog preseka debla (TCSA, cm^2). Prinos po stablu (kg) i kumulativni prinos po stablu (kg) su određeni na digitalnoj vagi ACS System Electronic Scale (Zhejiang, China). Koeficijent rodnosti - odnos između kumulativnog prinosa i finalnog TCSA (kg cm^{-2}) su obračunati na osnovu dobijenih podataka. Masa ploda i koštice (g) u fazi tehnološke zrelosti je merena na tehničkoj vagi Tehnica ET-1111 (Iskra, Horjul, Slovenija). Za tu svrhu, korišćeno je 20 plodova u četiri ponavljanja za svaku sortu. Na osnovu odnosa između njihovih masa izračunat je randman jestivog dela ploda (%). Čvrstina mezokarpa (kg cm^{-2}) je određena pomoću ručnog penetrometra Bertuzzi FT-327 (Facchini, Alfonsine, Italy).

Određivanje sadržaja ukupnih fenola i flavonoida i antioksidativnog potencijala

Sadržaj ukupnih felnola [mg ekvivalenata galne kiseline po g suvog ekstrakta ploda (mg GAE g^{-1})], ukupnih flavonoida [mg ekvivalenata rutina po g suvog ekstrakta ploda (mg RUE g^{-1})] i ukupni antioksidativni kapacitet [mg askorbinske kiseline po g suvog ekstrakta ploda (mg AA g^{-1})] su određeni spektrofotometrijski korišćenjem spektrofotometra MA9523-SPEKOL 211 (Iskra, Horjul, Slovenija), na osnovu metodologije koju su prethodno opisali Gutfinger (1981), Prieto et al. (1999), odnosno Brighente et al. (2007).

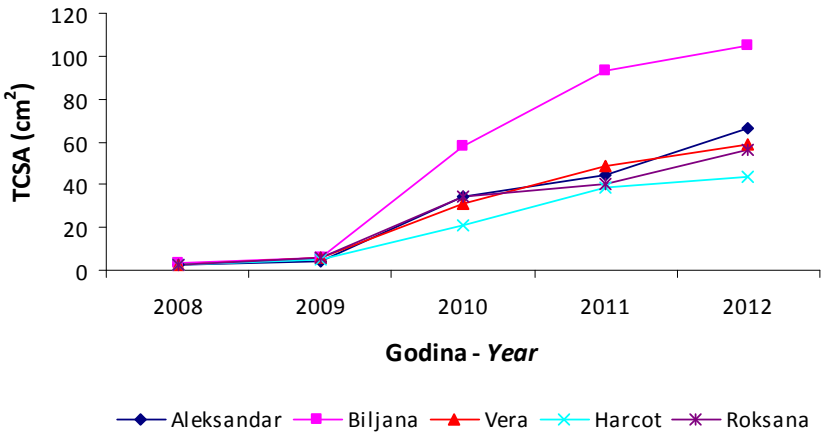
Statistička analiza

Dobijeni podaci su obrađeni analizom varijanse (ANOVA) pomoću softvera SPSS 7.0 (SPSS Inc., Chicago, IL, USA). Kada je *F* test bio značajan, sredine su upoređivane pomoću LSD testa za $P \leq 0.05$.

Rezultati istraživanja i diskusija

Rast stabla i komponente prinosa

Rast stabala ispitivanih sorti kajsije imao je očekivani uzlazni trend (Graf. 1). Razlike u bujnosti stabla po sortama u prvoj i drugoj godini (2008 i 2009) nisu bile značajne. Međutim, u sledeće tri godine razlike u bujnosti stabla bile su sve izraženije i statistički značajne. Najveća finalna bujnost je utvrđena kod Biljane, a najmanja kod sorte Harkot (Tab. 1). Sličnu bujnost su imali Vera i Roksana. Rezultati dobijeni u ovom radu nedvosmisleno ukazuju da Biljana kao bujna sorta kajsije može biti zanimljiva za gajenje na lošim zemljištima ili pak u monokulturi. Osim toga, u kombinaciji sa sejancem džanarike kao podlogom, a u uslovima sve većeg deficita padavina u tzv. kritičnim periodima za vlagu, koji su sve izraženiji u čitavoj zemlji, uključujući oblast oko Čačka, ova sorta može biti rešenje ovog problema, što je već ranije opisano za druge sorte bujnog stabla kalemljene na bujnim podlogama (Hernadez et al., 2010).



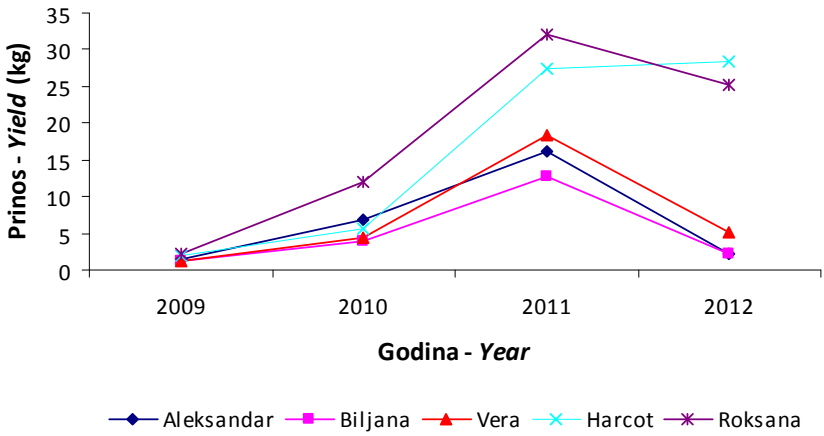
Grafikon 1. Promene površine poprečnog preseka debla (TCSA) sorti kajsije od prve do pete godine posle sadnje

Changes of trunk cross sectional area (TCSA) of apricot cultivars from the first to the fifth year after planting

Suprotno nekim podacima iz literature, Harkot je ispoljio najmanju bujnost stabla, verovatno zbog težeg prilagođavanja uslovima klime, a posebno zemljišta (Son i Küden, 2003). S druge strane, Roksana je pokazala da ima umeren rast stabla, čime je ispoljila veoma visok stepen prilagođavanja na uslove sredine i pogodnost za gušću sadnju što je već opisano u prethodnim radovima o kajsiji (Serafimov i Borisov, 1980; Milosevic et al., 2011).

U prvoj godini po sadnji (2009), prinos po stablu je bio veoma mali u svih sorti (oko 0,5 kg po stablu) i nije bilo značajnih razlika između njih (podaci nisu prikazani). Međutim, u narednim rodnim godinama (2010, 2011), prinos je očekivano rastao i sve sorte su se međusobno značajno razlikovale (Graf. 2). Trend povećanja rodnosti je u poslednjoj godini ogleda (2012) jedino registrovan u sorte Harkot. Kod Roksane prinos je pomenute godine bio za 24.4% manji u odnosu na prethodnu (2011). Sasvim neočekivano, drastičan pad prinosa u 2012. u odnosu na 2011. godinu registrovan je u Aleksandra, Biljane i Vere i to za 7.04, 5.98, odnosno 3.59 puta. Pošto u ovom zasadu nije bilo oštećenja cvetnih pupoljaka od mrazeva tokom februara 2012. godine (podaci nisu prikazani), a sve sorte su gajene u istim uslovima i isto negovane, pretpostavljamo da ove tri sorte, posebno Aleksandar i Biljana, imaju visoke zahteve prema optimalnim uslovima sredine za normalno formiranje rodnog potencijala, uzimajući u obzir činjenicu da od 29. jula do 19. septembra 2011. godine nije bilo padavina (podaci nisu prikazani). Nejasnoće u ovom pogledu za pomenute sorte biće predmet istraživanja u narednim godinama.

Podaci prikazani u tabeli 1. pokazuju da je daleko najveći prinos po stablu u 2012. godini utvrđen u sorti Harkot i Roksana. Obzirom na to, obe sorte imaju rano prorodevanje, brzo stupanje u rodnost i visok potencijal rađanja. Serafimov i Borisov (1980) i Mratinic et al. (2007) navode nešto niže vrednosti za Roksanu ističući da je njen prinos po stablu iznosio 24 kg u šestoj godini, odnosno 22 kg između 6 i 9. godine po sadnji.



Grafikon 2. Promene prinosa po stablu sorti kajsije od druge do pete godine posle sadnje
Changes of yield per tree of apricot cultivars from the second to the fifth year after planting

Visok potencijal rodnosti Roksane potvrđuju podaci koji se odnose na kumulativni prinos (Tabela 1), jer je imala daleko najveću vrednost. Slede je Harkot, Aleksandar, Vera i na kraju Biljana sa najmanjim kumulativnim prinosom.

Tabela 1. Karakteristike bujnosti i rodnosti stabla
Tree vigour and yield characteristics

Sorta *Cultivar*	PPPD* *TCSA* (cm^2) Godina - 2012 *Year - 2012*	Prinos (kg $stablo^{-1}$) *Yield* (kg $tree^{-1}$) Godina - 2012 *Year - 2012*	Kumulativni prinos (kg $stablo^{-1}$) *Cumulative yield* (kg $tree^{-1}$) 2009 - 2012	Koeficijent rodnosti *Yield efficiency* (kg cm^{-2})
Aleksandar	66.44 ± 3.77 b	2.31 ± 0.25 c	26.64 ± 3.38 c	0.40 ± 0.02 b
Biljana	105.08 ± 2.94 a	2.12 ± 0.47 c	17.71 ± 2.63 e	0.17 ± 0.01 c
Vera	57.52 ± 1.89 c	5.11 ± 0.31 b	23.95 ± 3.79 d	0.42 ± 0.03 b
Harkot	43.98 ± 2.21 d	28.51 ± 2.03 a	35.12 ± 7.00 b	0.80 ± 0.07 a
Roksana	56.02 ± 4.35 c	25.25 ± 1.14 a	46.17 ± 6.69 a	0.82 ± 0.05 a

* PPPD: površina poprečnog preseka debla / *TCSA: trunk cross sectional area*
Ista mala slova u kolonama označavaju slučajne razlike ($P \leq 0.05$) po LSD testu između sorti / *The same small letters in columns shows insignificant differences at $P \leq 0.05$ by LSD test among cultivars*.

Najveći koeficijent rodnosti je bio u sorti Roksana i Harkot, a najmanji u Biljane, jer prve dve sorte imaju najmanju bujnost stabla i dobar prinos, a Biljana najveću bujnost stabla i najmanju rodnost. Ove tendencije su utvrđene u prethodnim istraživanjima na kajsiji (Hernández et al., 2010). Vera i Aleksandar su imali slične vrednosti za ovaj parametar.

U literaturi se sreću kontradiktorni podaci vezani za rodnost kajsije na džanarici. Tako, Ondradu i Scalas (1999) ističu da sorte kajsije na ovoj podlozi imaju bolju rodnost nego na drugim, dok Son i Küden (2003) navode suprotno. Neusklađenost između rezultata različitih autora verovatno je rezultat jakog uticaja genotipa kajsije, primenjenih mera nege zasada i varijabilnih agro-klimatskih uslova pojedinih geografskih područja (Singh et al., 2010).

Fizičke osobine ploda

Podaci prikazani u tabeli 2. pokazuju da je Roksana u 95% slučajeva imala statistički značajno veću masu ploda u odnosu na ostale sorte. Dobra masa ploda je utvrđena kod Vere, zatim kod Aleksandra i Biljane. Prethodni radovi na kajsiji takođe ističu veliku varijabilnost između sorti u pogledu ove osobine (Badenes et al., 1998; Vachůn, 2003; Asma i Ozturk, 2005; Milošević et al., 2010). Dobijeni rezultati su veći od podataka Serafimova i Borisova (1980) i Mratinic et al. (2007) koji navode da je prosečna masa ploda Roksane iznosila 72 g, odnosno svega 53.2 g. Najmanju vrednost je imao Harkot što se razlikuje od rezultata do kojih su došli Milosevic et al. (2011) za ovu sortu. Varijacije mase ploda kajsije iz godine u godinu su prethodno opisane (Ruiz i Egea, 2008). Ovi podaci mogu biti od značaja za proizvođače kajsije prilikom izbora sortimenta za komercijalne zasade.

Tabela 2. Masa ploda i koštice, udeo jestivog dela i čvrstina ploda
Fruit and stone mass, flesh rate and flesh firmness

Sorta *Cultivar*	Masa ploda *Fruit mass* (g)	Masa koštice *Stone mass* (g)	Udeo jestivog dela *Flesh rate* (%)	Čvrstina ploda *Flesh firmness* (kg cm^{-2})
Aleksandar	66.40 ± 2.20 c	2.86 ± 0.07 c	95.66 ± 0.16 a	1.42 ± 0.02 c
Biljana	68.70 ± 1.11 c	3.59 ± 0.16 b	94.67 ± 0.37 b	2.07 ± 0.04 a
Vera	76.07 ± 2.21 b	4.33 ± 0.20 a	94.27 ± 0.32 b	2.12 ± 0.09 a
Harkot	50.08 ± 1.76 d	2.73 ± 0.06 c	94.47 ± 0.29 b	1.89 ± 0.01 b
Roksana	81.60 ± 2.32 a	3.82 ± 0.14 b	95.29 ± 0.20 a	1.47 ± 0.13 c

Ista mala slova u kolonama označavaju slučajne razlike ($P \leq 0.05$) po LSD testu između sorti.
The same small letters in columns shows insignificant differences at $P \leq 0.05$ by LSD test among cultivars.

Najveća masa koštice je utvrđena kod sorte Vera, a najmanja kod Aleksandra i Harkota (Tab. 2). Sorte Roksana i Biljana su imale srednje vrednosti ovog parametra. Masa koštice i njene dimenzije su veoma stabilne osobine gotovo svih predstavnika roda *Prunus* i služe za determinaciju i klasifikaciju njihovih sorti (Woldring, 2000). Naši podaci za masu koštice Roksane su približni rezultatima koje navode Mratinic et al. (2007).

Najbolji udeo jestivog dela ploda (randman) su imale sorte Aleksandar i Roksana, dok su sorte Biljana, Vera i Harkot imale značajno manje vrednosti koje se između njih nisu značajno razlikovale. Varijabilnost ovog parametra je prethodno utvrđena. Tako, Vachůn (2003) navodi da je udeo koštice u masi ploda 21 sorte kajsije varirao između 4.9% i 9.6%. Po istom autoru ova osobina je genetički uslovljena i potrošači i industrija zahtevaju plodove kajsije sa većim randmanom mezokarpa. Serafimov i Borisov (1980) navode da je udeo koštice u masi ploda Roksane oko 5% što su potvrdili naši rezultati.

Podaci prikazani u Tab. 2. pokazuju da su najveću čvrstinu mesa ploda imale sorte Vera i Biljana. Srednju vrednost je imao Harkot, dok su neočekivano najmanje vrednosti utvrđene kod Roksane i Aleksandra. Podaci iz literature ukazuju da je čvrstina ploda koštičavog voća značajan kvalitativni parametar od koga zavisi prihvatanje neke sorte od strane potrošača. Tako Cemagref (1981) i Scandella et al. (1998) navode da bi optimalne vrednosti čvrstine ploda kajsije, prihvatljive za potošače i prerađivačku industriju, trebalo da se kreću u rasponu od 0.5 do 3.0 kg cm^{-2}, što je slučaj u našem radu. Crisosto et al. (2005) navode da vrednosti čvrstine mezokarpa veće od 5.5 kg cm^{-2} uvek rezultiraju neprihvatljivim kvalitetom ploda.

Sadržaj ukupnih fenola i flavonoida i ukupni antioksidativni potencijal

Na osnovu statističke obrade rezultata, utvrđeno je da je sorta glavni faktor koji determiniše ukupan sadržaj fenola i flavonoida i antioksidativnu snagu ploda kajsije u ovom radu (Tab. 3). Najveći sadržaj ukupnih fenola je utvrđen u plodu sorte

Harkot, a najmanji u Roksane. U prethodnim istraživanjima kod kajsije takođe je utvrđeno da je sorta glavni izvor varijabiliteta u pogledu sadržaja ukupnih fenola (Kalyoncu et al., 2009). Prezrevanjem ploda kajsije, sadržaj fenola opada (Dragovic-Uzelac et al., 2007).

Tabela 3. Sadržaj ukupnih fenola i flavonoida i ukupni antioksidativni kapacitet
Total phenolics and flavonoids content and total antioxidant capacity

Sorta *Cultivar*	Sadržaj ukupnih fenola *Total phenolics content* (mg GAE g^{-1})	Ukupni sadržaj flavonoida *Total flavonoids content* (mg RUE g^{-1})	Ukupni antioksidativni kapacitet *Total antioxidant capacity* (mg AA g^{-1})
Aleksandar	13.20 ± 6.56 b	97.71 ± 1.99 a	12.72 ± 0.04 c
Biljana	12.32 ± 2.21 b	74.39 ± 3.67 b	17.98 ± 3.54 b
Vera	9.6 ± 1.05 c	43.53 ± 0.67 c	23.00 ± 0.03 b
Harkot	23.78 ± 0.72 a	5.01 ± 0.04 e	13.1 ± 0.18 c
Roksana	3.1 ± 2.06 d	10.10 ± 0.89 d	45.02 ± 4.06 a

Ista mala slova u kolonama označavaju slučajne razlike ($P \leq 0.05$) po LSD testu između sorti
The same small letters in columns shows insignificant differences at $P \leq 0.05$ by LSD test among cultivars

Kao i u slučaju ukupnih fenola, sadržaj ukupnih flavonoida je značajno varirao između sorti. Najveću količinu je imao plod Aleksandra, a najmanju plod Harkota. Dobijeni rezultati su mnogo veći u odnosu na rezultate do kojih su za neke grupe sorti kajsije došli Scalzo et al. (2005) i Kalyoncu et al. (2009) što je znak da osim sorte, na ovu osobinu utiču i drugi činioci kao što su ekološki uslovi, mere nege zasada, dužina perioda rasta i razvitka ploda, njegov položaj u krošnji, stanje zrelosti kao i korišćen analitički metod (Dragovic-Uzelac et al., 2007; Hegedűs et al., 2010).

U pogledu ukupnog antioksidativnog kapaciteta utvrđeno je da je plod Roksane imao najveću vrednost, zatim plod Vere i Biljane, dok su najmanji antioksidativni kapacitet imali plodovi sorti Harkot i Aleksandar. Hegedűs et al. (2010) navode da sorte kajsije ranijeg perioda zrenja ploda imaju manji antioksidativni potencijal što su potvrdili rezultati našeg rada. Takođe, podaci iz literature ukazuju da na ovu osobinu, osim sorte, značajnu ulogu imaju stepen zrelosti ploda, geografsko područje, nega zasada i sezona, odnosno godina (Scalzo et al., 2005; Schmitzer et al., 2011).

Zaključak

Dobijeni rezultati u ovom radu pokazuju da su na plitkom, peskovitom i kiselom zemljištu, u gustini sklopa od 607 stabala po hektaru, ispitivane sorte kajsije kalemljene na džanarici ispoljile umeren rast, dobru rodnost i fizičke i hemijske osobine ploda, osim Biljane i Aleksandra, koji su pokazali tendenciju bujnijeg rasta stabla i manje rodnosti. Značajno manju bujnost i daleko najbolju rodnost imale su

sorte Harkot i Roksana. Najveću masu ploda imale su Roksana i Vera, a najveći randman mezokarpa Aleksandar i Roksana. Najveću čvrstinu mezokarpa imali su plodovi Biljane i Vere. Najveći sadržaj ukupnih fenola je registrivan u plodu Harkota, ukupnih flavonoida u plodu Aleksandra, a najveći antioksidativni potencijal imao je plod Roksane. Sorta *per se* (genotip) je ispoljila veoma jak uticaj na ispitivane osobine. Ovaj način gajenja kajsije može biti interesantan za proizvođače kao alternativa klasičnom gajenju u smislu poboljšanja tehnologije gajenja u sličnim agroekološkim uslovima.

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Some Indicators of Successful Apricot (*Prunus armeniaca* L.) Growing in Semi-high Density Planting System

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Summary

The study focused on characterizing the five apricot cultivars grafted on Myrobalan to acknowledge the tree growth, precocity, yield performances, fruit and stone mass, their ratio, flesh firmness and some chemical traits grown on shallow, sandy and acidic soil with 600 trees ha^{-1} in Cacak region from 2008 to 2012. The cultivar *per se* (genotype) behaved as the most influencing factor conditioning apricot characteristics evaluated. All cultivars had moderate tree growth, good precocity yield, and fruit physical properties, except Biljana and Aleksandar, who tended to vigorous tree growth and lower yield. Smallest tree vigour and best yield had Harkot and Roksana cultivars. The highest fruit mass had Roksana and Vera, while the best flesh rate had Aleksandar and Roksana. The highest flesh firmness had Biljana and Vera. The highest content of total phenolic compounds was registered in the fruit of Harcot, total flavonoids content in Aleksandar, and the highest antioxidant potential had fruit of Roksana. Generally, all cultivars on Myrobalan rootstock with 600 tree ha^{-1} had good adaptation capability to shallow, sandy and acidic soil and respectable fruit physical and chemical attributes, and also had good potential as a commercial fruit for fresh and processing markets in similar conditions.

Key words: Antioxidant capacity, tree vigour, apricot, fruit and stone mass, yield, semi-high density planting.

Originalni naučni rad

OSETLJIVOST SORTI KAJSIJE NA ZIMSKI I POZNI PROLEĆNI MRAZ

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Izvod. U radu je ispitivan je uticaj zimskog i poznog prolećnog mraza na izmrzavanje generativnih organa kod 33 sorte kajsije na području beogradskog Podunavlja u toku 2012. godine. Apsolutna minimalna temperatura od -20,7°C zabeležena je 9. februara, dok je 10. aprila došlo do pojave poznog prolećnog mraza intenziteta -3,0°C. Prosečno izmrzavanje cvetnih pupoljaka od zimskog mraza iznosilo je 32,8%, sa variranjem od 12,1% kod sorte NS-6 do 98,8% kod sorte Mary Lady. Pozni prolećni mraz, koji se javio nakon završetka cvetanja, doveo je do prosečnog izmrzavanja od 61,4% plodića, sa variranjem od 18,1% kod sorte Bergarouge do 93,0% kod sorte Silvercot. Iako su zimski i pozni prolećni mraz uticali na značajno smanjenje roda, 11 sorti je i pored toga dalo zadovoljavajući prinos (više od 10 kg po stablu). Najviši prinos su dale sorte Harcot, Litoral i Re Umberto.

Ključne reči: *Prunus armeniaca*, zimski mraz, pozni prolećni mraz, cvetni pupoljci, plodići, prinos.

Uvod

Niske temperature u toku zime i proleća su jedan od ograničavajućih faktora za uspešno gajenje kajsije, naročito u zemljama sa hladnijom klimom. One mogu izazvati izmrzavanje cvetnih pupoljaka, cvetova i zametnutih plodića, a time i smanjenje ili potpuni gubitak roda. Otpornost kajsije na mrazeve je pre svega genetski uslovljena, odnosno zavisi od sorte. Pored toga, na nju utiču i drugi faktori, kao što su vreme pojave, dužina trajanja i intenzitet niskih temperatura, pripremljenost voćaka za mirovanje (bujnost, rodnost, agrotehničke mere, zdravstveno stanje), podloga na kojoj su voćke kalemljene, starost voćaka.

Kajsija je najotpornija na zimske mrazeve u periodu dubokog (biološkog) zimskog mirovanja, koji se u našim klimatskim uslovima odvija u decembru i prvoj polovini januara. Layne i Gadsby (1995) su kod 27 sorti i selekcija kajsije u uslovima Kanade utvrdili da je prosečna LT_{50} (temperatura na kojoj izmrzava 50% organa) za cvetne pupoljke u periodu dubokog mirovanja bila -28,7°C. Szalay et al. (2006) su kod 20 sorti kajsije u uslovima Mađarske utvrdili da je vrednost LT_{50} za cvetne pupoljke u toku dubokog zimskog mirovanja iznosila od -18 do -25°C.

Ispitivanjem osetljivosti cvetnih pupoljaka sorti kajsije na zimske mrazeve u našoj zemlji se bavilo više autora. Đurić (1987) je u uslovima Fruške Gore u toku dve zime ispitivao uticaj temperature od oko -20°C, koja se javila krajem januara, na izmrzavanje cvetnih pupoljaka kod 60 sorti kajsije i utvrdio je stepen oštećenja od 15-80%. Najveću otpornost pokazale su sorte Alfred i Nikitskij. Pejkić et al. (1987) su ispitivali osetljivost sorti kajsije na zimske mrazeve intenziteta od -20°C do -24°C, koji su se javili tokom januara i februara u tri lokaliteta (Subotica, Beograd-Krnjača i Čačak). Oštećenja su varirala od 3-95%. Najveću otpornost ispoljile su sorte Kečkemetska ruža i Krupna rana, dok su najosetljivije bile sorte Blen Ril, Nugget i Stark Early Orange. Miletić et al. (2006) su ispitivali uticaj zimskog mraza intenziteta -18°C, koji se javio krajem januara na izmrzavanje cvetnih pupoljaka kajsije u okolini Čačka i utvrdili su prosečno oštećenje od 67,9%.

Jaki zimski mrazevi predstavljaju značajan limitirajući faktor za podizanje zasada kajsije, jer se u većem delu naše zemlje mogu javiti sa verovatnoćom 30% do 40%. Najmanja verovatnoća pojave ovih mrazeva je u beogradsko-smederevskom Podunavlju, koje je i najznačajnije proizvodno područje kajsije u Srbiji. U ovom području se može očekivati da će u dve od deset godina doći do pojave jakih zimskih mrazeva. U ostalim proizvodnim područjima kajsije, kao što su Vojvodina, dolina Zapadne i Južne Morave i južna Srbija verovatnoća pojave jakog zimskog mraza je nešto veća i on se može očekivati tri puta u deset godina (Radičević et al., 2011).

Stupanjem kajsije u ekološko zimsko mirovanje povećava se njena osetljivost na mraz. Szalay et al. (1999) su utvrdili da postoji značajna korelacija između stadijuma mikrosporogeneze i stepena otpornosti cvetnih pupoljaka kajsije na mraz. Nastupanjem mejoze u materinskim ćelijama polena otpornost na mraz se značajno smanjuje. U početnom periodu ekološkog zimskog mirovanja temperature od -18°C mogu izazvati značajna oštećenja, dok su u kasnijoj fazi kritične temperature od -10 do -15°C (Milatović, 2013).

U našim klimatskim uslovima kajsija je najosetljivija na mraz u periodu pred cvetanje, u fenofazi cvetanja ili neposredno nakon cvetanja. Pozni prolećni mrazevi u su najznačajniji činilac neredovne rodnosti kajsije i oni nanose veće štete proizvodnji u odnosu na zimske mrazeve. Đurić i Keserović (2007) navode da zatvoreni cvetovi kajsije izmrzavaju na -3 do -4°C, otvoreni cvetovi na -2 do -3°C, a mladi plodići na -1 do -2,5°C. Szabo (2003) navodi da su generativni organi najosetljiviji na prolećni mraz u periodu od punog cvetanja do neposredno nakon zametanja. Kod mladih plodića najosetljivije su njihove semenke zbog visokog sadržaja vode.

Pozni prolećni mrazevi umerenog i jakog intenziteta u vreme cvetanja kajsije su uobičajena pojava u klimatskim uslovima Srbije. Rizik od pojave mraza umerenog intenziteta (-2,1 do -4,0°C) je najmanji na području Beograda i Vranja, jer se tu umeren mraz može javiti jednom u deset godina. Verovatnoća pojave umerenog mraza u većem delu Vojvodine i Podunavlju je 20%, u centralnoj Srbiji, Negotinskoj Krajini i dolinama Morave i Ibra 30%, dok je u istočnoj i zapadnoj Srbiji 40%. Jak prolećni mraz (ispod -4,1°C) u vreme cvetanja kajsije u većem delu proizvodnog

područja Srbije javlja se jednom u deset godina, dok se u istočnoj Vojvodini i delu istočne Srbije javlja svake pete godine (Radičević et al., 2011).

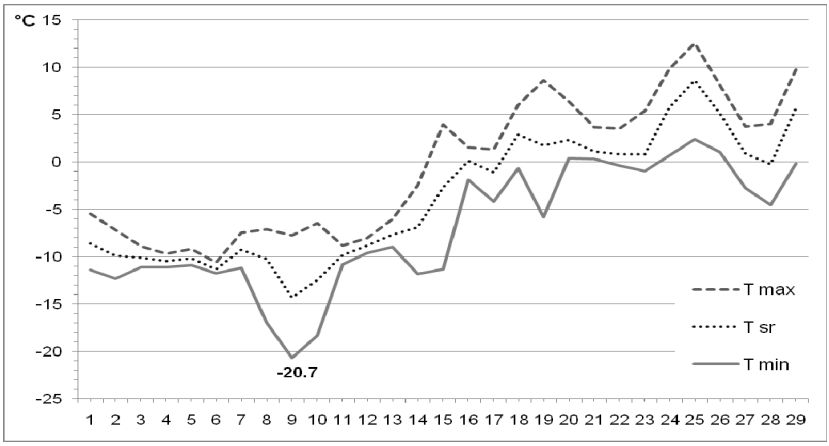
Cilj ovog rada je bio da se na utvrdi stepen osetljivosti na zimski i pozni prolećni mraz kod većeg broja sorti kajsije. Dobijeni rezultati će biti od koristi za izbor sorti za gajenje na području beogradskog Podunavlja, kao i u drugim područjima sa sličnim klimatskim uslovima.

Materijal i metode

Ispitivanja su obavljena u kolekcionom zasadu kajsije na Oglednom dobru „Radmilovac“ Poljoprivrednog fakulteta iz Beograda. Ogledni zasad je podignut 2007. godine, podloga je sejanac džanarike (*Prunus cerasifera* Ehrh.), a razmak sadnje 4,5 x 3 m. Proučavane su 33 sorte kajsije, od kojih je sedam poreklom iz Kanade (Harcot, Harlayne, Harojem, Harojoy, Harostar, Laycot i Veecot), šest iz Italije (Aurora, Mary Lady, Ninfa, Pisana, Portici i Vitillo), pet iz Francuske (Bergeron, Bergarouge, Pinkcot, Silvercot i Sylred), po tri iz Srbije (Novosadska rodna, NS-4 i NS-6), SAD (Goldrich, Robada i Tomcot), Mađarske (Cegledi arany, Cegledi biborkajszi i Magyar kajszi C.235) i Rumunije (Litoral, Neptun i Re Umberto), i po jedna iz Češke (Leskora), Bugarske (Roxana) i Južnoafričke Republike (Palstein).

Meteorološki podaci su korišćeni sa automatske meteorološke stanice koja se nalazi na Oglednom dobru „Radmilovac“, na nadmorskoj visini od 112 m i udaljena je oko 200 m od oglednog zasada.

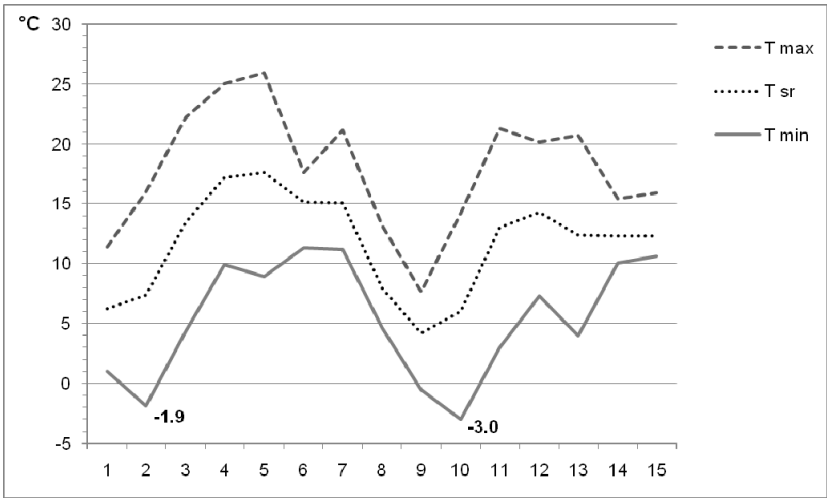
U prvoj polovini februara 2012. godine na području Srbije je zabeleženo ekstremno hladno vreme i obilne snežne padavine, koje su uslovile formiranje visokog snežnog pokrivača. Na OD „Radmilovac“ apsolutna minimalna temperatura od -20,7°C zabeležena je 9. februara (Grafikon 1).



Grafikon 1. Temperature vazduha na OD „Radmilovac“ u februaru 2012. god.
Air temperatures in Experimental farm „Radmilovac“ in February 2012

Početkom marta, od svake sorte je uzeto po 10 dugih (mešovitih) rodnih grančica. One su stavljene u tegle sa vodom na sobnu temperaturu. Posle deset dana određen je stepen izmrzavanja prebrojavanjem izmrzlih i neoštećenih cvetnih pupoljaka. Broj analiziranih cvetnih pupoljaka je bio u proseku oko 300.

U drugoj polovini marta 2012. godine je bilo relativno toplo vreme, sa maksimalnim dnevnim temperaturama od 15-25°C. To je uslovilo rano cvetanje kajsije, koje je bilo u periodu od 22. marta do 2. aprila. U prvoj polovini aprila u dva navrata su zabeleženi pozni prolećni mrazevi (Grafikon 2). Prvi mraz se javio 2. aprila i bio je intenziteta -1,9°C, a drugi mraz se javio 10. aprila i imao je intenzitet od -3,0°C. Pored jačeg intenziteta, drugi mraz se odlikovao i znatno dužim trajanjem, koje je iznosilo osam časova (od 23 sata uveče do 7 sati ujutro).



Grafikon 2. Temperature vazduha na OD „Radmilovac“ u aprilu 2012. god.
Air temperatures in Experimental farm „Radmilovac“ in April 2012

Nakon pojave poznog prolećnog mraza, od svake sorte je analizirano po 300 zametnutih plodoća. Plodići kod kojih su semeni zameci imali braon boju, evidentirani su kao izmrzli. Prinos je određivan merenjem mase ubranih plodova i izražen je u kg po stablu.

Dobijeni podaci su obrađeni statistički metodom analize varijanse. Značajnost razlika između srednjih vrednosti utvrđena je pomoću LSD testa.

Rezultati i diskusija

Rezultati ispitivanja osetljivosti sorti kajsije na zimski i pozni prolećni mraz prikazani su u tabeli 1.

Tabela 1. Osetljivost cvetnih pupoljaka na zimski mraz (-20,7°C, 9. februar 2012) i plodića na pozni prolećni mraz (-3,0°C , 10. april 2012) kod sorti kajsije
Susceptibility of flower buds to winter frost (-20,7°C, 9 February 2012) and flowers to spring frost (-3.0°C, 10 April 2012) in apricot cultivars

Sorta *Cultivar*	Broj izmrzlih cvetnih pupoljaka od zimskog mraza *Flower bud injury from winter frost* (%)	Obilnost cvetanja (Skala 0-5) *Abundance of flowering (0-5 Scale)*	Broj izmrzlih cvetova od prolećnog mraza *Flower injury from spring frost* (%)	Prinos (kg po stablu) *Yield (kg per tree)*
Aurora	53,4	2,2	72,7	0,2
Bergarouge	15,6	3,5	18,1	13,2
Bergeron	21,5	3,0	77,3	9,2
Cegledi Arany	19,0	3,5	60,0	8,5
Cegledi biborkajszi	45,3	2,7	67,0	8,2
Goldrich	35,7	3,5	91,0	5,7
Harcot	18,7	5,0	25,9	16,4
Harlayne	14,6	4,8	45,3	10,3
Harojem	22,4	4,0	38,0	10,6
Harojoy	16,7	4,3	74,3	4,8
Harostar	13,4	3,5	77,7	5,1
Laycot	17,3	4,5	87,7	3,2
Leskora	20,2	4,0	84,0	6,6
Litoral	28,2	4,2	35,1	15,6
Magyar kajszi C.235	24,3	1,2	50,6	2,0
Mary Lady	98,8	0,1	-	0,0
Neptun	27,3	3,5	92,0	5,8
Ninfa	58,8	1,5	23,8	3,6
Novosadska rodna	17,7	4,0	72,9	5,6
NS-4	20,6	4,2	49,7	10,9
NS-6	12,1	4,0	41,7	11,6
Palstein	95,3	0,2	-	0,0
Pinkcot	38,2	2,5	68,7	6,2
Pisana	41,1	3,5	72,3	9,4
Portici	33,8	2,7	23,7	10,3
Re Umberto	16,8	4,5	46,6	14,3
Robada	36,8	1,5	84,0	1,6
Roxana	27,7	4,0	54,0	11,4
Silvercot	21,1	3,3	93,0	0,5
Sylred	17,3	2,2	73,0	6,7
Tomcot	54,4	2,7	87,0	4,7
Veecot	34,8	3,8	38,3	11,2
Vitillo	57,8	2,0	77,7	5,6
Prosečno / *Average*	**32,8**	**3,2**	**61,4**	**7,2**
LSD 0,05	15,2	-	12,9	
LSD 0,01	20,0	-	17,1	

Prosečno izmrzavanje cvetnih pupoljaka usled pojave zimskog mraza (-20,7°C od 9. februara) za sve ispitivane sorte kajsije je iznosilo 32,8%. Izmrzavanje je bilo najveće kod italijanske sorte Mary Lady (98,8%), a najmanje kod domaće sorte NS-6 (12,1%). Razlike između sorti su bile statistički veoma značajne.

Na osnovu osetljivosti cvetnih pupoljaka na zimski mraz ispitivane sorte kajsije su podeljene u četiri grupe:

1. Veoma osetljive sorte (izmrzavanje veće od 70%): Palstein i Mary Lady.
2. Osetljive sorte (izmrzavanje 50-70%): Aurora, Tomcot, Vitillo i Ninfa.
3. Srednje osetljive sorte (izmrzavanje 30-50%): Portici, Veecot, Goldrich, Robada, Pinkcot, Pisana i Cegledibiborkajszi.
4. Relativno otporne sorte (izmrzavanje ispod 30%): NS-6, Harostar, Harlayne, Bergarouge, Harojoy, Re Umberto, Laycot, Sylred, Novosadska rodna, Harcot, Cegledi arany, Leskora, NS-4, Silvercot, Bergeron, Harogem, Magyar kajszi C.235, Neptun, Roxana i Litoral.

Posmatrano po zemljama porekla, može se reći da su najveću otpornost na zimske mrazeve pokazale sorte koje potiču iz Kanade. Takođe, dobru otpornost su ispoljile sorte koje potiču iz Srbije i Rumunije, kao i većina sorti iz Mađarske i Francuske. Najveću osetljivost su pokazale sorte poreklom iz Italije i SAD.

Usled izmrzavanja cvetnih pupoljaka kod pojedinih sorti je značajno smanjena obilnost cvetanja (Mary Lady, Palstein, Aurora, Ninfa, Pinkcot, Tomcot). Međutim, treba istaći da razlog manje obilnosti cvetanja kod nekih sorti, kao što su Magyar kajszi C.235 i Sylred, nisu bila oštećenja od zimskog mraza, već drugi razlozi (slabije diferenciranje cvetnih pupoljaka ili prevelika rodnost u prethodnoj godini).

Naši rezultati o otpornosti pojedinih sorti kajsije na zimski mraz u skladu su sa rezultatima koje su dobili drugi autori u laboratorijskim uslovima. Layne i Gadsby (1995) su ispitivali otpornost na zimske mrazeve kod 27 sorti i selekcija kajsije, a kao standard su koristili sortu Goldcot, koja ima visoku otpornost. Veću otpornost u odnosu na standard je imala sorta Harlayne, približno istu sorte Harcot i Harogem, a nižu sorta Veecot. Takođe, Szalay et al. (2006) su ispitivali osetljivost cvetnih pupoljaka na niske temperature kod 20 sorti kajsije u toku dubokog zimskog mirovanja. U otporne sorte su svrstali Bergeron, Harlayne i Veecot, u srednje otporne Litoral, a u osetljive Ceglédi biborkajszi.

Naši podaci o oštećenjima cvetnih pupoljaka kod sorti kajsije Bergeron, Roxana, Magyar kajszi C235 i Ceglédi biborkajszi su bili neznatno niži u odnosu na podatke koje navodi Đurić (1987). Od navedenih sorti najveću otpornost je pokazala Bergeron, a najveću osetljivost Ceglédi biborkajszi, što su potvrdili i rezultati našeg istraživanja.

Prosečno vreme cvetanja ispitivanih sorti kajsije je bilo od 22. marta do 2. aprila. Usled visokih temperatura u ovom periodu cvetanje je bilo eksplozivno i trajalo je 5-6 dana. Nakon završetka cvetanja, 10. aprila je došlo do pojave poznog mraza sa temperaturom od -3,0°C. U momentu pojave ovog mraza zametnuti plodoći kajsije su imali prečnik od 5-12 mm.

Prosečno izmrzavanje plodića usled pojave poznog prolećnog mraza je bilo 61,4%. Najmanje oštećenje je bilo kod sorte Bergarouge (18,1%), a najveće kod sorte Silvercot (93,0%). Razlike između sorti su bile statistički veoma značajne.

Iako je otpornost na pozni prolećni mraz genetički determinisana (Rodrigo, 2000), veći uticaj na stepen oštećenja ima intenzitet i dužina trajanja mraza, kao i fenološka faza u kojoj se nalaze reproduktivni organi. Iako se smatra da su sorte kajsije koje cvetaju ranije osetljivije na pozne prolećne mrazeve, u nekim istraživanjima nije utvrđena korelacija između vremena cvetanja kajsije i oštećenja od ovih mrazeva (Bassi et al., 1995; Szabo, 2003). U našem istraživanju takođe nije utvrđena korelacija između vremena cvetanja i oštećenja plodića kajsije od mraza.

Đurić (1983) je u uslovima Vojvodine ispitivao osetljivost plodića većeg broja sorti kajsije na mraz koji se javio krajem aprila u toku dve godine. Mraz jačine -2,4°C uticao je na izmrzavanje 18-100% plodića, dok je mraz jačine -1,1°C uticao na izmrzavanje 0-56% plodića.

Izmrzavanje cvetnih pupoljaka usled pojave zimskog mraza, kao i izmrzavanje plodića usled pojave poznog prolećnog mraza uticalo je na znatno smanjenje prinosa kajsije u 2012. godini. Kod četiri sorte je praktično izostao rod u ovoj godini (Mary Lady, Palstein, Aurora i Silvercot). Prosečan prinos u ovoj godini za sve sorte je iznosio 7,2 kg po stablu (ili 5,3 t/ha). U poređenju sa prethodnom godinom (2011), kada je prosečan prinos bio 16,6 kg po stablu ili 12,3 t/ha, to je smanjenje od 57%. Ipak, treba istaći da je, uprkos pojavi zimskog i poznog prolećnog mraza, dobijen prinos veći od 10 kg po stablu kod 11 sorti kajsije. Najviši prinos su dale sorte Harcot, Litoral i Re Umberto.

Dobijeni podaci o prinosu su u skladu sa rezultatima koje navode Szabó et al. (1995). Oni ističu da se pri dobrim uslovima za oprašivanje i oplođenje kod kajsije može dobiti visok prinos ako u toku zime izmrzne 30-40%, a prosečan prinos ako izmrzne 50-80% od ukupnog broja cvetnih pupoljaka.

Zaključak

Zimski mraz intenziteta -20,7°C koji se javio 9. februara 2012. godine uslovio je prosečno izmrzavanje cvetnih pupoljaka od 33% za sve ispitivane sorte kajsije. Izmrzavanje je bilo najveće kod sorti Mary Lady (99%) i Palstein (95%), a najmanje kod sorte NS-6 (11%).

Pozni prolećni mraz intenziteta -3,0°C koji se javio 10. aprila 2012. godine, nakon završetka cvetanja, doveo je do prosečnog izmrzavanja od 61% zametnutih plodića. Najmanje oštećenje je bilo kod sorte Bergarouge (18%), a najveće kod sorte Silvercot (93%).

Usled pojave zimskog i poznog prolećnog mraza, došlo je do značajnog smanjenja prinosa kajsije. Kod četiri sorte je praktično izostao rod (Mary Lady, Palstein, Aurora i Silvercot). Najviši prinos imale su sorte Harcot, Litoral i Re Umberto.

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Susceptibility of Apricot Cultivars to Winter and Late Spring Frosts

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Summary

The influence of winter and spring frost on the injury of flower buds and flowers was studied in 33 apricot cultivars during 2012 year. The experimental orchard was planted in 2007 at the Experimental farm “Radmilovac” of the Faculty of Agriculture in Belgrade. The rootstock is Myrabolan (*Prunus cerasifera* Ehrh.) seedling, and the tree spacing is 4 x 1.5 m.

Winter frost intensity of -20.7°C, which occurred on 9th February, caused the average injury of 32.8% of flower buds for all studied apricot cultivars. Frost damage was highest in cultivar ‘Mary Lady’ (98.8%), and lowest in cultivar ‘NS-6’ (12%).

Spring frost intensity of -3.0°C occurred on 10th April, after apricot cultivars finished flowering. It caused the average injury of 61.4% of fruitlets. The damage was lowest in cultivar ‘Bergarouge’ (18.1%), and the highest in cultivar ‘Silvercot’ (93.0%).

Due to the occurrence of winter and late spring frosts, there was a signifiucant reduction in yield of apricot. The average yield for all cultivars was 7.2 kg per tree. Four cultivars practically had no yield (‘Mary Lady’, ‘Palstein’, ‘Aurora’, and ‘Silvercot’). The highest yield was found in cultivars ‘Harcot’, ‘Litoral’, and ‘Re Umberto’.

Key words: *Prunus armeniaca*, winter frost, spring frost, flower buds, fruitlets, yield.

Original paper

EFFECT OF SOME SOIL HERBICIDES ON THE VEGETATIVE HABITS OF THE PLUM-APRICOT CULTIVAR ‘STANDESTO’ IN A NURSERY

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Abstract. The trials were carried out in the period 2010-2012 in a fruit tree nursery established on the territory of the Fruit-Growing Institute – Plovdiv. The experiment aimed at studying the effect of the combined soil herbicide metolachlor + oxyfluorfen (Metofen) and the contact soil herbicide with a leaf effect flumioxazin (Pledge 50 WP) on the vegetative habits of the cultivar ‘Standesto’ grafted on the apricot seedling rootstock. In the period 15-25 March, before the beginning of vegetation, treatment with the soil herbicides was applied in the row strip in a second-year nursery. The following variants were set: 1. Control (untreated, hand-weeded); 2. Metofen – 1.2 l/ha; 3. Metofen – 2.4 l/ha; 4. Pledge 50 WP – 80 g/ha; 5. Pledge 50 WP – 200 g/ha.

The effect of the herbicides on weed infestation and on the vegetative habits of the cultivar/rootstock combination ‘Standesto’/apricot seedling rootstock was followed up.

The results showed that the herbicides applied at the studied rates provided good weed control, the duration of the herbicide efficacy lasting for 3.5 – 4 months. That enabled the elimination of the competitive effect of the weeds on the development of the grafted plants for about a 4-5-month period after the beginning of vegetation.

Neither visual symptoms of phytotoxicity (chlorosis or necrosis in the leaves and shoots), nor an obvious suppression of the grafted tree development was observed in the variants treated with the herbicides. In a second-year nursery, the application of Metofen at the rate of 1.20 -2.40 l/ha or Pledge 50 WP at the rate of 80.0 g/ha could be recommended for weed control. Treatment with higher rates of Pledge 50 WP causes plant growth suppression.

Key words: herbicides, weeds, plum – apricot cultivar Standesto , vegetative habits.

Introduction

Weed vegetation is the major factor of growth suppression of rootstocks and grafted trees in the fruit tree nurseries. That is why the application of efficient herbicides with proven selectivity to the cultivar/rootstock combination is a very important part of the complex of agrotechnical activities for the successful production of planting material. The first vegetation period in the nursery when the rootstocks are at the stage of emergence and initial growth, is risky for the incidence of phytotoxicity and some plant damages (Rankova, 2011; Rankova and Tityanov,

2013). During the second year of the planting material production process the application of herbicides is also a necessary and important technological practice with the aim of providing good conditions for the development of the grafted cultivars by maximal elimination of the weed competition for the vegetation factors. That is why it is necessary to study the habits of the cultivar/rootstock combination after treatment with herbicides with the aim of obtaining greater quantities of standard planting material per unit of area.

In previous studies it was established that treatment with two new herbicides – Metofen applied at the rate of 1.20 l/ha and Pledge 50 WP at the rate of 80 g/ha did not have a suppressing effect on the development of apricot seedling rootstocks (Rankova and Tityanov, 2013). Best quality planting material of rootstocks was produced and in August the rootstocks were grafted with the new Bulgarian plum-apricot cultivar ‘Standesto’.

The aim of the present study was to establish the effect of the two soil herbicides – the combined soil herbicide metolachlor + oxyfluorfen (Metofen) and the contact soil herbicide with a leaf effect flumioxazin (Pledge 50 WP) – on the vegetative habits of the cultivar/rootstock combination ‘Standesto’ grafted on an apricot seedling rootstock and to recommend efficient rates to be applied in order to develop a system of weed control in the fruit tree nurseries during the second year of the planting material production cycle.

Material and methods

The trials were carried out in the period 2010-2012 on an experimental plot of the nursery established on the territory of the Fruit-Growing Institute – Plovdiv.

The effect of the active substances metolachlor and oxyfluorfen (Metofen) and flumioxazin (Pledge 50 WP) on the vegetative habits of the cultivar/rootstock combination ‘Standesto’ grafted on an apricot seedling rootstock was studied. The plumcot cultivar ‘Standesto’ was established by crossing of the plum cultivar ‘Stanley’ with the apricot cultivar ‘Modesto’. It was officially recognized in February 2012 and in practice, that is the first Bulgarian plum-apricot cultivar (Zhivondov, 2012). Each of the hybrids was applied at two rates. In the period 15-25 March, before the beginning of vegetation, the experimental plot of the second-year nursery was treated with the soil herbicides. The following variants were set: 1. Control (untreated, hand-weeded); 2. Metofen – 1.2 l/ha; 3. Metofen – 2.4 l/ha; 4. Pledge 50 WP – 80 g/ha; 5. Pledge 50 WP – 200 g/ha.

The control was maintained free of weeds by hand weeding carried out every 30 days. During the vegetation period the plants were grown following the conventional technology.

For the evaluation of the herbicide efficiency of the applied herbicides during vegetation, weed infestation level was reported in the separate variants in dynamics, every 30 days after the date of treatment until the end of the herbicide post-effect, following the quantity-weight method.

During the vegetation period, observations were carried out on the eventual appearance of external symptoms of phytotoxicity on the grafted plants and for obvious suppression of growth.

In October, when the trees were dug out, quality grading was performed according to the biometric characteristics stem height (cm), stem thickness (mm), measured at 15 cm above the place of grafting) and mean annual shoot length increment (cm). The obtained results were processed by the dispersion analysis method.

Results and discussion

Weed association in the fruit tree nursery in the experimental field of the Fruit-Growing Institute – Plovdiv is characterized as the “arable type”, i.e. the prevailing weeds belong to the group of annual early and late spring weed species. The development of the following grassy weed species was reported: ivy leaf speedwell (Veronica hederifolia L.), blackgrass (*Alopecurus myosuroides* L.), groundsel (*Senecio vulgaris* L.), field brome (*Bromus arvensis* L.), wall barley (*Hordeum murinum* L.), white goosefoot (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), prostrate knotweed (*Polygonum aviculare* L.), purslane (*Portulaca oleracea* L.), horseweed (*Erigeron canadensis* L.).

All the herbicides applied at the tested rates showed a good control of weed infestation and the post-effect lasted for about 3,5 – 4 months. That helped to eliminate the competitive influence of the weeds on the development of the grafted trees for a 4-5-month period after the beginning of vegetation. The herbicide effect subsided about 120 days after treatment, i.e. at the beginning of August.

The major representatives in the weed association in the period when the herbicide post-effect subsided, were the late spring species purslane (*Portulaca oleracea* L.) and horseweed (*Erigeron canadensis* L.), (Rankova and Tityanov, in print). Directed treatment (protecting the foliage of the trees) with the total leaf contact herbicide diquat – Reglon Forte – 3.50 l/ha was applied against late weed infestation in the tree nursery.

Neither visual symptoms of phytotoxicity (chlorosis or necrosis in the leaves and shoots), nor an obvious growth suppression was observed in the grafted trees in the variants treated with the herbicides. That lead to the conclusion that the apricot seedling rootstocks in a first-year nursery show higher susceptibility after treatment with herbicides compared to cultivars grafted on them in a second-year nursery (Rankova and Tityanov, 2013).

The results of the biometric analysis of the plum-apricot cultivar ‘Standesto’ grafted on the apricot seedling rootstock, after treatment with the herbicides included in the study, were presented in Fig. 1. Data in the separate years of the investigation showed the same tendency and they were discussed as average values.

The plants treated with the two rates of Metofen (Var. 2 and 3) and the lower rate of Pledge 50 WP (Var. 4) had higher or close to the control variant values of the reported biometric characteristics (Figures 1-3). That led to the conclusion that those applied rates of the herbicides did not exert a depressing effect on the growth and development of the grafted trees.

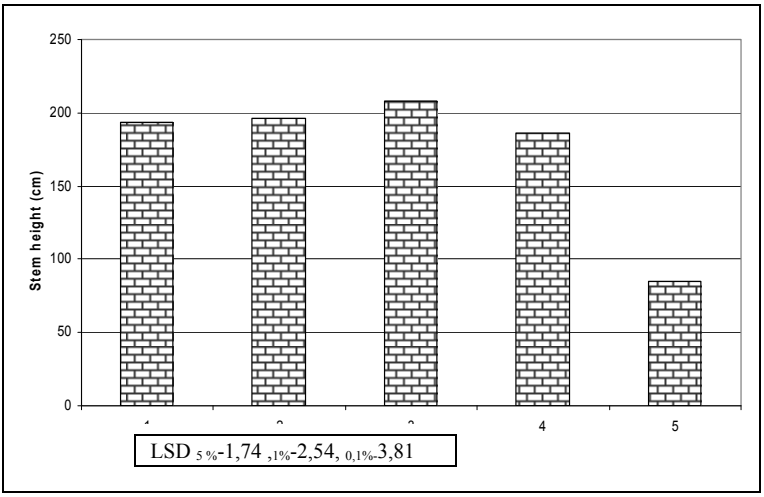

Figure 1. Effect of the soil herbicides on the stem hight (cm) of the nursery trees of plum-apricot cultivar ‘Standesto’ grafted on the apricot seedling rootstock

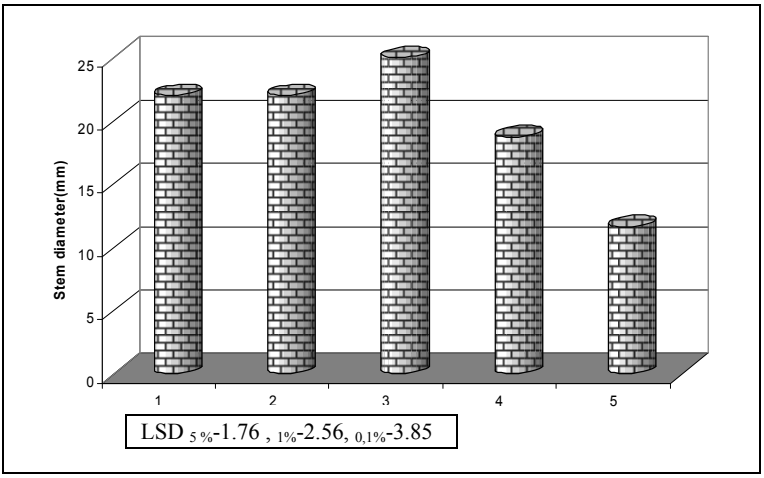

Figure 2. Effect of the soil herbicides on the stem diameter 8 mm) of the nursery trees of plum-apricot cultivar ‘Standesto’ grafted on the apricot seedling rootstock

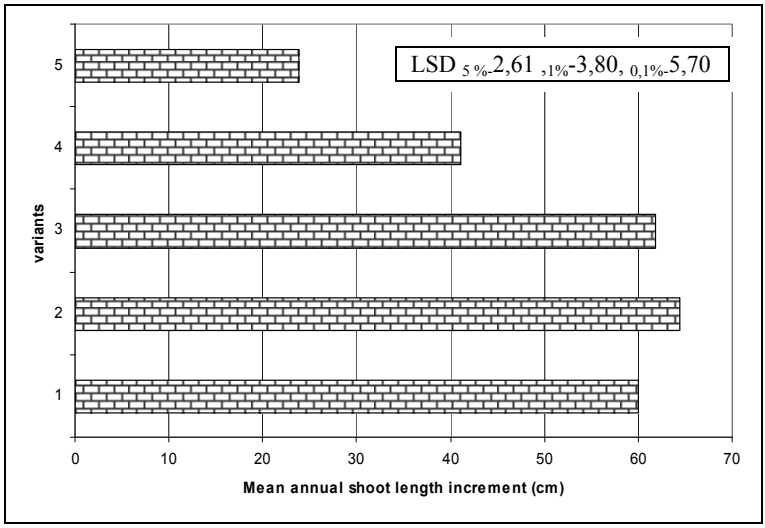

Figure 3. Effect of the soil herbicides on the mean annual shoot length increment (cm) of the nursery trees of plum-apricot cultivar ‘Standesto’ grafted on the apricot seedling rootstock

The higher rate of flumioxazin – Pledge 50 WP – 200,0 g/ha (Var. 5) caused growth suppression. In that variant, the plants had lower values of the three analyzed biometric characteristics. The differences compared to the control variant were statistically significant.

Figure 4. Nursery trees of the plum-apricot cultivar ‘Standesto’ grafted on the apricot seedling rootstock, after treatment with Metofen – 1.2 l/ha (Var. 2)

The results obtained lead to the conclusion that treatment with Metofen at the rate of 1.2-2.4 l/ha or Pledge 50 WP – 80 g/ha could be recommended for weed control in a second-year nursery with the cultivar-rootstock combination ‘Standesto’/apricot seedling rootstock. Treatment with higher rates of Pledge 50 WP caused plant growth suppression. Directed treatment with the total leaf contact herbicide diquat – Reglon Forte – 3.5 l/ha should be carried out against late weed infestation in the tree nursery, protecting the foliage of the young trees. Applying the proposed system of suitable soil and leaf herbicides guarantees the production of best quality planting material.

Conclusions

1. Visual symptoms of phytotoxicity (chlorosis and necrosis on the leaves and shoots) and visual suppression in the development of the grafted cultivar ‘Standesto’ were not observed in the variants treated with the herbicides.
2. Treatments with Metofen at the rate of 1.2-2.4 l/ha or Pledge 50 WP – 80 g/ha could be successfully applied in the production of planting material of the plum-apricot cultivar ‘Standesto’ for providing an efficient weed control in the second-year nursery. Treatment with higher rates of Pledge 50 WP causes plant growth suppression.

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Original paper

EFFECT OF SOME SOIL HERBICIDES ON THE VEGETATIVE HABITS OF APRICOT SEEDLINGS

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Abstract. A study on the effect of applying the soil herbicides metolachlor + oxyfluorfen (Metofen) and flumioxazin (Pledge 50 WP) on the vegetative habits of apricot seedling rootstocks was carried out in the period 2010-2012 at the Fruit-Growing Institute – Plovdiv. Treatment with the herbicides was applied in the second half of March, before the beginning of vegetation, immediately after planting the apricot seeds. The following variants were set: 1. Control (untreated, hand-weeded); 2. Metofen – 1.20 l/ha; 3. Metofen – 2.4 l/ha; 4. Pledge 50 WP – 80 g/ha; 5. Pledge 50 WP – 200 g/ha. For evaluating the efficacy of the applied herbicides during the vegetation period, weed infestation in the separate variants was reported in dynamics by the quantity-weight method, every 30th day after the date of treatment untill the end of the herbicide post-effect. In August (15-20 August) the rootstocks were graded for quality, reporting the following biometric characteristics: stem height (cm) and thickness at the place of grafting (mm).

The results showed that the soil herbicides included in the study, provided full control of weed infestation at the applied rates, the efficient herbicide post-effected lasting for 3.5-4 months. Visual symptoms of phytotoxicity expressed as a light chlorosis, were observed in the plants treated with the higher rate of Metofen – 2.4 l/ha and it was overcome about the 30th – 35th day after the emergence. Necrosis and chlorosis was also observed after treatment with Pledge 50 WP, but the symptoms of phytotoxicity were overcome in about a month after seedling emergence. In the production of seedling rootstocks for apricot, Metofen – 1.2 l/ha or Pledge 50 WP – 80 g/ha could be applied immediately after seed planting, before plant emergence. Treatment with higher rates of those active substances creates a risk of phytotoxicity, which is expressed in growth suppression of the rootstocks.

Key words: herbicides, weeds, rootstocks, apricot.

Introduction

The production of best quality planting material of a good health status requires a complex of agrotechnical practices applied in the fruit tree nursery, which ensure the successful start of rootstock emergence and development at the optimal use of water, light and nutrients. The efficient weed control necessitates the application of herbicides with proven selectivity to the rootstocks that provide satisfactory weed control.

There are data in literature about different effects of a number of soil and leaf herbicides on the growth of fruit species used as rootstocks, i.e. from the lack of phytotoxicity and the production of best quality rootstocks suitable for grafting, to a severe toxicity after applying some of the active substances contained in the herbicides, leading to dying of the plants (Abdul, et al.,1998; Kaufman and Libek, 2000a; Kaufman and Libek, 2000b; Rankova, 2004; Rankova, 2011). In previous studies on the effect of soil herbicides on the growth habits of apricot seedlings it was established that treatment with the soil herbicides napropamid (Devrinol 4F – 4 l/ha), pendimethalin (Stomp 33 EC – 4 l/ha) and terbacil (Sinbar 80 WP – 1 kg/ha) under the conditions of alluvial-meadow soil did not suppress plant growth (Rankova, 2007).

Optimization of the weed control in fruit tree nurseries requires studying the effect of the application of some active substances on weed infestation and on the vegetative habits of the rootstocks.

The aim of the present investigation was to study the effect of the soil herbicides Metofen (metolachlor + oxyfluorfen) and Pledge 50 WP (flumioxazin) on the growth habits of apricot seedling rootstocks.

Material and methods

Stratified apricot seeds (stones) were planted in an experimental plot at 3-5 cm depth and 5-7 cm in-row distance in the period 15-25 March. Immediately after that, treatment with the soil herbicides was applied. The effect of the active substances metolachlor + oxyfluorfen (Metofen) and flumioxazin (Pledge 50 WP) was studied, each herbicide being applied at two rates. The following variants were set: 1. Control (untreated, manually weeded); 2. Metofen – 1.2 l/ha; 3. Metofen – 2.4 l/ha; 4. Pledge 50 WP – 80 g/ha; 5. Pledge 50 WP – 200 g/ha.

The trial was set following the standard long-row method in 4 replications. The control was maintained free of weeds by manual weeding carried out every 30 days. During vegetation the rootstocks were grown following the standard technology.

For the evaluation of the herbicide efficiency of the applied herbicides during vegetation, weed infestation level was reported in the separate variants in dynamics, every 30 days after the date of treatment until the end of the herbicide post-effect, following the quantity weighing method.

During the vegetation period, observations were carried out on the growth and development of the plants – emergence, external symptoms of phytotoxicity, i.e. chlorosis, necrosis, suppression of growth.

In the period 15-20 August quality grading of the rootstocks was performed, reporting the biometric characteristics stem height (cm) and thickness at the grafting zone (mm). At that time, plant grading coincided with the time of grafting, determined as the most suitable period in our fruit-growing practice. The results obtained were processed by the dispersion analysis method.

Results and discussion

Weed association in the fruit tree nursery in the experimental fields of the Fruit-Growing Institute – Plovdiv is of the “arable type”, i.e. annual early and late spring weed species being prevailing. The development of the following grassy weed species was reported: ivy leaf speedwell (*Veronica hederifolia L.*), blackgrass (*Alopecurus myosuroides* L.), groundsel (*Senecio vulgaris* L.), field brome (*Bromus arvensis L.*), wall barley (*Hordeum murinum* L.), white goosefoot (*Chenopodium album L.*), redroot pigweed (*Amaranthus retroflexus* L.), prostrate knotweed (*Polygonum aviculare* L.), purslane (*Portulaca oleracea* L.), horseweed (*Erigeron canadensis* L.).

During the first three months after applying the herbicides, the weeds available in the different variants were reported by species and in number. On the 60th and 90th day single plants of the species - *Alopecurus myosuroides* L. and *Bromus arvensis L* were found in the variants treated with the herbicides (Fig. 1). All the studied herbicides at the applied rates showed a good control of weed infestation and the post-effect lasted for about 3,5-4 months. That helped to eliminate the competitive influence of the weeds on the seedlings at the earliest stages of seed germination and plant emergence. The herbicide effect lasted about 120 days after treatment, i.e. until the beginning of August.

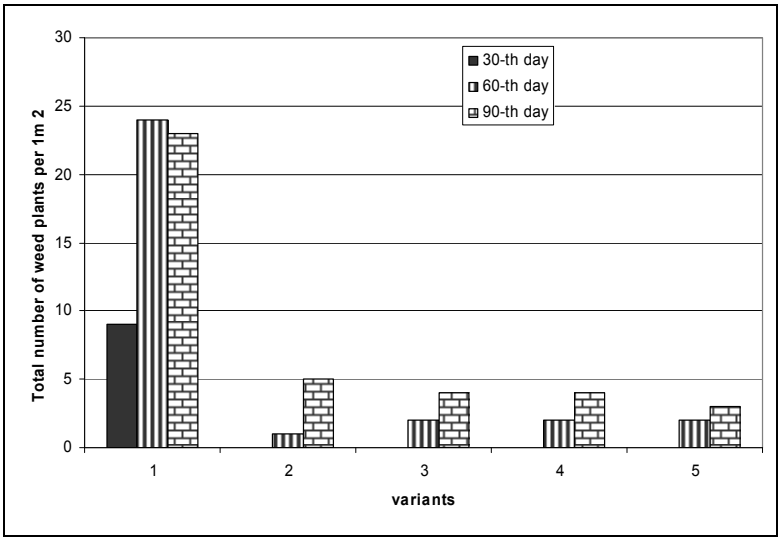

Figure 1. Effect of the soil herbicides on the weed infestation level (mean number/m^2)

The major representatives in the weed association in the period when the herbicide post-effect subsided were the late spring species purslane (*Portulaca oleracea* L.) and horseweed (*Erigeron canadensis* L.).

The results obtained about the effect of the active substances applied at the tested rates, on the weed infestation level and the duration of the efficient herbicide post-effect showed that it is possible to realize an efficient weed control in the fruit tree nursery. Inclusion of broad-spectrum herbicides in the study (controlling grassy and broad-leaved weed species) contributed to the good control of almost all the weed species, which could develop in the fruit tree nursery. The realization of a long-term herbicide effect lasting for about 4 months after the herbicide application provide favourable conditions for the development of the seedlings at the earliest stages of germination and emergence, as well as of the grafted plants, when weed-cultural plant competition has the greatest suppression effect.

The results about the habits of the apricot seedlings after treatment with the soil herbicides showed a similar tendency throughout the years of the study. A slight chlorosis was observed in the plants treated with the higher rate of Metofen (Var. 3, Figure 2) after the seedling emergence, which was overcome for about 30-35 days (Figure 3). Differences in the emergence rate were not established between the separate variants. Comparatively more severe necrosis and chlorosis were reported after treatment with Pledge 50 WP (Var. 4 and 5)

Figure 2. Phytotoxicity in apricot seedlings after treatment with Metofen – 2.4 l/ha (Var. 3)

Figure 3. Overcome symptoms of phytotoxicity in apricot seedlings after treatment with Metofen – 2.4 l/ha (Var. 3)

All the variants treated with herbicides had a smaller stem height, the difference being more obviously expressed in the variants with the higher rates of the active substances (Fig. 4). Treatment with the tested herbicides did not exert a considerable negative effect on the thickness at the place of grafting. The plants treated with the lower rates of the herbicides (Var. 2 and Var. 4) had bigger values of thickness compared to the control. The differences were statistically significant. It could be explained by the absence of phytotoxicity after the application of the tested rates of the herbicides and the efficient elimination of the weed competition during the vegetation period of the seedlings.

Lower values of the thickness at the place of grafting were reported after treatment with the higher rates of the studied herbicides (Var. 3 and Var. 5). That lead to conclude that treatments with the higher rates induce suppression of the seedling growth (Fig. 5). In the rest of the variants the reported values of the thickness were close or higher compared to the control. It shows that with an exception of the higher rate of Metofen – 2.4 l/ha (Var. 3), treatment with soil herbicides results in obtaining the best quality rootstocks suitable for grafting in the year of planting.

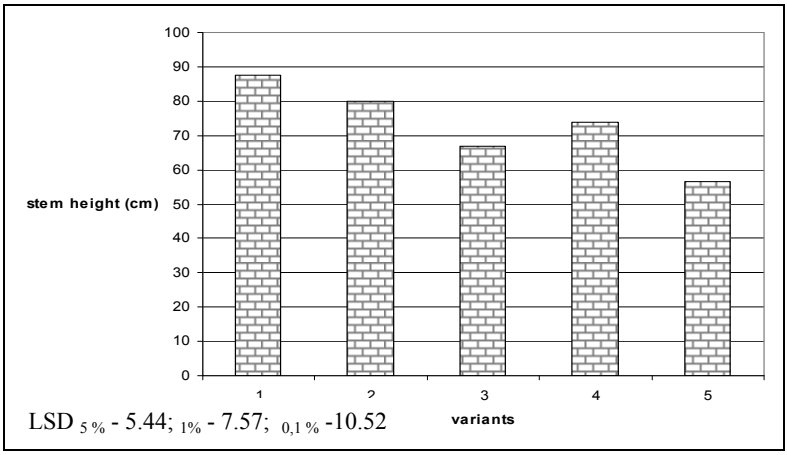

Figure 4. Effect of soil herbicides on stem height in apricot seedling rootstocks

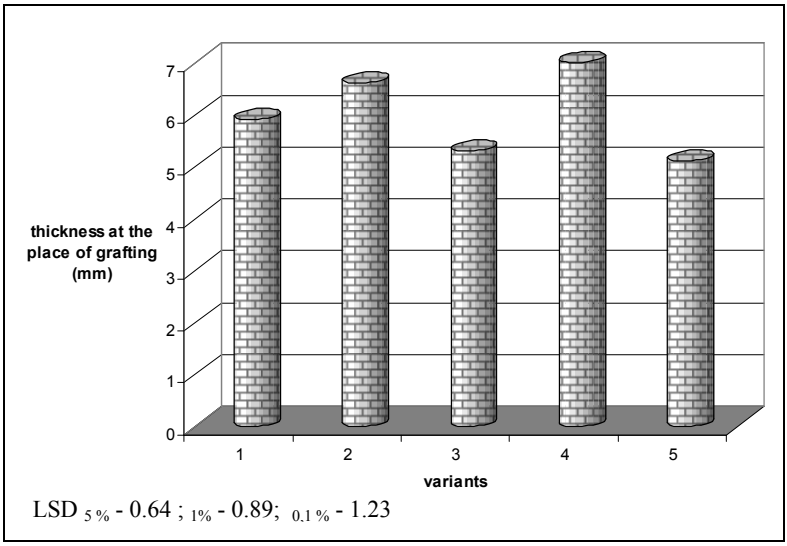

Figure 5. Effect of soil herbicides on thickness at the place of grafting in apricot seedling rootstocks

Conclusions

1. Better and longer-term weed control in a first year fruit tree nursery was achieved after treatment with the higher rates of the studied herbicides.
2. Good herbicide efficiency was also observed after the application of the lower tested rates (Variants 2 and 4).
3. The studied soil herbicides applied at the tested rates provided a total weed control, the post-effect lasting for about 3,5-4 months.
4. A slight chlorosis was observed in the plants treated with the higher rate of Metofen (Var. 3), which was overcome in about 30-35 days. Necrosis and chlorosis were also observed after treatment with Pledge 50 WP, however the symptoms of phytotoxicity were overcome in about a month after the seedling emergence.
5. Metofen – 1.20 l/ha and Pledge 50 WP – 80 g/ha could be applied in the production of apricot seedling rootstocks immediately after sowing before plant emergence. Treatment with higher rates of those active substances causes the risk of phytotoxicity expressed in plant growth suppression.

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Pregledni rad

PROBLEMI I PREPORUKE U OPRAŠIVANJU KAJSIJE

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Izvod. Savremena proizvodnja kajsije suočena je sa mnogostrukim problemima. Tendencija ka sigurnoj proizvodnji i proširenju oblasti gajenja kajsije je u direktnoj vezi sa uplivom nauke u odstranjivanju agrotehničkih, pomotehničkih, klimatskih i bioloških ograničenja.

U ovom radu je analizirano korišćenje insekata oprašivača kao činioca osiguranja i kontrole oprašivanja kajsije u cilju efikasnije proizvodnje. Od oprašivača su obrađeni: medonosna pčela (*Apis mellifera carnica*), pčele voćnjaka (*Osmia* spp.), solitarna pčela (*Anthophora pilipes villosula*) i bumbari (*Bombus* spp.).

Medonosne pčele i bumbari spadaju u manipulativne zajednice. Medonosne pčele je moguće usmeriti direktno na cvetove kajsije. Bumbari su efikasni pri hladnom vremenu. Pčele voćnjaka su najefikasnije u oprašivanju različitih voćaka, a naročito kajsije i badema. Solitarne pčele se relativno lako mogu gajiti i održavati u blizini zasada, aktivne su i pri hladnom i vlažnom vremenu, a u praksi su korišćene u proizvodnim zasadima.

Zasnivanjem kolonija u blizini zasada kajsije ili ciljnim dovoženjem i odvoženjem navedenih oprašivača u znatnoj meri se može ublažiti dejstvo poznih prolećnih mrazeva, loše diferencijacije cvetnih pupoljaka iz prethodne godine, umanjiti efekat moguće zaraze i smanjiti troškove zaštite i proređivanja plodova.

Ključne reči: kajsija, medonosna pčela, pčele voćnjaka, bumbari, plansko oprašivanje.

Uvod

Kajsija (*Prunus armeniaca* L.) kao voćka mediteranskog klimata još uvek ne može u potpunosti ispoljiti svoje biološko-proizvodne potencijale na našim prostorima. Neujednačen i neizvestan eksploatacioni period su ograničavajući činioci širenja areala njenog gajenja. U rejonima intenzivne proizvodnje, ni najsavremenija agro i pomotehnika ne garantuju uspešnu i rentabilnu proizvodnju. Konstantnim sagledavanjem problematike i prilagođavanju proizvodnih načela ovoj voćnoj vrsti, ipak se postiže značajan pomak u proizvodnji. Čitav niz procesa, od proizvodnje sadnica kajsije do berbe, daje mogućnost multidisciplinarnog pristupa rešavanju problema u proizvodnji.

Fenofaza cvetanja, odnosno period oprašivanja i oplođenja, je veoma važan period kada se može povećati rentabilnost proizvodnje u smislu obilnijeg i sigurnijeg plodonošenja (Mladenović i sar.1998., Mladenović i sar.2000, Mladenović i sar.2006). Planskim korišćenjem različitih polinatora (oprašivača), mogu se drastično umanjiti negativne klimatske, fiziološke i biološke pojave koje su tipične za kajsiju u tom periodu.

Cilj ovog rada je analiza oprašivanja kajsije korišćenjem različitih vrsta pčela kao oprašivača. Analizirani su komercijalno dostupni oprašivači kajsije na našim prostorima: medonosna pčela (*Apis mellifera carnica*), pčele voćnjaka (*Osmia cornuta i O. bicornis*), solitarna pčela (*Anthophora pilipes villosula*) i bumbari (*Bombus* spp.). Preporučiće se načela primene navedenih oprašivača u cilju sigurnije i ekonomičnije proizvodnje kajsije.

Problemi u proizvodnji kajsije

Glavne odlike gajenja kajsije u Srbiji su regionalna ograničenost i variranje proizvodnje iz godine u godinu. Visina godišnje proizvodnje tokom poslednjih godina varira od 27.000 – 41.000 tona (Veljković i sar., 2009), mada u pojedinim godinama rod u potpunosti izostaje (Milatović i sar., 2006).

Variranje proizvodnje kajsije u našoj zemlji je uslovljeno uticajem većeg broja faktora kao što su uticaj poznih prolećnih mrazeva, pojava iznenadnog sušenja kajsije (Keserović i sar., 2010), izmrzavanje cvetnih pupoljaka pre cvetanja kao i nizak nivo tehnologije gajenja (Milošević i sar., 2008).

Za kajsiju je karakteristična pojava formiranja cvetova sa nedovoljno razvijenim prašnicima, tzv. defektnih cvetova. Procenat defektnih cvetova jedne sorte varira u zavisnosti od godine. Smatra se da 40% defektnih cvetova kod samooplodnih sorti ne utiče na rodnost, međutim kod samobesplodnih sorti i 25% defektnih cvetova znatno smanjuje rodnost (Mratinić, 2004).

Kajsija je otporna na zimske mrazeve samo u dubokom biološkom mirovanju koje traje relativno kratko (15-30 dana), pri čemi cvetni pupoljci podnose temperature i do -25°C. U zimskom mirovanju, naročito posle pojave temperaturnih kolebanja, kajsija je veoma osetljiva na niske temperature. Pozni prolećni mrazevi često nanose štete kajsiji ako se jave u fenofazama cvetanja i oplodnje (Mratinić, 2004).

Perspektiva u gajenju kajsije je uslovljena optimalnim agroekološkim uslovima i rejonizacijom njenog gajenja (Nikolić i sar., 2012).

Medonosna pčela kao oprašivač

Medonosna pčela (*Apis mellifera L.*) je najrasprostranjeniji oprašivač (polinator, prenosilac polena) gajenih cvetnica. Ona u Srbiji učestvuje u oprašivanju voćnjaka sa 75-90 % (Mladenović 1986., Mladenović i Veličković, 1994., Mladenović i Stojnić, 1995., Mladenović i Pešić, 1996., Mladenović i Radulović,

1996., Mladenović i Savić, 1998., Nedić et al., 2000) . Intenzivne agrotehničke mere i primena zaštitnih hemijskih sredstava uzrokovala je znatno smanjenje broja spontanih oprašivača. Medonosna pčela, koja se gaji od strane čoveka (pčelara) sve više postaje značajna i sve više se upotrebljava za oprašivanje voćnjaka i drugih poljoprivrednih kultura dovoženjem košnica na parcelu (Mladenović i Lukić, 2003; Mladenović et al., 2005, 2009, 2011).

Slika 1. Medonosne pčele na cvetovima kajsije
Honeybees on apricot flowers

Tokom evolucije medonosna pčela i biljke cvetnice su se međusobno prilagođavale. Biljka luči nektar i daje polenov prah samo do trenutka oplođenja, nakon čega prestaje da bude atraktivna za pčele. Pčela posećuje jedan isti cvet sve dok on daje nektar i polen, odnosno sve do trenutka oplođenja, zbog čega predstavlja sigurnog oprašivača.

Medonosne pčele su aktivne i izleću iz košnice na temperaturi većoj od 13,9°C, a na temperaturi ispod 9°C se uklubljuju. Lepo, sunčano vreme, bez vetra i padavina najviše godi letu pčela a svako pogoršanje vremena ograničava let pčelama i uslovljava veći broj košnica potrebnih za oprašivanje, a izrazito lošije vremenske prilike mogu biti i pogubne za pčele na paši.

Ukoliko su u zasadu prisutne korovske biljke cvetnice, koje obično imaju jače obojene krunične listiće, one privlače medonosne pčele skrećući ih sa parcele koju bi trebalo da oprašuju zbog čega nam je potrebno više košnica za oprašivanje. Preporučljiva i obavezna preventiva je u ovom slučaju agrotehnička mera suzbijanja korova pre početka fenofaze cvetanja.

Košnice predodređene za oprašivanje se dovoze na parcelu u početku fenofaze cvetanja (kada je 15-20 % cvetova otvoreno). Ako se dovezu ranije postoji opasnost od preorjentacije na neku drugu kulturu u blizini, a ako se zakasni biće umanjen efekat oprašivanja. Košnice je poželjno postaviti u cik-cak rasporedu, u grupama od po 10-15 košnica i sa letom okrenutim prema parceli.

U jednom pčelinjem društvu (košnici) broj pčela se kreće od 20.000-60.000 (40.000 u proseku od kojih su polovina pčela izletnice), jedna pčela dnevno ostvari 10-14 (12 u proseku) izleta, na paši se zadržava 10-12 minuta i poseti 1.000-4.000 (2.500 prosečno) cvetova u toku dana. Broj posećenih cvetova u toku dana od strane jednog pčelinjeg društva prosečno iznosi 60.000.000.

Metode usmeravanja medonosnih pčela na željenu parcelu

Radi što većeg iskorišćenja medonosnih pčela u oprašivanju, odnosno opravdanosti prisustva pčela na parceli za polinaciju, poželjno je pčele usmeriti na cvetove kajsije i to dresurom:

Metoda aromatizovanog sirupa. U topao šećerni sirup (šećer : voda = 1:1) u večernjim satima dodaju se cvetovi kajsije bez čašičnih listića (odnosu 3:1 (3 dela sirupa i 1 deo cvetova). Čašični listići se odstranjuju jer u sirup ekstrahuju opore, netipične aromatične materije. U toku noći se izvrši ekstrakcija eteričnih ulja. U jutarnjim časovima, pre izletanja pčela, svakom društvu se u hranilicu sipa 150-200 ml ovog sirupa koji pčele raspoređuju u ćelije saća i predaju drugim pčelama. Time se u košnici širi miris kajsije, pa će se pčele vođene ovim mirisom koji asocira na izvor hrane usmeravati na cvetove kajsije. Neophodno je da sudovi i hranilice budu besprekorno čisti, bez stranih mirisa, a takođe je poželjno da cvetovi budu sveži, jer ako su u precvetavanju odlikuju se nekarakterističnim mirisom.

Metoda flitovanja. Priprema se aromatizovani sirup kao u predhodnoj metodi. Posle ekstrakcije eteričnih ulja, 2-3 sata pre izletanja pčela u hranilicu svakog društva se sipa 200-250 ml aromatizovanog sirupa, a 1 sat pre izletanja pčela vrši se razblaživanje aromatizovanog sirupa vodom u odnosu 3:1 (3 dela vode i 1 deo sirupa) i tako razređenim sirupom se prska (flituje) željena parcela – zasad kajsije. Pčele će se, kao i u prethodnom slučaju, vođene mirisom usmeravati na cvetove kajsije.

Metoda inserta. 20 dana pre cvetanja kajsije vrši se skidanje grančica sa cvetnim pupoljcima i na sobnoj temperaturi isprovocira njihovo cvetanje. Posle toga se skidaju antere sa polenovim prahom i polen se čuva u frižideru do cvetanja kajsije na otvorenom. Kada nastupi cvetanje polenov prah se meša sa krečnim prahom u odnosu 3:1, stavlja u kutiju inserta i premešta na poletaljku ispred leta košnice. Izlazeći iz košnice, pčele svojim dlačicama zahvataju smešu i raznose polenova zrna na žigove tučka posećujući cvetove kajsije.

Usmeravanje pčela na udaljene zasade. Koristi se ukoliko ne postoji mogućnost postavljanja pčelinjih društava blizu voćnjaka koji se želi oprašiti. Vrši se spravljanje aromatizovanog sirupa po već navedenom postupku uz dodatak neke jake i prijatne aromatične materije (mentola). U neku posudu se sipa sirup i materijal koji će onemogućiti davljenje pčela i stavi se da stoji otvorena ispred košnice. Po nakupljanju pčela prekrije se čistom gazom i tako prenese na parcelu na kojoj se želi vršiti oprašivanje. Po postavljanju se skloni gaza i pčele polako prelaze na cvetove kajsije. Radi veće efikasnosti, postupak se ponavlja 2-3 puta.

Pčele voćnjaka kao oprašivači

Prva vrsta solitarne pčele koja je korišćena kao alternativni oprašivač u Japanu je *Osmia cornifrons.* Japanski voćar E. Matsuyama zapazio je 1930. godine da ova pčela veoma brzo posećuje cvetove jabuka i da se gnezdi u šupljinama zaostalim od izvađenih eksera u drvenoj kući, u blizini njegovog voćnjaka. Kasnije je pčelama ponudio presečene stabljike bambusove trske i one su se u njima uspešno gnezdile. Od tada pa do danas tehnike za gajenje *Osmia cornifrons* su se razvijale u Japanu, gde je ova vrsta najefikasniji oprašivač jabuka. Danas se u Japanu dve trećine voćnjaka sa jabukama oprašuje ovim pčelama. One su introdukovane u Severnu Ameriku i Kinu, gde se koriste za oprašivanje (Stanisavljević, 2002; Krunić i Stanisavljević, 2006a).

Slika 2. Pogodan materijal za gnežđenje pčela voćnjaka
Suitable nesting material for orchard bees

Ove pčele su dva puta introdukovane u SAD, 1965. godine u državu Juta, gde se nisu održale i 1976. godine u državu Merilend, gde su opstale zahvaljujući sličnim klimatskim uslovima kao u centralnom Japanu. Danas se sve češće za oprašivanje voćaka koriste u Evropi i evropske vrste *Osmia cornuta* i *Osmia bicornis* (syn. *rufa*), kao i u SAD-u severnoamerička vrsta *Osmia lignaria*.

Slika 3. Različite vrste Osmia koje se danas koriste za oprašivanje voćaka.
Diferent Osmia species which are today used for pollination of fruit trees.

Oko 500 – 600 ženki *Osmia cornifrons* ili oko 600 – 1.800 *O. lignaria* je dovoljno za oprašivanje 1 ha jabuka. Za istu površinu potrebno je 2 – 6 košnica medonosnih pčela sa hiljadama jedinki. Medonosna pčela, od 100 posećenih cvetova, opraši u proseku 5, dok *O. cornuta* i njoj srodne vrste opraše 85 – 95 cvetova od posećenih 100 (Stanisavljević, 2002; Krunić i Stanisavljević, 2006a).

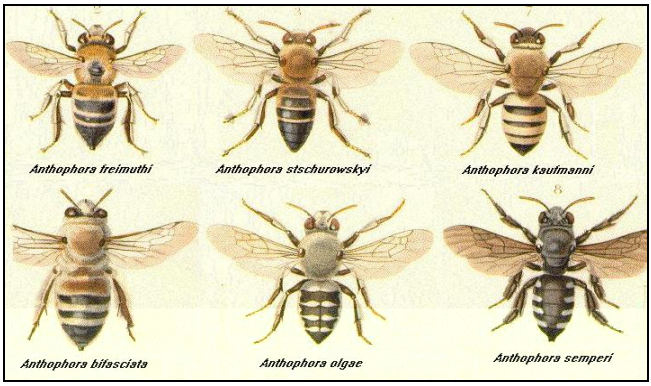
Ženke *O. cornifrons* preferiraju cvetove iz familije *Rosaceae.* Jedna ženka *O. cornifrons* je oko 80 puta efikasnija od radilice medonosne pčele u oprašivanju jabuka (Maeta, po Stanisavljeviću, 2002). *O. cornifrons* se u Americi koristi i za oprašivanje badema i vrsta roda *Brassica.*

Osmia lignaria je autohtona vrsta u severozapadnim delovima pacifičke obale SAD. Ona se upotrebljava za oprašivanje voćaka. Ova pčela može da opstane u hladnijim i sušnijim klimatima od introdukovane *O. cornifrons*. Danas su obe vrste komercijalno dostupne u SAD, a prilikom njihove primene najvažnije je voditi računa da se one dobiju od uzgajivača iz istih klimatskih zona. *O. lignaria* i *O. cornifrons* mogu se zajedno koristiti u istom voćnjaku (Stanisavljević, 2009a).

Evropske pčele voćnjaka *O. cornuta* i *O. bicornis* (Slika 3) se danas uspešno uzgajaju u Srbiji (Centar za biologiju pčela, Univerzitet u Beogradu – Biološki fakultet). One se uglavnom koriste za oprašivanje ranocvetajućih voćaka širom Evrope (kajsija i badema u južnoj Francuskoj i Španiji, krušaka i jabuka u Italiji, trešanja, kajsija, krušaka, jabuka, malina i aronije u Srbiji) (Krunić i Stanisavljević, 2006b, 2006c; Maccagnani *et al*., 2007). Njihova prednost u odnosu na domaće medonosne pčele ogleda se pre svega u efikasnosti oprašivanja, jer preko 90% posećenih cvetova od strane ugnežđenih ženki biva i oprašeno. Preporučuje se do 300 ženki *O. cornuta* po hektaru kajsija, krušaka, jabuka i do 500 ženki iste vrste pčele voćnjaka po hektaru trešanja, višanja i aronije, za njihovo potpuno oprašivanje (Krunić i Stanisavljević, 2006a). *O. bicornis* se koristi za voćke koje kasnije cvetaju u proleće. U tom smislu one su zajedno sa bumbarima najefikasnije za oprašivanje malina. Obe vrste evropskih pčela voćnjaka su aktivne, posećuju cvetove i vrše oprašivanje već na temperaturi iznad +8ºC, od ranog jutra do kasnog sumraka čak i po kišovitom vremenu. Njihova aktivnost u uslovima jugoistočne Evrope obično traje oko mesec i po dana, najčešće od sredine marta do kraja aprila (*O. cornuta*) i od kraja marta do sredine maja (*O. bicornis*) (Krunić i Stanisavljević, 2006a).

Ostale solitarne pčele kao oprašivači

Solitarna pčela *Anthophora pilipes villosula* je oprašivač borovnica u Japanu. Ona je 1990. godine introdukovana u SAD gde je korišćena za oprašivanje nekoliko vrsta voćaka. Evropske podvrste *Anthophora pilipes* se takođe koriste za oprašivanje voćnjaka. Aktivnost adulata *Anthophora pilipes* poklapa se sa periodom cvetanja borovnice, breskve, kajsije, jabuke, kruške, šljive, višnje i još nekih voćaka koje ova pčela posećuje. Aktivne su obično oko 6 nedelja u proleće od zore do sumraka čak i po hladnom i kišovitom vremenu. Gnezde se u suvoj i tvrdoj zemlji, a ćelije u gnezdu oblažu gustim sekretom iz voljke. Larve se razvijaju u toku leta, u jesen su lutke, a prezimljavaju u ćelijama kao adulti. Relativno je lako gajiti ovu vrstu zbog toga što se gnezdi u blokovima od tvrde zemlje ponuđenim od strane čoveka.



Slika 4. Različite vrste solitarnih pčela roda Anthophora
Different species of solitary bees from the genus Anthophora

Ove pčele imaju dobru orjentaciju za vraćanje u gnezdo, tako da ne napuštaju oblast u kojoj se gnezde. Za gajenje *Anthophora pilipes* najbolje je postavljati stalne zaklone sa blokovima od tvrde zemlje u neposrednoj blizini voćnjaka (Stanisavljević, 2009b*)*. U Srbiji živi nekoliko vrsta solitarnih pčela roda *Anthophora* (*A. parietina*, *A. acervorum*, *A. crinipes*) koje imaju sličnu biologiju kao i pomenuta komercijalizovana japanska vrsta. Sve one su odlični oprašivači ranocvetajućih voćaka (badema, kajsija, trešanja) (Mučalica, 1987). Prema istraživanju američkih naučnika, poseban potencijal za domestifikaciju ima naša vrsta *A. parietina*, koja se smatra vrstom budućnosti za oprašivanje ranovetajućih voćaka na niskim prolećnim temperaturama od oko +8 do +10°C (Batra, 2000, lična komunikacija).

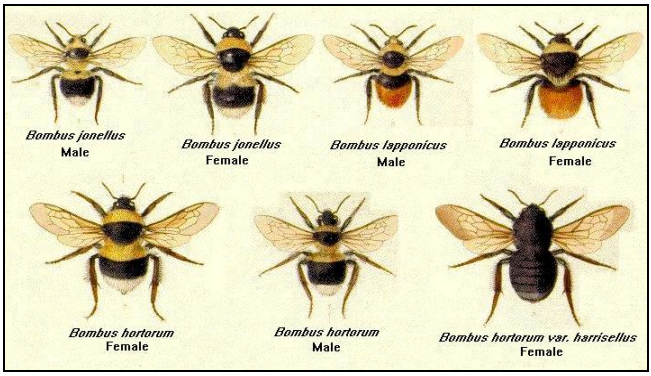
Bumbari kao oprašivači

Bumbari (*Bombus* spp.) su takođe veoma efikasni oprašivači. Od gajenih biljaka posebno dobro oprašuju: ranocvetajuće voćke (kajsiju, badem, trešnje), maline, lucerku, borovnice, paradajz, plavi patlidžan, paprike i dr. Bumbari oprašuju duboke cevaste cvetove (gde prednjače neke dugorilične vrste bumbara) i cvetove koji su bogati polenom. Bumbari posećuju cvetove i po kišovitom, hladnom ili vetrovitom vremenu, kada većina pčela ostaje u gnezdu.

U prirodnim uslovima bumbari zasnivaju nova gnezda svakog proleća. Oplođena ženka koja sama prezimljuje, u proleće pronalazi pogodno mesto za gnežđenje, često u napuštenim gnezdima miševa ili sličnim šupljinama.

Ženka gradi nekoliko ćelija od voska, odlaže nektar i polen i u njima polaže po jedno jaje iz kojeg se izleže sitnija radilica. Na taj način počinje obrazovanje kolonije bumbara. Tokom leta kolonija raste i postaje složena. U zavisnosti od vrste, kada je društvo najaktivnije, obično sadrži: maticu, 30 – 150 radilica i manji broj mužjaka. U jesen se mužjaci i polno zrele ženke spare, posle čega oplođene ženke

napuštaju gnezdo, pronalaze pogodna mesta i stupaju u mirovanje, dok mužjaci i radilice uginu.



Slika 5. Različite vrstebumbara roda Bombus.
Different species of bumblebees from the genus Bombus.

Mnogobrojni pokušaji gajenja bumbara proteklih decenija bili su bezuspešni sve dok 1985. godine nije razvijena posebna metoda od strane više evropskih istraživača (V. Ptaček, P.F. Roseler i R. de Jonghe). Danas se veliki broj veštački proizvedenih društava bumbara (*Bombus terrestris, Bombus impatiens*) koriste za oprašivanje paradajza i plavog patlidžana u staklenicima, zatim lucerke i borovnice, jagode i maline u mnogim razvijenim zemljama Evrope, SAD i Japanu. Međutim, metode uzgajanja su uglavnom poslovne tajne i nisu publikovane (Stanisavljević 2009b). Kolonije bumbara se permanentno moraju nabavljati za oprašivanje u fenofazi cvetanja.

Bumbar se bolje orijentiše u zatvorenom prostoru (plasteniku, stakleniku, itd.) od medonosne pčele, i dok pčela nastoji da prođe kroz foliju ili staklo da bi izašla napolje, bumbar se po poseti cvetovima i njihovom oprašivanju vraća u svoje gnezdo (košnicu u plasteniku).

Što se tiče njihove aktivnosti u polinaciji u odnosu na medonosnu pčelu karakterišu se sledećim osobinama:

- Bumbari su aktivni već od 8°C, pčela teorijski od 10°C, a u praksi od 15°C.
- Mnogo su aktivniji tokom oblačnih, maglovitih, ili kišnih dana u odnosu na medonosnu pčelu, koja je prilično neaktivna kod slabog osvetljenja.
- Bumbari lete i pri brzini vetra do 60 km/h, dok je pčela aktivna do maksimalnih 30 km/h.
- Bumbari imaju vrlo dug radni dan u polinaciji, od rane zore do kasne večeri.
- Prenose do 2,5 puta više polena prilikom svake posete, shodno i njihovoj veličini.
- Bolje se orijentišu u uslovima difuznog osvetljenja zbog čega su aktivniji ispod protivgradne mreže.

- Usled eventualne grube manipulacije i korišćenja košnica, bumbari nisu ni približno agresivni kao medonosna pčela, a košnicu sami možete postaviti i ne morate se brinuti o njoj.
- Bumbari se mogu koristiti u polinaciji vrlo ranih, ili vrlo kasnih vrsta tokom čitave godine.
- Prilikom primene hemijskih zaštitnih sredstava lako je sakupiti koloniju bumbara i privremeno ukloniti košnicu.
- Nesavršeniji su u komunikaciji, te izostaje prenošenje informacija kao kod plesa pčela, pa je i verovatnoća odlaska na kvalitetniju pašu mnogo manja nego kod medonosne pčele.
- U pojedinačnom letu radilica bumbara posećuje znatno veći broj cvetova, pa je mogućnost strano-oplođenja veća.
- U sakupljanju nektara i polena radilice bumbara su manje sistematične, te je mogućnost stranooplođenja veća.
- Bumbari podnose pomeranje košnica na samo desetak metara, za razliku od medonosne pčele koja ide na novu lokaciju udaljenu najmanje nekoliko kilometara, što omogućuje selidbu košnica sa kajsije na trešnju, sa trešnje na krušku i slično..

Preporuke za oprašivanje kajsije

Za oprašivanje kajsije koriste se „jaka“ pčelinja društva. To su društva koja imaju odrasle pčele na 8 od 10 ramova u košnici i 5 ramova sa leglom, odnosno 20.000 – 32.000 odraslih pčela (Stanisavljević, 2009a).

U zavisnosti od klimatskih faktora treba postaviti 3 – 6 košnica po hektaru. Košnice je poželjno postaviti popreko na redove (ne uzdužno) jer je efekat oprašivanja bolji.

Košnice se postavljaju na 50 – 200 m od voćnjaka, a najdalje do 800 m. Dalje od toga znatno opada učestalost posećenosti cvetova od strane pčela i opada efekat polinacije (Mladenović et al., 2001). Bliže od toga remeti pčelu jer ona mora da ima uzletnu putanju dok ne uhvati pravac leta. Bolje je postavljati košnice po ivici voćnjaka.

Kada se radi o većim parcelama (dužim od 800 m) neophodno je rasporediti košnice sa obe strane zasada kajsije, radi obezbeđivanja susretnog oprašivanja. Susretno oprašivanje se može primeniti i na parcelama od 200 – 800 m, jer je efekat oprašivanja svakako bolji. Ovim postupkom se eliminiše mogućnost da pojedini delovi parcele budu uskraćeni prisustva pčela.

Pre fenofaze cvetanja kajsije preporučuje se ukljanjanje korova, da pčele ne bi posećivale njihove cvetove umesto cvetova kajsije. Maslačak npr. ili mrtva kopriva su veoma atraktivni za pčele pa će ih primamiti svojim prisustvom (Jevtić et al., 2003) .

Takođe je poželjno primeniti usmeravanje pčela na cvetove kajsije. Može se koristiti jedna metoda, ali se bolji efekat dobija kombinovanjem dve (npr. metoda flitovanja i inserta).

Od svih pčela najveći udeo u oprašivanju voćaka imaju medonosne pčele, što ne znači da su i najefikasnije kao oprašivači, jer postoje pčele voćnjaka kao npr. *Osmia cornifrons, O. cornuta* i *O. bicornis,* čije ženke su i do 80 puta efikasnije od radilice medonosne pčele. Zbog slabije adaptacije na različite klimatske uslove areal njihovog širenja je ograničen na postojeće. Evropske vrste pčela voćnjaka (naročito *O. cornuta*) se koriste već duži niz godina za oprašivanje kajsija u Srbiji, Španiji, Italiji i Francuskoj. Preporučuje se do 300 ženki/ha kajsija, što se u sezoni 2012. godine pokazalo dovoljno efikasno za potpuno oprašivanje ove voćne kulture i po veoma hladnom i kišovitom vremenu, na parcelama Oglednog dobra „Radmilovac“ (Slika 6).

Slika 6. Zaklon sa gnezdima pčela voćnjaka *Osmia cornuta* u voćnjaku kajsije na Oglednom dobru „Radmilovac“, pčela voćnjaka na cvetu kajsije i grana kajsije sa plodovima nakon oprašivanja sa pčelama voćnjaka.
Shelter with the nests of the orchard bee Osmia cornuta in the appricot orchard of Experimental Station "Radmilovac", orchard bee on the appricot flowers, and appricot fruits on a branch after pollination with orchard bees.

Raspored gnezda i pogodnog materijala za gnežđenje ovih pčela treba da bude na oko 200 m udaljenosti, zbog njihovog ograničenog radijusa letenja. Solitarne pčele voćnjaka se relativno lako održavaju u blizini voćnjaka, bez nekih posebnih mera. Potrebno je iskoristiti postojeću mogućnost i dostupnost *Osmia* u Srbiji za njenu što širu primenu u zasadima kajsije.

Bumbari, koji se odlično orijentišu u zatvorenom prostoru (Momirović, 2012), se mogu iskoristiti za oprašivanje zasada kajsije zaštićenim protivgradnim mrežama.

Zaključak

- Osnovni problem u proizvodnji kajsije na našim prostorima je klimatska neadaptibilnost praćena izmrzavanjem cvetnih pupoljaka i cvetova i apopleksijom kajsije.

- Oprašivanje kajsije medonosnom pčelom (*Apis mellifera carnica*) kod nas se uglavnom svodi na spontanu posećenost cvetova kajsije od strane pčela, bez ciljnog dovoženja pčelinjih zajednica na parcelu.

- Najpogodnije i najefikasnije vrste pčela za oprašivanje voćnjaka, a posebno kajsije su pčele iz roda *Osmia.*

- Solitarna pčela (*Anthophora pilipes villosula*) zbog potencijalnog lakog gajenja i dobre adaptacije na hladne uslove proleća, predstavlja izuzetan biološki polinatorski potencijal za kajsiju na našim prostorima.

- Bumbari (*Bombus* spp.) su se dokazali kao odlični polinatori u zatvorenim prostorima i na niskom temperaturama, pa se mogu preporučiti I za oprašivanje kajsija.

- Navedenim polinatorima se mogu znatno ublažiti, ili čak neutralisati:
- gubici fertilnih cvetova usled izmrzavanja;
- neutralisati gubici usled iznenadnog sušenja grana i grančica;
- gubici usled pojave tzv. defektnih cvetova;
- gubici zbog preranog odbacivanja cvetnih pupoljaka i nepotpunog cvetanja;
- gubici zbog pojave hladnih i jakih vetrova, naročito korišćenjem bumbara.

- Planskim oprašivanjem se postiže skraćenje fenofaze cvetanja što umanjuje rizik od infestacije kajsije preko cveta, a ujedno se redukuje i primena pesticide.

- Planskim oprašivanjem (postavljanjem i uklanjanjem kolonija polinatora) se može uticati na opterećenost rodom i izbegnuti proređivanje plodova, što znatno smanjuje troškove proizvodnje.

- Hladno i kišovito vreme u fenofazi cvetanja naročito iziskuje prisustvo polinatora u zasadu.

- Planskim oprašivanjem se povećeva opterećenost rodom u početku plodonošenja što doprinosi bržem stupanju kajsije u punu rodnost.

- Planskom polinacijom se obezbežuje sigurnije plodonošenje i povećava ekonomičnost proizvodnje.

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Problems and Recommendations in the Pollination of Apricot

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Summary

Modern apricot production is confronted with multiple problems. The trend towards the safe production and expansion of apricot growing areas is directly related to the influence of science in annihilation of agro technical, pomotechnical, climatic and biological constraints.

This paper analyzes the use of insect pollinators as a factor of security and control pollination of apricot to more efficient production. The pollinators discussed are: the honey bee (*Apis mellifera carnica*), Orchard bees (*Osmia* spp.), Solitary bees (*Anthophora pilipes villosula*) and bumblebees (*Bombus* spp.).

Honeybees and bumblebees are manipulative communities. Honey bees may be pointed directly at the apricot blossoms. Bumblebees are effective in cold weather in the plantation with hail nets. Orchard bees are the most efficient in the pollination of fruits and apricots. Some other solitary bees are relative easily maintained in the vicinity of orchards and are active in cold and wet weather, but in Eurpe not yet used in commercial production.

Through the establishment of a colony near the apricot orchards or by target migration of these pollinators may significantly temper spring frost, poor differentiation of flower buds of the previous year, to reduce the possibility of infestation and pesticide application, and eliminate the thinning.

Key words: apricot, honeybees, orchard bees, bumblebees, planned pollination.