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DOSTIGNUĆA I TRENDYOVI U PROIZVODNJI JAGODE U SRBIJI

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Izvod. U radu je analizirano stanje u proizvodnji jagode u poslednjih deset godina sa prikazom rezultata ispitivanja proizvodnih osobina sorti jagode u funkciji primene različitih tehnologija gajenja na otvorenom polju i u zaštićenom prostoru. Permanentna introdukcija novih sorti stvorenih u različitim oplemenjivačkim stanicama u Italiji, Holandiji, Francuskoj i Engleskoj uslovila je i veliku dinamičnost sortimenta u proizvodnji jagode u Srbiji. Od 2005. godine dominantno mesto u zasadima zauzela je sorta 'Clery', prevashodno zbog ranog vremena zrenja, visokog kvaliteta ploda i izražene adaptivnosti na različite sisteme gajenja u sezonskoj i vansezonskoj proizvodnji (uključujući hidropontski uzgoj u visokim tunelima). Gajenje jagode na gredicama u formi dvoreda sa primenom sintetičkih/organskih malčeva, sistema za navodnjavanje i fertigacije postaje polako već standardna tehnologija, koja obezbeđuje značajno veće komercijalne prinose. Novi trendovi se ogledaju u mogućnosti uvođenja jednorednog sistema gajenja na gredicama, primeni plastenika ili polu zaštićenog prostora u cilju sprečavanja nepovoljnog uticaja klimatskih faktora i introdukciji novih, konzumnih sorti jagode tolerantnih na bolesti.

Ključne reči: *Fragaria ananassa* Duch., sorta, tehnologija gajenja, prinos, kvalitet ploda.

Uvod

Baštenska jagoda (*F. ananassa* Duch.) je veoma cenjena vrsta jagodastih voćaka, čija rentabilnost proizvodnje je pod značajnim uticajem genotipa, primenjene tehnologije gajenja, uslova spoljašnje sredine i stanja na tržištu. U Srbiji se tokom poslednjih deset godina proizvodnja jagode realizovala na površini od preko 7.000 ha, dostižući ukupne prinose od preko 30.000 t. Prema zvaničnim statističkim podacima ukupna proizvodnja jagode u 2012. godini iznosila je 37.487 t (FAOSTAT/crops/ 2012), mada je dugotrajni kišni period u vreme zrenja plodova značajno narušio njihov kvalitet umanjujući komercijalne prinose jagode u pomenutoj godini (Nikolić et al., 2012). Slična situacija je zabeležena i u 2014. godini, kada je usled velike sume padavina tokom fenofaze zrenja plodova i pojave poplava u pojedinim područjima, značajna količina plodova ostala neubrana ili odbačena zbog plesnjivosti i velikog sadržaja vode. U isto vreme, sa otvaranjem tržišta i novim tendencijama u prometu jagode, koje su prevashodno uslovljene promenama u potrošačkim navikama, pojavljuju se i specifični standardi u pogledu ambalaže i kvaliteta svežeg ploda jagode. U cilju ispunjenja novih zahteva, zapaža se i povećan interes proizvođača za primenom boljih tehnologija gajenja i introdukcijom novih visokoproduktivnih i kvalitetnih sorti (Milivojević, 2012a). Ipak, pored zasada koji su zasnovani na otvorenom polju po principima savremene tehnologije gajenja, još uvek postoje ekstenzivni zasadi, posebno u južnim delovima Srbije. Oni su najčešće podignuti korišćenjem nekategorisanih živića, proizvedenih u već postojećim rodnim zasadima, bez primene PE folije ili organskog malča i sistema za navodnjavanje. U

takvim zasadima je dominantno zastupljena stara sorta 'Senga Sengana', koja uz minimalna ulaganja u proizvodnju ostvaruje odličan kvalitet ploda namenjen preradi.

Noviji, savremeniji zasadi jagode na gredicama prekrivenim crnom PE folijom prevlađuju u okolini Šapca, Beograda, Smedereva, Novog Sada, Kruševca, Valjeva i drugih većih potrošačkih centara. Međutim, primena niskih PE tunela, visokih tunela ili plastenika je prisutna u manjem obimu (svega oko 5-10%) sa tendencijom njihovog širenja (Nikolić et al., 2012). Pored vansezonskog uzgoja, značaj proizvodnje jagode u zaštićenom prostoru se ogleda i u mogućnosti gajenja u vrećama/kontejnerima sa različitim supstratima (tzv. „soilless“ tehnika), kada prinosi mogu dostići nivo od 30 t/ha i više, zavisno od zapremine vreća/kontejnera, gustine sklopa biljaka, režima đubrenja itd. U poređenju sa ovakvom visokointenzivnom tehnologijom, u ekstenzivnim zasadima se ostvaruju znatno niži prinosi od 7-8 t/ha.

Za zasnivanje zasada se uglavnom koriste „frigo“ sadnice, koje se uvoze iz inostranih rasadnika. S obzirom da postoje zakonska ograničenja u podizanju matičnjaka u našoj zemlji i da su skupa licencna prava stvaraoca sorti, može se očekivati da će nabavka sadnica i dalje predstavljati značajni deo investicionih ulaganja kod podizanja novih zasada. To je uslovilo i pojavu nekontrolisanog umnožavanja živića u rodним zasadima tokom poslednjih nekoliko godina. Zelene sadnice proizvedene na ovaj način su uglavnom lošijeg kvaliteta, sa slabije razvijenim korenom, a često i bez sortne identifikacije. Kao takve, one nisu pogodne za zasnivanje visokointenzivnih zasada.

Sortiment jagode u zasadima je ispoljio priličnu dinamiku tokom poslednje decenije, kada su najpre introdukovane sada već potisnute sorte 'Elsanta', 'Queen Elisa', 'Miss', 'Dora' i 'Patty', sa izuzetkom sorte 'Clery' (koja je zadržala primat u proizvodnji do danas), a zatim poslednjih 6-7 godina sorte 'Arosa', 'Antea', 'Alba', 'Asia' i 'Roxana', koje su u svojoj ponudi imali uvoznici sadnica iz Italije. S obzirom na vrlo intenzivan oplemenjivački rad u brojnim privatnim i državnim institucijama u Italiji, Holandiji, Francuskoj i Engleskoj, pored već pomenutih, poslednjih nekoliko godina su introdukovane i novije sorte: 'Joly' i 'Dely' (Italija), 'Daroyal' (Francuska), 'Sonata', 'Figaro', 'Salsa' i 'Rumba' (Holandija), 'Florence' (Engleska). Sadnice ovih sorti, izuzev dve italijanske, mogu se obezbediti iz uvoza samo za prolećnu sadnju jagode, koja je u manjem obimu zastupljena u Srbiji. Velika heterogenost sorti nameće potrebu za ispitivanjem njihovih najvažnijih proizvodnih svojstava u našim agroekološkim uslovima kako bi se dobio odgovor na postavljene ciljeve oplemenjivanja u konkretnim uslovima, kada kombinovani efekat sorte, tipa sadnice i primjenjenog sistema gajenja dolazi do izražaja. Posebna pažnja se posvećuje testiranju sorti u funkciji primene različitih sistema gajenja kroz sagledavanje nivoa njihove produktivnosti, vremena zrenja i senzoričkog/nutritivnog kvaliteta plodova.

U skladu sa tim u ovom radu su prikazana dostignuća u proizvodnji jagode u Srbiji tokom poslednjih deset godina kroz prikaz rezultata naučnih istraživanja izvedenih u praksi, kao i novi trendovi koji se pojavljuju u proizvodnji ukazujući na neophodnost inovacija u pravcu prevaziilaženja izvesnih nedostataka, a sve sa ciljem unapređenja proizvodnje jagode.

SAVREMENA TEHNOLOGIJA PROIZVODNJE JAGODE NA OTVORENOM POLJU – NOVI TRENDLOVI I IZAZOVI

Jedan od važnih preduslova intenziviranja proizvodnje jagode predstavlja primena savremene tehnologije gajenja, koja se zasniva na formirajući gredica, njihovom zastiranju polietilenском (PE) folijom i instaliranju sistema za zalivanje (Nikolić et al., 2009). Gajenje jagode na PE foliji pokazuje brojne prednosti, koje se ogledaju u obezbeđivanju ranijeg vremena zrenja, visokog kvaliteta plodova, njihove dobre tržišnosti i olakšanog plasmana. Raznovrsnost folija (crne, srebrno-braon, bele, zelene i providne), visok stepen

mehanizovanosti podizanja zasada, veći prinosi i brz povraćaj uloženih sredstava bili su dodatni motivi za ozbiljnije širenje ovakvog načina proizvodnje jagode tokom poslednjih deset godina (Milivojević, 2012a).

Trenutno najzastupljeniji sistem gajenja u proizvodnim zasadima u Srbiji je gajenje u dvoredima na gredicama, koje se zastiru PE folijom širine 120 cm sa dva reda otvora prečnika 6 do 8 cm (cik-cak raspored). U ovakvom sistemu gajenja primenjeno rastojanje sadnje je 30 x 30 cm. Udaljenost od centra jedne do centra susedne gredice iznosi 150 cm, tako da se po 1 ha dobije oko 60 gredica, a ukupan broj biljaka potreban za zasnivanje 1 ha zasada iznosi 40.000. Zapaženo je kod nekih bujnijih sorti da se gajenjem u dvoredima (posebno u II godini plodnošenja) javlja nedovoljna provetrenost bokora što uslovjava povećanu infekciju patogenom *Botrytis cinerea* Pers. Stoga, uvođenje jednorednog sistema gajenja se pojavljuje kao jedno od potencijalnih rešenja kod sorti sa robusnijim bokorom i visokim rodnim potencijalom, kao što su: 'Joly', 'Alba', 'Brilla', 'Capri' i dr. Kod ovog sistema gajenja udaljenost od centra jedne do centra susedne gredice iznosi 120 do 130 cm (zavisno od mašine koja ih pravi), tako da je broj gredica po hektaru nešto veći (oko 80) u odnosu na dvoredni sistem gajenja. Živići se sade po sredini gredice na udaljenosti od 15 do 20 cm (najčešće se koriste perforirane folije sa rastojanjem između otvora od 18 cm), tako da je za zasnivanje 1 ha zasada potrebno 41.-43.000 biljaka. Interesantni rezultati su dobijeni pri komparativnom proučavanju uticaja jednorednog i dvorednog sistema gajenja kod sorte 'Joly', koja je u jednorednom sistemu imala veći prinos po bokoru (1,03 kg), prvenstveno zahvaljujući većem broju zametnutih plodova po bokoru (51,3) i većoj masi ploda (29,8 g). Međutim, iako je broj rodnih stabljika po bokoru bio isti u oba sistema gajenja (5,6), ukupni prinos po bokoru u dvorednom sistemu gajenja iznosio je 785,4 g, sa prosečnom masom ploda od 27,0 g. Kod ispitivane sorte je registrovano i variranje u hemijskom sastavu ploda između primenjenih sistema gajenja, odnosno u jednorednom sistemu gajenja je dobijen nešto veći sadržaj rastvorljive suve materije (8,1%) i vitamina C u plodu (58,1 mg/100 g sv.m.pl.), kao i nešto niži sadržaj ukupnih kiselina (0,49%). Da bi se donela konkretna preporuka koji sistem gajenja je bolji, potrebno bi bilo izvršiti detaljna ispitivanja kod svih privredno značajnih sorti, pošto interakcijski efekat sorte i sistema gajenja može imati značajan uticaj. Pored pomenutih pozitivnih efekata jednorednog sistema gajenja, treba istaći da se u uslovima visokih temperatura praćenih jakom insolacijom (tzv. letnje žege) mogu pojaviti ožegotine na plodovima zbog njihove veće izloženosti direktnom dejstvu sunčevog zračenja u jednoredima.

Jedan od izazova sa kojim se suočavaju proizvođači jagode poslednjih nekoliko godina jeste i određivanje optimalnog vremena sadnje. Iako se sadnja jagode na PE foliji može obaviti tokom svih letnjih meseci, najviše se u praksi primenjuje letnja sadnja od početka jula do sredine avgusta. Izvođenjem sadnje u pomenutom periodu obezbeđuje se ostvarivanje maksimalnog pravca u prvoj godini nakon sadnje (Nikolić i Milivojević, 2010). Međutim, poslednjih nekoliko godina u manjem obimu se primenjuje i prolećna sadnja jagode, koja se izvodi tokom aprila sa favorizovanjem prvog plodnošenja već nakon 50 do 60 dana (početkom juna). Drugi, glavni rod se dobija sledeće godine na proleće (maj-jun). U funkciji primene prolećne sadnje ispitivana je produktivnost pet sorti jagode ('Rumba', 'Honeoye', 'Daroyal', 'Salsa' i 'Florence') u proizvodnom zasadu, koji se nalazi u mestu Konjuh kod Kruševca. U prvom periodu plodnošenja (55 dana nakon sadnje), najveću produktivnost je ispoljila sorta 'Salsa' (277,5 g/bok.), dok je najniža rodnost zabeležena kod sorte 'Rumba' (92,0 g/bok.). Imajući u vidu dug period razvoja biljaka u prvoj vegetacionoj sezoni, 13 meseci nakon sadnje kod sorti 'Salsa' i 'Florence' je registrovan veliki broj rodnih stabljika po bokoru (11,2 i 11,1, po redosledu), kao i veliki broj zametnutih plodova po bokoru (123,1 i 109,7, po redosledu sorti). Visok rodnji potencijal je za posledicu imao i nedovoljnu provetrenost bokora, što u kombinaciji sa dužim kišnim periodom tokom fenofaze zrenja

plodova u 2012. godini pojačalo infekciju patogenom *Botrytis cinerea* Pers. značajno smanjujući komercijalni prinos kod pomenutih sorti jagode. Najbolje rezultate sa aspekta produktivnosti, ranog vremena zrenja i kvaliteta ploda dala je sorta 'Daroyal'.

Kada se u obzir uzme činjenica da se pri prolećnoj sadnji, koja se obavlja tri meseca ranije, utroši više rada, vode za navodnjavanje i đubriva za ishranu jagode postavlja se pitanje opravdanosti iste u odnosu na postignute prinose i potencijalne probleme, koji se mogu javiti naredne godine. Dodatno, pre letnje sadnje jagode moguće je gajenje neke predkulture, čime se ostvaruje izvestan prihod što kod prolećne sadnje nije moguće ostvariti.

Pored vremena sadnje, sistema gajenja i genotipa, ostvarivanje visokih prinosa i vrhunskog kvaliteta ploda jagode se nalazi i pod značajnim uticajem uslova spoljašnje sredine (Milivojević et al., 2013a; Crespo et al., 2009). Od svih spoljašnjih faktora, koji mogu negativno uticati na proizvodnju jagode, pojava mraza tokom ranog proleća izaziva možda i najveće štete. Najugroženija je fenofaza cvetanja kada usled izmrzavanja primarne i eventualno sekundarne serije cvetova u cvastima dolazi do značajnih gubitaka u prinosu, naročito plodova iz prve serije, koji su i najkomercijalniji. Zaštita biljaka od pozognog prolećnog mraza se može izvesti na različite načine, među kojima se po jednostavnosću svoje primene posebno ističe upotreba specijalne agrotekstilne tkanine, koja dodatno ispoljava i pozitivan uticaj na ubrzavanje fenoloških faza razvoja biljaka (Milivojević et al., 2010). Posebno je značajno primeniti ovu vrstu tkanine kod sorti rane epohe zrenja u kombinaciji sa crnom malč folijom, kako bi se uticalo na što raniji početak zrenja i obezbedio visok kvalitet plodova namenjenih tržištu sveže potrošnje.

Uticaj primene agril termozaštitne tkanine težine 19 g/m^2 na parametre proizvodne vrednosti i nutritivnog kvaliteta ploda sorte jagode 'Clery' ispitivali su Milivojević et al. (2010) u uslovima beogradskog Podunavlja. Primljena agril termozaštitna tkanina je ispoljila pozitivan uticaj na vreme zrenja plodova ispitivane sorte, koje je nastupilo 9 dana ranije u odnosu na tretman bez agrila (01. maj i 09. maj, po redosledu). Više vrednosti broja rodnih stabljika i plodova po bokoru, kao i mase ploda dobijene su pod agrilom (Tab. 1).

Tabela 1. Rodni potencijal sorte jagode 'Clery' u zavisnosti od primene agrila
Cropping potential of strawberry cultivar 'Clery' depending on agril foil utilization

Tretman <i>Treatment</i>	Broj rodnih stablj. po bokoru <i>No of inflorescen- ces per plant</i>	Broj plodova po bokoru <i>No of fruits per plant</i>	Masa ploda <i>Fruit weight (g)</i>	Prinos po bokoru <i>Yield per plant (g)</i>	Prinos po m^2 <i>Yield per square meter (kg)</i>
Sa agrilom <i>With agril</i>	$4,1 \pm 0,12$	$40,4 \pm 1,93$	$24,0 \pm 0,55$	$960,1 \pm 53,75$	$4,80 \pm 0,27$
Bez agrila <i>Without agril</i>	$3,4 \pm 0,00$	$34,0 \pm 2,95$	$29,8 \pm 2,54$	$1.029,9 \pm 100,2$	$5,15 \pm 0,50$
<i>t - test</i>	**	*	*	nz	nz

Rezultati su prikazani kao prosečne vrednosti za tri ponavljanja \pm standardna devijacija.

^{nz}Statistički nije značajna razlika; *statistički značajna razlika na nivou 0,05; **statistički značajna razlika na nivou 0,01.

Results are the means of three replications \pm standard deviation. ^{nz} No significant differences.

**Significant differences at $P \leq 0,05$. ** Significant differences at $P \leq 0,01$.*

U pogledu hemijskog sastava ploda, pod agrilom je registrovan veći sadržaj rastvorljivih suvih materija i ukupnih fenola, kao i visok antioksidativni kapacitet ploda ispitivane sorte. Sveukupno posmatrano, dobijeni rezultati ukazuju na opravdanost upotrebe agril termozaštitne tkanine u zasadima jagode, što su potvrđili i brojni drugi primjeri u proizvodnoj praksi.

PROIZVODNJA JAGODE U ZAŠTIĆENOM PROSTORU – KOMBINOVANI UTICAJ SORTE I SISTEMA GAJENJA

S obzirom na porast tražnje za svežim plodovima jagode tokom cele godine i sve evidentniji štetan uticaj klimatskih faktora (velike količine padavina, pozni prolećni mrazevi i jako sunčev zračenje), raste i interes proizvođača za pronalaženjem uspešnih sistema uzgoja jagode u zaštićenom prostoru. Prema Milivojević et al. (2007) postoje različiti načini gajenja jagode u plastenicima i drugim vidovima zaštićenog prostora, među kojima se primena standardne tehnologije gajenja na gredicama uz obavezno zastiranje zemljišta PE folijama i instaliranje sistema za navodnjavanje smatra najjednostavnijom i ekonomski najracionalnijom.

Bitna komponenta povećanja intenzivnosti proizvodnje u ovakvoj tehnologiji gajenja je i primena različito obojenih PE malčeva, čiji je uticaj posebno značajan na porast, prinos i kvalitet ploda jagode (Sharma i Sharma, 2003). Pomenuti efekti prvenstveno nastaju usled optičkih osobenosti PE malča i činjenice da folija sprečava evaporaciju, reguliše temperaturni režim zemljišta, doprinosi očuvanju fizičke strukture zemljišta i smanjenju razvoja korova (Nikolić i Milivojević, 2010). Crna polietilenska folija predstavlja standard među proizvođačima širom sveta (Schales, 1990), ali je specijalizovana i primena drugih obojenih plastičnih materijala (bela, srebrna, zelena i providna folija).

Ispitivanjem uticaja tri različito obojene PE folije (crna, bela i srebrna) na pomološke osobine sorti jagode 'Clery' i 'Miss' gajenih u plasteniku na demonstraciono-oglednom polju firme argoeB zi "tiH ineleZ"da u periodu 2005-2006. godine, Milivojević et al. (2007) su registrovali raniji početak zrenja na crnoj i srebrnoj malč foliji, dok su bolje fizičke osobine ploda kod obe ispitivane sorte dobijene na beloj i srebrnoj malč foliji. Najveći sadržaj rastvorljive suve materije i šećera u plodu sorte 'Clery' je registrovan na srebrnoj malč foliji, a kod sorte 'Miss' najveća vrednost za pomenute parametre dobijena na crnoj malč foliji. Bela malč folija je ispoljila pozitivan uticaj na sadržaj ukupnih kiselina kod obe ispitivane sorte.

Na osnovu rezultata ispitivanja većine analiziranih parametara za vansezonsku proizvodnju u plasteniku sorte jagode 'Clery' mogu se preporučiti srebrna i bela malč folija, dok je kod sorte 'Miss' i crna malč folija pored bele ispoljila pozitivan uticaj na hemijski sastav ploda. Imajući u vidu da je zadovoljstvo potrošača visoko zavisno i od organoleptičkih osobina ploda jagode (Darbellay et al., 2002), najbolje ocene za boju, ukus i aromu ploda dobila je sorta 'Clery' i time sveobuhvatno ostvarila najveću ukupnu organoleptičku ocenu kvaliteta ploda na srebrnoj malč foliji (23,1). Dodatno, posmatrano samo sa aspekta ranostasnosti, crna malč folija nalazi svoju primenu kod obe ispitivane sorte.

Nikolić i Milivojević (2008) su u uslovima plastenika ispitivali važnije pomološke osobine introdukovanih sorti jagode ('Patty', 'Queen Elisa', 'Miss', 'Clery', 'Eva', 'Dora' i 'Elsanta'), koje su gajene u zemljištu objekta na gredicama prekrivenim srebrnom PE folijom.

U ovim istraživanjima, za komercijalnu i ranu proizvodnju jagode u plasteniku preporučene su sorte 'Clery', 'Queen Elisa' i 'Elsanta', dok je sorta 'Dora' preporučena za gajenje sa aspekta dobrih fizičkih osobina ploda, visoke rodnosti i kasnostasnosti značajne za produžetak sezone potrošnje svežih plodova jagode (Tab. 2).

Tabela 2. Pomološke osobine introdukovanih sorti jagode gajenih na gredici u plasteniku
Pomological properties of introduced strawberry cultivars grown in plastic tunnel

Sorta <i>Cultivar</i>	Masa ploda <i>Fruit weight (g)</i>	Indeks oblika ploda <i>Index of fruit shape</i>	Dužina peteljke <i>Stalk length (cm)</i>	Rastvorljiva suva mat. <i>Soluble solids content (%)</i>	Ukupne kiseline <i>Total acids (%)</i>	Prinos po bokoru <i>Yield per plant (g)</i>
Patty	36,2 a	0,98 bc	3,31 c	8,3 b	0,79 b	787,3 b
Queen Elisa	33,3 a	1,05 ab	4,48 b	8,1 b	1,04 a	1103,1 a
Miss	28,0 ab	1,05 ab	4,78 ab	7,3 c	0,96 ab	808,0 b
Clery	22,9 c	1,10 a	5,41 a	9,0 a	0,99 ab	518,0 c
Eva	35,1 a	1,08 a	4,35 b	8,0 bc	0,80 b	377,0 cd
Dora	33,9 a	1,05 ab	2,94 cd	7,9 bc	0,75 bc	822,3 b
Elsanta	26,5 b	1,03 b	4,49 b	8,4 b	1,05 a	865,9 ab
<i>F-test</i>	*	*	*	*	*	*

Rezultati su prikazani kao prosečne vrednosti za tri ponavljanja. Vrednosti u kolonama praćene istim slovnim oznakama nisu statistički značajno različite. *statistički značajna razlika na nivou 0,05.

*Results are the means of three replications. Values within the column followed by the same letter are not significantly different at P ≤ 0.05. * Significant differences at P ≤ 0.05.*

Nažalost, od svih preporučenih sorti u proizvodnim zasadima u Srbiji se zadržala samo sorta 'Clery', koja je i dalje veoma cenjena i tražena sorta ne samo od strane proizvođača, već i samih potrošača. Sporadično se u proizvodnim zasadima mogu pronaći i sorte 'Queen Elisa' i 'Patty', iako nema zvaničnog uvoza sertifikovanih sadnica ovih sorti. Posebno treba istaći interesovanje proizvođača za gajenjem sorte 'Queen Elisa', koja je i pored odličnih proizvodnih svojstava ispoljenih u našim agroekološkim uslovima brzo potisnuta iz proizvodne prakse, uglavnom zbog ograničenih količina proizvedenih sadnica u rasadnicima u Italiji, gde nije pokazala dobre rezultate.

Povećani zahtevi za svežim plodovima jagode i van sezone, kao i znatno veća cena na tržištu utiču na zainteresovanost proizvođača za pronalaženjem pogodnih sistema hidroponskog gajenja u plastenicima i visokim tunelima. Uglavnom se teži korišćenju različitih tipova kontejnera ili vreća ispunjenih supstratom, pri čemu se jagoda tempirano sadi sa ciljem obezbeđivanja prvog roda već nakon 50 do 60 dana. Generalno, uspešnost primene različitih sistema hidroponskog uzgoja u zaštićenom prostoru zavisi od nivoa regulacije mikroklimatskih uslova unutar objekta (temperaturе i relativne vlažnosti vazduha, intenziteta svetlosti), veličine kontejnera, fizičkih i hemijskih osobina supstrata, metode primene i izbora đubriva sa adekvatnim dozama, kao i primjenjenog načina navodnjavanja, trajanja i normi zalivanja (Milivojević et al., 2006a).

Supstrat koji se koristi u hidroponskom gajenju jagode najčešće čine beli ili crni treset, kisele reakcije (pH 2,5 do 3) i odlične vododržeće sposobnosti, kokosova vlakna, ekspandirani minerali gline: vermikulit (1-2 mm) i agroperlit i sl., kao i različite mešavine navedenih supstratnih komponenti kako bi se obezbedili povoljni uslovi za optimalan porast biljaka. U upotrebi se nalazi i originalni holandski supstrat BVB HAASNOOT upakovani u vreće zapremine 15 l, sa 10 otvora tj. sadnih mesta. Proučavajući pomološke osobine pet sorti jagode gajenih u vrećama ispunjenim ovim supstratom, koje su bile postavljene na podne konzole visine 1,1 m, sa gustinom sklopa od 10 biljaka/m², Milivojević et al. (2006a) su

najveću rodnost u jesenjoj (50-60 dana nakon sadnje) i prolećnoj berbi sledeće godine registrovali kod sorte Tuchampion (188 g/biljci i 772,6 g/biljci, po redosledu). Najmanju rodnost u ovom sistemu gajenja pokazala je sorta 'Clery' obezbeđujući prinos od 87,8 g po biljci u jesenjoj berbi i 431,5 g po biljci u prolećnoj berbi. Međutim, ona se odlikovala najranijim vremenom zrenja u oba perioda plodonošenja (08. septembar i 06. maj), što pored odličnog kvaliteta ploda doprinosi izraženoj komercijalnoj vrednosti ove sorte.

Rodni potencijal sorte jagode 'Clery' je ispitivan i u funkciji njenog gajenja u vrećama zapremine 20 l, koje su ispunjene sa osam različitih supstratnih smeša i postavljene na pod visokog tunela, sa gustinom sklopa od 8 biljaka/m² (Milivojević et al., 2006b). Najbolja rodnost je ustanovljena na supstratu kombinovanom od 50% treseta, 30% kokosovih vlakana i 20% perlita, uz dodatak 5 kg đubriva Multi Comp Base, 1,5 kg siforge, 1,5 kg CaNO₃ i 80 g Fe.

Zahvaljujući velikoj prilagodljivosti sorte 'Clery' na različite sisteme gajenja u sezonskoj i vansezonskoj proizvodnji, Milivojević et al. (2009a) su komparativno ispitivali uticaj tri sistema gajenja u zaštićenom prostoru: dva sistema hidroponskog uzgoja (sistem A - u vrećama sa 15 l BVB HAASNOOT supstrata postavljenim na podne konzole visine 1,1 m sa gustinom sklopa od 10 biljaka/m²; sistem B - u vrećama sa 20 l supstratne smeše sastavljene od 50% treseta, 30% kokosovih vlakana i 20% perlita, koje su postavljene u redove na pod visokog tunela sa gustinom sklopa od 8 biljaka/m²) i sistem C – plastenički uzgoj u formi dvoreda na gredicama prekrivenim crnom PE folijom sa gustinom sklopa od 5,5 biljaka/m². U svim sistemima gajenja frigo sadnice kategorije A su posadene početkom avgusta 2005. godine, nakon čega je pušten prvi jesenji rod u septembru, a zatim je na istim biljakama drugi glavni rod dobijen u proleće 2006. godine.

Tabela 3. Uticaj sistema gajenja na rodni potencijal sorte jagode 'Clery' gajene u zaštićenom prostoru (2005-2006 god., Demonstraciono-ogledno polje firme "Zeleni hit", Beograd)

The influence of growing system on cropping potential of 'Clery' strawberry in protected conditions (2005-2006, Experimental field of 'Zeleni Hit' enterprise in Belgrade)

Godina Year	Sistem gajenja <i>Growing system</i>	Broj plodova po bokoru <i>No of fruits per plant</i>	Masa ploda <i>Fruit weight</i> (g)	Prinos po bokoru <i>Yield per plant</i> (g)	Prinos po m ² <i>Yield per square meter</i> (g)
2005 (jesen) <i>autumn</i>	A	9,0*	9,8	87,8*	878,3**
	B	7,8	10,7	83,2	665,6
	C	6,0	11,5**	68,7	412,2
2006 (proleće) <i>spring</i>	A	22,7	19,0	431,5	4315,0**
	B	26,7	17,4	464,6	3716,8
	C	22,7	22,9**	518,0*	3180,2

Rezultati su prikazani kao prosečne vrednosti za tri ponavljanja. ** Statistički značajna razlika na nivou 0,01; * Statistički značajna razlika na nivou 0,05.

*Results are means of three replications. **Significant differences at P ≤0.01; *Significant differences at P ≤ 0.05.*

Sistem A, u kome je gajeno po 10 biljaka u vrećama sa 15 l BVB HAASNOOT supustrata, ispoljio je pozitivan uticaj na rodni potencijal ispitivane sorte 55 dana nakon sadnje, značajno povećavajući broj plodova i prinos po bokoru (9,0 i 87,8 g, po redosledu) u poređenju sa ostala dva ispitivana sistema. Međutim, u proleće sledeće godine kada je dobijen drugi glavni rod, najveća masa ploda i prinos po bokoru (22,9 g i 518,0 g, po redosledu) su zabeleženi u sistemu gajenja na gredicama prekrivenim crnom PE folijom, sa najmanjom gustinom sklopa biljaka. Stoga, dobijeni rezultati opravdavaju primenu ovog najjednostavnijeg sistema gajenja jagode u zemljištu unutar plastenika, koji se može uspešno koristiti za vansezonsku proizvodnju uz znatno niža ulaganja. Uzimajući u obzir i činjenicu da je sorta 'Clery' sklona dvorodnosti, može se očekivati produkcija još jedne serije plodova nakon pomenutog glavnog roda. Iako će biljke tada dati niži prinos po bokoru, cena po kilogramu sveže jagode u vansezoni pokazala se veoma stimulativnom za proizvođače.

Vertikalni sistem uzgoja jagode u visokom tunelu predstavlja jedinu tehnologiju gajenja, koja do sada nije dala dobre rezultate u proizvodnoj praksi. Ova tehnologija se zasniva na sadnji jagode u specijalno konstruisane stiroporske saksije zapremine 5,5 l, koje se po devet ređaju u vertikalnom rasporedu na stubove nosače, tako da zarotirane jedna iznad druge zaklapaju ugao od 45 stepeni. Sa sadnjom po 4 biljke u svakoj saksiji, gustina sklopa je 36 biljaka po m². U ovom sistemu gajenja Milivojević i Nikolić (2009c) su proučavali biološka svojstva sorte jagode 'Elsanta' u funkciji primene redukcije lisne mase (30% odbačenih listova) i poredili dobijene rezultate sa kontrolnim biljkama – bez redukcije lisne mase. Istraživanja su izvedena u visokom tunelu dimenzija: 5 m širina x 18 m dužina x 3,25 m visina. Stubovi nosači saksija su bili postavljeni na rastojanju od 1,2 m unutar reda i između redova. Unutar objekta instaliran je sistem za navodnjavanje sa kapaljkama iznad svakog stuba kapaciteta 4 l/čas, pri čemu su dreniranjem iz vršne saksije zalinjane sve ostale saksije u vertikali. Dobijeni rezultati potvrđuju da ovakav način gajenja jagode stvara velike razlike u rodnosti (od 254,8 g/biljci u najnižoj saksiji do 800,6 g/biljci u vršnoj saksiji u tretmanu sa redukcijom lisne mase). Zapaženo je i variranje u kvalitetu ploda (masa ploda se kretala od 17,6 g u donjim saksijama do 23,9 g u vršnim saksijama u tretmanu sa redukcijom lisne mase), dok je u pogledu hemijskog sastava ploda došlo do povećanja sadržaja rastvorljive suve materije, šećera i vitamina C idući od donjih ka vršnim saksijama. Ustanovljene razlike se javljaju kao posledica nejednakih mikroklimatskih uslova u proizvodnom prostoru biljaka gajenih u gustom sklopu po vertikalnom rasporedu. Stoga treba težiti modifikaciji ovog sistema gajenja u smislu smanjenja broja biljaka po jedinici površine i obezbeđivanja jednakih mikroklimatskih uslova u proizvodnom prostoru biljaka, što je moguće ostvariti povećanjem zapremine objekta ili postavljanjem kontejnera (saksija, vreća) u jednoj ravni, čime bi se znatno povećala/ujednačila produktivnost gajene sorte jagode uz poboljšanje i samog kvaliteta ploda. Čak se i primenjena mera redukcije lisne mase u ovom radu pokazala kao korisna, s obzirom na registrovano povećanje rodnosti i mase ploda, ali je negativan uticaj ispoljila na hemijske osobine ploda u poređenju sa kontrolnom varijantom (bez redukcije lisne mase).

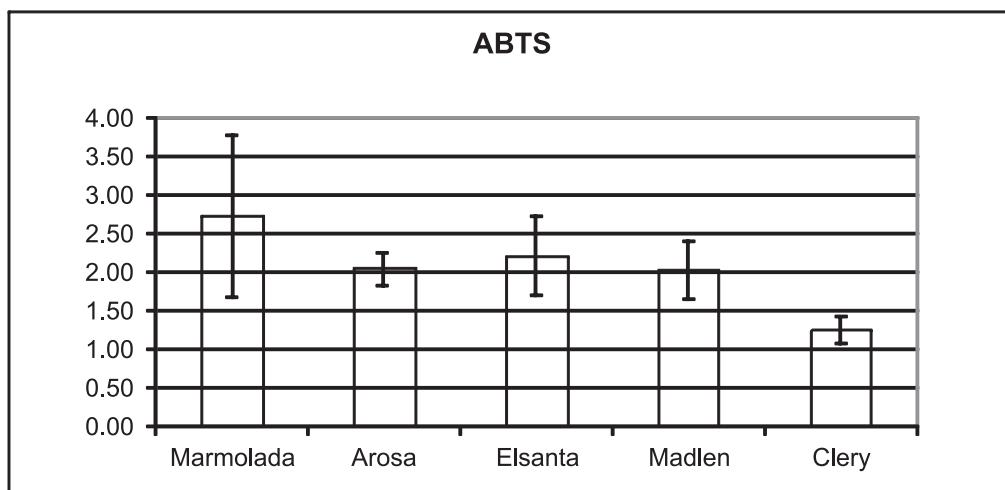
PROIZVODNA SVOJSTVA JEDNORODNIH I REMONTANTNIH SORTI JAGODE I PROMENE U KVALITETU PLODA TOKOM ĆUVANJA

Klasifikacija savremenog sortimenta jagode bazirana je na različitim kriterijumima, kao što su prilagodljivost različitim sistemima gajenja i ekološkim uslovima sredine, izražena rezistentnost na bolesti i štetočine, visina prinosa i kvalitet ploda (Milivojević et al., 2012b; Milivojević et al., 2009b). Nasuprot željama proizvođača koji traže visoko-produktivne sorte, krupnog ploda sa dugim rasponom zrenja, potrošači preferiraju sorte sa širokim opsegom

senzornih odlika. Stoga se velika pažnja poklanja i ispitivanju nutritivne vrednosti ploda jagode, koja može biti opisana sa standardnim pokazateljima kvaliteta (sadržajem rastvorljivih suvih materija, ukupnih kiselina i šećera) i analizom specifičnih komponenti (sadržaja vitamina C i fenolnih jedinjenja), kao važnih izvora ispoljene antioksidativne aktivnosti ploda jagode (Scalzo et al., 2005). Pored sorte, kao važnog faktora u određivanju nutritivnog kvaliteta ploda, značajan uticaj imaju i uslovi spoljašnje sredine, intenzitet primene agro i pomotehničkih mera, stepen zrelosti ploda i uslovi skladištenja posle berbe (Milivojević et al., 2013b; Capocasa et al., 2008).

Milivojević et al. (2009) su u proizvodnom zasadu zasnovanom u blizini Šapca na površini od 5 ha ispitivali pomološka i antioksidativna svojstva pet sorti jagode ('Clery', 'Elsanta', 'Marmolada', 'Arosa' i 'Madlen'). Primjenjeni sistem gajenja je forma dvoreda na gredicama zastrtim crnom PE folijom. Među ispitivanim sortama, 'Arosa' je ispoljila najbolje fizičke osobine ploda, kao i najveći sadržaj rastvorljivih suvih materija (8,7%). Ujedno je kod ove sorte registrovan i najkasniji početak zrenja (22. maj), što sa aspekta prolongiranja sezone berbe može biti od velikog značaja. Iako već prevaziđena u proizvodnim zasadima u našoj zemlji, sorta 'Marmolada' je u ovim istraživanjima ispoljila najveći sadržaj vitamina C u plodu (80,9 mg/100 g sv.m.pl.), čiji doprinos se ogleda ne samo u povećanju antioksidativne aktivnosti, već i u sprečavanju tamnjjenja i obezbojavanja plodova.

Prvi korak u determinisanju potencijala zdravstvene korisnosti voća predstavlja merenje antioksidativne aktivnosti, čiji rezultati su prikazani u Graf. 1. Dobijene vrednosti antioksidativnog kapaciteta ploda kod ispitivanih sorti jagode su se kretale proporcionalno sa sadržajem ukupnih fenola, pri čemu su najsnažniju antioksidativnu aktivnost ispoljile sorte 'Marmolada' (2,72 mg ekv ask./g sv.m.pl.) i 'Elsanta' (2,20 mg ekv ask./g sv.m.pl.), dok je najniži antioksidativni kapacitet ploda registrovan kod sorte 'Clery' (1,24 mg ekv ask./g sv.m.pl.).



Grafikon 1. Antioksidativni kapacitet ploda ispitivanih sorti jagode (mg ekv ask./g sv.m.pl.). Rezultati su prikazani kao prosečne vrednosti za tri ponavljanja ± standardna greška. *Antioxidant capacity of studied strawberry cultivars (mg ekv asc./g FW)*
Results are means of three replications ± standard error.

Permanenta introdukcija novih sorti jagode nameće potrebu za komparativnim proučavanjem njihove proizvodne i upotrebljive vrednosti, kako bi se došlo do saznanja da li određena sorta sa zadovoljavajućom do visokom produktivnošću poseduje i dobar biohemski sastav ploda. To je posebno značajno sa stanovišta definisanja komercijalne prihvatljivosti sorte, ali i određivanja nutritivnog kvaliteta i senzoričkih svojstava njenih plodova. U tom pogledu, Milivojević et al. (2012b) su proučavajući proizvodna svojstva i kvalitet ploda devet introdukovanih sorti jagode ('Elsanta', 'Sonata', 'Figaro', 'Honeoye', 'Daroyal', 'Salsa', 'Florence', 'Symphony' i 'Polka') gajenih na otvorenom polju u beogradskom Podunavlju ustanovili da je većina sorti komercijalno prihvatljiva bazirano na ispoljenim agronomskim osobinama. Ipak, samo četiri sorte se mogu sa sigurnošću preporučiti za šire gajenje zahvaljujući visokom rodnom potencijalu i kvalitetu ploda ('Figaro', 'Florence', 'Sonata' i 'Symphony'). U laboratoriji Katedre za voćarstvo Poljoprivrednog fakulteta Univerziteta u Beogradu praćen je i uticaj dva režima čuvanja na promene u kvalitetu svežih plodova ispitivanih sorti jagode (1. Čuvanje u specijalnoj komori na temp. +4°C sa vazduhom tretiranim bipolarnom jonizacijom – sinergizam pozitivnih i negativnih jona kiseonika i ozona; 2. Čuvanje u frižideru na temp. +4°C bez modifikovane atmosfere). Upoređujući masu ploda ispitivanih sorti jagode pre čuvanja sa masom ploda posle čuvanja zaključeno je da tretman sa bipolarnom jonizacijom vazduha smanjuje gubitke u masi ploda, pri čemu je najniži kalo registrovan kod sorte 'Florence' (2,8%). Za razliku od nje, sorte 'Figaro', 'Daroyal' i 'Salsa' su pokazale bolju trajnost plodova u uslovima frižidera, posebno sorta 'Figaro', čiji plodovi su uspešno čuvani do 6 dana. U komori sa bipolarnom jonizacijom najduži period čuvanja imala je sorta 'Symphony', koja je ostvarila i najvišu ukupnu ocenu za senzorički kvalitet ploda (19,0 poena od max. 20,0 poena). Pored pomenutih efekata bipolarne jonizacije, zapažen je i njen pozitivan uticaj na smanjenje razvoja sive truleži ploda (prouzrokovala *Botrytis cinerea* Pers.), što potvrđuje i činjenica da je razvoj ovog patogena detektovan samo kod sorti 'Salsa', 'Florence' i 'Symphony'.

U prethodno pomenutim istraživanjima stavljen je akcenat na proizvodne sisteme, produktivnost i kvalitet ploda različitim jednorodnim sorti jagode, koje su pretežno zastupljene u proizvodnim zasadima u Srbiji. Međutim, zapaža se i povećano interesovanje za remontantnim (stalnorađajućim) sortama, koje kontinuirano cvetaju i plodonose tokom 5-6 meseci (od maja do oktobra) obezbeđujući na taj način vansezonsko snabdevanje tržišta svežim plodovima. Ipak, još uvek nije precizno poznat šablon rađanja ovih sorti (kada su pikovi berbi i koji je nivo produktivnosti po mesecima). Vrlo je važno ispitati i da li dolazi do promena u fizičkim i hemijskim svojstvima plodova između perioda plodonošenja tj. različitih datuma berbe. Milivojević et al. (2012d) su sa ciljem dolaženja do ovih saznanja izvršili komparativna ispitivanja parametara rodnog potencijala i kvaliteta ploda kod dve remontantne sorte 'Elsinore' i 'Diamante'. Eksperiment je izведен tokom 2011. godine, u proizvodnom zasadu jagode zasnovanom na otvorenom polju u blizini Zaječara. Rezultati istraživanja ukazuju da je sorta 'Elsinore' ostvarila značajno veći kumulativni prinos po bokoru (2,02 kg) u odnosu na sortu 'Diamante' (1,68 kg), sa ispoljenim variranjem u nivoima produktivnosti između pikova berbi kod obe ispitivane sorte. Prosečna masa ploda se kretala u rasponu od 19,7 g ('Elsinore') do 22,5 g ('Diamante'), pokazujući opadajući trend idući od prve ka četvrtoj berbi. Sorta 'Diamante' je ispoljila bolji hemijski sastav ploda, uključujući veći sadržaj rastvorljive suve materije (8,6%), ukupnih kiselina (0,87%) i vitamina C (60,1 mg/100 g sv.m.pl.). Generalno, najveće povećanje prinsa i mase ploda je registrovano u prva dva perioda plodonošenja/berbe, dok su povećane koncentracije rastvorljivih suvih materija i ukupnih kiselina dobijene tokom sredine leta i rane jeseni. Iako kod sadržaja vitamina C nije

zabeležen značajan uticaj vremena berbe, može se reći da postoji potreba za poboljšanjem kvaliteta ploda ovih sorti u kasnijim jesenjim berbama.

Uzimajući u obzir važnost kvaliteta ploda jagode uključujući i antioksidativni kapacitet, ispoljen kroz prisustvo vitamina C i fenolnih jedinjenja, cilj istraživanja sprovedenih od strane Milivojević et al. (2012c) je bio da se identifikuju i kvantifikuju važne komponente ukusa i neka od fenolnih jedinjenja sadržana u plodu šumske jagode *F. vesca*, sorte 'Regina' (selekcija stalnoradajuće samonikle forme *F. vesca* var. *semperflorens*) i komercijalne stalnoradajuće sorte 'Irma'. Sorta 'Regina' je ispoljila najveći sadržaj fruktoze (14,44 mg/g sv.m.pl.) i glukoze (10,85 mg/g sv.m.pl.), dok je najveći sadržaj saharoze imala šumska jagoda (19,04 mg/g sv. m.pl.). Limunska kiselina je dominantno zastupljena organska kiselina u plodovima šumske jagode i sorte 'Regina' (11,04 i 15,09 mg/g sv. m. pl., po redosledu). Međutim, kod sorte 'Irma' sadržaj limunske i jabučne kiseline je pokazao skoro identične vrednosti. Vrlo visok sadržaj slobodne elaginske kiseline dobijen je iz semenki ploda sorte 'Regina' (151,36 µg/g sv.m.pl.), kao i najveći sadržaj ukupnih fenola (128,19 mg ekv. GA/g sv.m.pl.). Shodno tome, najveću antioksidativnu aktivnost ispoljile su semenke ploda sorte 'Regina' (8,04 mg ekv. ask./g sv.m. pl.), a zatim mezokarp ploda šumske jagode (2,70 mg ekv. ask./g sv.m.pl.). Sveobuhvatno posmatrano, pored šumske jagode *F. vesca* superiornost u pogledu sadržaja svih ispitivanih komponenti ukusa i antioksidativne aktivnosti ploda ispoljila je i sorta 'Regina'. Ova saznanja su značajna s obzirom na povećano interesovanje za zasnivanjem komercijalnih zasada jagode sorte 'Regina' poslednjih nekoliko godina u Srbiji.

Zaključak

Da bi se povećala proizvodnja jagode i konkurentnost na svetskom tržištu potrebno je pre svega iskoristiti komparativne prednosti širokog područja Srbije pogodnog za ovu proizvodnju. One se ogledaju u planskoj rejonizaciji, sa pravilnim izborom sorti, uz iskorišćavanje terena na različitim nadmorskim visinama sa mogućnošću organizovanja produžene sezone berbe u trajanju od nekoliko meseci. Povećanjem obima proizvodnje sa mogućnošću kontinuirane isporuke prema zahtevima kupaca, kao i primenom različitih sistema gajenja u zaštićenom prostoru odnosno specifičnim merama zaštite na otvorenom polju sa ciljem smanjivanja nepovoljnog uticaja klimatskih činilaca na visinu prinosa i kvalitet plodova, mogli bi se smanjiti rizici u proizvodnji i povećati rentabilnost gajenja jagode. Postojanje rashladnih kapaciteta za privremeno skladištenje plodova je takođe od primarnog značaja za očuvanje njihovog kvaliteta, pored već nametnutih standarda za pakovanje plodova u adekvatnu ambalažu, posebno kada je u pitanju izvoz plodova u svežem stanju. Konačno, podržavajući koncept proširenih zahteva potrošača u kojima su bioaktivne komponente sadržane u plodovima jagode visoko željeni kvalitativni atributi, može se značajno doprineti promovisanju ovog voća i sa zdravstvenog aspekta.

Sve pomenuto se može postići pod uslovom da sistematski otklanjamo slabosti u proizvodnji prevodeći ih u prednosti, za šta je potrebno što pre preduzimati konkretne aktivnosti na polju ubrzanja procesa unapređenja konkurentne proizvodnje jagode.

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Achievements and Trends in Strawberry Production in Serbia

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Summary

This paper presents the state of strawberry production over last ten years showing the results of production traits of strawberry cultivars affected by different growing technologies in the open field and under protected conditions. Permanent introduction of new cultivars selected in various breeding stations in Italy, Holland, France and England has caused a great dynamic of assortment in strawberry production in Serbia. Since 2005 cv. 'Clery' has taken over a dominant place in strawberry plantations due to its early ripening time, excellent fruit quality and high adaptability to different growing systems in both seasonal production and off – seasonal one (including hydroponic system in high tunnels). Growing system in the form of double rows on raised beds covered with synthetic/organic mulches, irrigation system and fertigation are slowly becoming a common growing technology providing higher commercial yields. New trends face the possibilities of introduction of one-row growing system on raised beds and plastic tunnels application the purpose of which is to prevent unfavourable climatic factors effects, as well as introduction of new table strawberry cultivars tolerant to diseases.

Key words: *Fragaria ananassa* Duch., cultivar, growing technology, yield, fruit quality.

CURRENT DEVELOPMENTS IN THE BREEDING OF NEW STRAWBERRY VARIETIES FROM 'FRESH FORWARD'

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Abstract. Strawberry breeding is a time consuming and laborious job. Fresh Forward is one of the leading strawberry breeding companies and has developed important strawberry cultivars for the European market. The most recent cultivars that have been released by Fresh Forward are Sonata, Rumba, Salsa, Figaro, Jive and Vivaldi. For over 30 years, the Northern European market was dominated by one single cultivar ('Elsanta'), which was used in nearly all types of cultivation. However, currently there is a clear trend towards diversification in cultivar usage and also a professionalization of the cultivation systems in general. This is driven by the need of growers to diversify and adapt to developments in the market. Hence, there is a demand for specifically tailored new cultivars.

Key words: breeding, selection, strawberry, cultivar

Company history

Fresh Forward is a private company focused on the breeding and marketing of new strawberry cultivars for professional growers. The breeding programme was initiated in 1943. Until recently, the breeding programme was executed by the Ministry of agriculture and horticulture (Plant Research International (PRI)). In 2005 the programme was privatized and continued by Fresh Forward, which is owned by two shareholders: Plant Research International and Fragaria Holland BV. Fragaria Holland BV is a company owned by four strawberry plant propagators: De Kemp BV, Neessen BV, RAPO BV and Van Alphen Aardbeiplanten BV. So far, Fresh Forward has developed and introduced six cultivars (Table 1). The Fresh Forward philosophy is to introduce a new cultivar only when it shows a clear improvement or addition to the present market situation.

Table 1. Short-day cultivars introduced by Fresh Forward

Name	Season	Growing area	Introduction year
Sonata	Mid	Northwest and middle Europe	2002
Salsa	Late	Northwest Europe	2002
Figaro	Mid	West and middle Europe	2006
Rumba	Early	Northwest Europe	2009
Jive	Late	Northwest and middle Europe	2013
Vivaldi	Mid	Northwest and middle Europe	2013

Breeding history

Each year several new strawberry cultivars are released on the market. According to Faedi (Faedi et al., 2002) 463 different cultivars from 35 different countries were introduced from 1982 till 2002. Checking the Community Plant Variety Office list of granted and active strawberry cultivars indicates a clear and steady increase in number of granted and active applications (Figure 1) over the last 20 years.

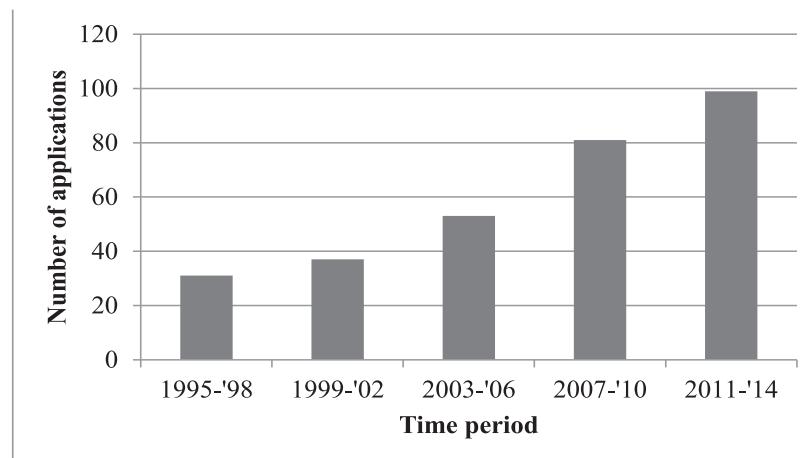


Figure 1. CPVO: Number of applications granted or active per year
Source: <http://www.cpvo.europa.eu/main/en/home>

This list includes all types of short-day and everbearing cultivars suited for either Northern, central or Southern Europe. Even though, many new cultivars are introduced each year, yet only a few of them have become really important and managed to remain for more than 5 years.

The cultivar 'Elsanta', which was developed in the seventies from our breeding program, has been a leading cultivar in Northwest Europe for many years (Simpson, 2014; Lieten, 2014). When it was introduced in 1981, it presented an enormous improvement over contemporary cultivars for fruit firmness, fruit size and yield. Previous cultivars like 'Tenira', 'Elvira', 'Sivetta', 'Bogota', etc. were so fragile that all fruits had to be picked by their fruit stalks. 'Elsanta' however, was much firmer and less fragile. This allowed fruits to be picked without their fruit stalks and resulted in a significant reduction of picking time and therefore labour costs. It is often said by growers, that 'Elsanta' saved the strawberry production for The Netherlands. Another key factor in the success of 'Elsanta' was its versatility, which led to the inception, development and improvement of several (new) cultivation systems for strawberries. Although 'Elsanta' was initially introduced for the open field production in the summer, it has quickly become the leading cultivar for glasshouse production, 60-day culture and table top production systems.

Several other cultivars have been introduced to replace 'Elsanta'. Some of them were successful like 'Sonata', 'Clery' and 'Elegance', but many have been without long lasting success like for example 'Kimberly', 'Marmolada', 'Daroyal', 'Emily', 'Alice', 'Eros' and 'Elianny'. Some recent introductions such as 'Jive', 'Vivaldi', 'Dream', 'Magnum' and 'Malling Centenary' might take over a part of the production area of 'Elsanta', but still have to prove their value.

The first real threats to the supremacy of 'Elsanta' were the introductions of 'Darselct' (1996) and 'Sonata' (2002). 'Darselct' challenged 'Elsanta' in the forcing culture of glasshouse production, whereas 'Sonata' challenged 'Elsanta' in the open field production and 60-day culture. More recently, 'Clery' (2006) has taken over a significant area of 'Elsanta', because of its earliness.

In Southern Europe the predominant cultivar was 'Camarosa' for many years (Medina et al., 2014). However, the predominance of one cultivar has made room for several new cultivars here as well. Each of them for a special reason. The main cultivars in South Spain are now, free cultivars like 'Florida', 'Fortuna', 'Sabrina', 'Primori', 'Sabrosa', 'Sahara' and 'Splendor' and some club cultivars like 'Virtue' and several Driscoll's cultivars.

In the North of Europe the most important cultivars are 'Polka', 'Honeoye' and 'Korona'. Here we see a very slow shift to new cultivars, because of the long growing cycle applied by many growers in their cultivation system. Very often the plants are kept for at least three years before it is replanted. Therefore it takes rather long to replace old cultivars by new ones. Upcoming cultivars are mainly 'Sonata' and 'Rumba'.

Nowadays, the dominance of one cultivar is replaced by a much more dynamic situation, where several cultivars are competing with one and another for the best position in the market. New cultivars come and go at a much higher speed. This process is driven by the requirements demand of the market, and by diversification and professionalization of the cultivation systems. Therefore many breeders have intensified and upgraded their breeding programmes, whereas, at the same time the number of strawberry breeders has risen as well. New strawberry breeding programmes were initiated for example by: Hansabred, Flevoplant, Fresas Nuevos Materiales and Limberry. All these developments put a higher pressure on breeders in order to be successful.

Current trends in breeding

The production of strawberries in Northwest Europe has changed a lot during the past 25 years. Best prices are obtained at the beginning and end of the production season, therefore both earliness and lateness have become much more important. Examples of early varieties are 'Darselct', 'Honeoye', 'Alba', 'Clery', 'Rumba' and 'Flair', whereas late cultivars include 'Kent', 'Salsa', 'Florence', 'Symphony', 'Yamaska', 'Isaura', 'Pandora' and 'Malwina'. Instead of using late short-day varieties the season can also be extended by the use of everbearers. During the last 10 to 15 years many everbearing cultivars have been introduced. However, there doesn't seem to be one dominant cultivar as most cultivars disappear after a few years on the market, to be replaced by new introductions. Cultivars that were grown over the last 15 years include: 'Selva', 'Evita', 'Evie 2', 'Everest', 'Charlotte', 'Albion', 'Ava', 'Portola', 'San Andreas', 'Capri', 'Monterey', 'Florin', 'Florina' and 'Florentina'.

Besides cultivar improvements, there have also been many improvements in cultivation techniques. Strawberry production has gone from simple open field cultivations, planted in the autumn, to a variety of new systems (Table 2). Each cultivation system is demanding its own cultivar, which means that we, as breeders, have to adapt our selection strategies as well.

Table 2. Different cultivation systems and cultivars used in these systems

Cultivation system	Type of plants used	Planting time	Harvesting period	Main cultivars used for this cultivation
Open field	Bare rooted plants	August	June	Elsanta, Sonata, Rumba, Clery, Florence
Frigo cultivation	Frigo plants	April-June	June-July	Elsanta, Sonata, Rumba, Salsa, Clery, Florence
Early forcing glasshouse	Tray plants	December-January	March-May	Sonata, Clery
Continuous culture in glasshouse	Tray plants	August	October-December and April-May	Elsanta
Tunnel cultivation	Waiting bed plants, A ⁺ plants	February-May	May-July	Elsanta, Sonata, Rumba
60-day culture	Waiting bed plants	March-July	June-September	Elsanta, Sonata, Jive
Table top culture	Waiting bed plants, plug plants, A plants	Spring till end of summer	Late spring till autumn	Elsanta, Sonata, Jive

New demands for improvement and changes can come from unexpected developments. The need for good tasting strawberries is getting louder each year. Other traits, like for example disease resistance to fungal pathogens, need further improvement. Meanwhile, there are new threats such as *Drosophila suzukii*, thrips, new viruses, white streak, etc. All these threats require new breeding efforts. Finally, growers, retailers, supermarkets and consumers will only cherish an improvement on one single trait, when it is embedded in a cultivar with good traits overall.

Breeding at Fresh Forward

Fresh Forward has three different breeding programmes for strawberries. The main breeding programme deals with the development of short-day cultivars for Northwest Europe. In 2000 we started a similar programme for the selection of short-day cultivars for Southern Europe (and all other similar climate zones). Our third programme aims to develop excellent everbearing or day-neutral cultivars. The breeding programmes of Fresh Forward are based on classical breeding tools. They consist of making crosses between cultivars or selections and performing rigorous selection on the progeny. These crosses are made in pollination cages inside a greenhouse. Ripe fruits from the mother plants are harvested and seeds are removed from the fruits. In the spring, seeds are sown and raised to young seedling plants. These seedling plants are then either planted in the open field in August or raised as a tray plant. The field plants are selected in the open field in the following spring and summer. The tray plants are planted in a greenhouse in early January. These tray plants will develop rather quickly, which has the advantage that all selection work can be done before the start of the selection work in the open field.

When a seedling is selected, runner plants are harvested. This is done for two purposes: preservation of the genotype, and for evaluation in the production trials for next year. Subsequently, each selected genotype is preserved and evaluated over several years. Discarded genotypes are completely removed, from both the trials as well as from the

nurseries. This way, the number of genotypes originating from a certain year is slowly decreasing. When a genotype is selected for more than four or five years, it is generally promoted to the status of Advanced Selection. At this stage candidate plants are sent to a test centre of NAK-tuinbouw in the Netherlands to check the virus and disease status. The test centre will produce Super Elite (SEE) plants for the Elite Soft Fruit Certification Scheme. From this moment on more plants will be produced to have sufficient plants available for tests in different cultivation systems as well as for tests with growers, and the application for Plant Breeders' Rights.

The breeding programmes for Southern Europe and for day-neutrals follow more or less the same path. On average Fresh Forward starts every year with about 22.000 seedlings for the short-day programme for Northwest Europe, 10.000 seedlings for the short-day programme for Southern Europe and 8.000 seedlings for the day-neutral program. Thus the total breeding programme amounts to about 40.000 seedlings that are screened annually.

In the production trials genotypes are tested and evaluated for many important characteristics, such as yield, fruit quality, plant habit and general disease resistance in the field. Specific disease tests are performed in the greenhouse under more controlled conditions. So far two disease tests, for *Phytophthora cactorum* (crown rot) and *Colletotrichum acutatum* (anthracnose), have been incorporated into the breeding program. Selections that make it to the fourth year are also tested under different cultivation systems, such as early greenhouse production, 60-day culture, outdoors table top production and continuous greenhouse production.

Molecular markers

Molecular markers help to improve and speed up the selection process. It is for example much easier to pyramid different resistance genes with molecular markers than by biological test trials. Most strawberry breeding programmes are still in the early stages of implementing molecular markers into their breeding program. Through collaboration with Wageningen University, Fresh Forward has aided pioneering work on molecular genetic research in strawberry. We have made use of pedigree based analysis (PBA) (Van de Weg et al., 2006; Bink et al., 2014), Microsatellite Allele Dose & Configuration Establishment (MADCE) (Van Dijk et al., 2012), and helped in the development of the 'Holiday' x 'Korona' genetic map (Van Dijk et al., 2014). Recently, Fresh Forward has started to implement molecular markers as a selection tool. The first molecular markers applied were on resistance to *Phytophthora fragariae* (red core) (Haymes et al., 2000). We are currently performing marker studies for traits such as *Phytophthora cactorum* resistance, long day flowering (everbearing) and *Colletotrichum* resistance.

An overview of the cultivars released by Fresh Forward

The ambition of Fresh Forward is to become one of the leading strawberry breeding companies in the world. We have released several new cultivars for Northwest Europe such as: 'Rumba', 'Sonata', 'Figaro', 'Vivaldi', 'Salsa' and 'Jive' (Table 3). The breeding programme for short-day cultivars for Northwest Europe is split up into three main time segments: early, mid-season and late. It is important to have top quality cultivars available for each time segment. The following section contains an extensive description of the varieties that have been developed by Fresh Forward for each time segment.

Table 3. Results of Fresh Forward cultivars and some standard cultivars over several years' evaluation in the breeding program

Cultivar	% Yield class 1 compared to Sonata	Average fruit weight (g)	Earliness compared to Sonata	Firmness*	Skin toughness*	General appearance*
Clery	68%	16,1	-8 days	4,2	3,7	2,9
Rumba	85%	19,3	-7 days	3,8	3,4	3,6
Honeoye	78%	16,9	-7 days	3,0	2,5	2,4
Sonata	100%	18,8	0	3,8	3,4	3,8
Elsanta	89%	17,0	0	3,7	3,2	2,8
Vivaldi	92%	17,4	-2	4,8	4,6	4,1
Salsa	89%	25,1	+8 days	3,3	2,5	2,4
Figaro	77%	19,8	0	4,5	4,2	3,8
Jive	127%	26,2	+9 days	4,3	3,7	3,8
Florence	98%	20,6	+ 9 days	4,0	3,5	2,2

* scored on a scale from 1 to 5, 1 meaning bad/poor, 5 meaning excellent

Early

Rumba, a shiny start to the summer

Blossoming and harvest period

'Rumba' blossoms rather early; sometimes a late night frost will cause a few flowers to freeze. The blossoms are medium sized and have well-developed stamens. More than enough pollen is produced to ensure good fruit setting. The blossoming and harvest periods are similar to those of 'Clery' and 'Honeoye'.

Fruit quality

Rumba's beautiful fruit is uniform, intensively shiny and red to dark red. It is juicy and generally has a relatively good flavour. Though the seeds are usually slightly recessed, sometimes they stand out clearly on the berries. The berries are quite robust and tolerate handling well, as long as they are picked under the right conditions. Additionally, they remain very glossy even after several days of storage.

The average fruit weight is significantly higher than that of 'Honeoye'. The secondary fruit are of a good size as well. In exceptional situations the primary fruit can become quite large. Like 'Honeoye', 'Rumba' is a somewhat darker coloured strawberry, and its fruit must be harvested regularly and on time. Generally the fruit is quite resistant to fruit rot (*Botrytis cinerea*), mildew (*Podosphaera aphanis*) and the effects of rain.

Productivity

Yield of 'Rumba' is greater than that of 'Honeoye' or 'Clery'. The fruit weight is considerably better, too. Especially the secondary and tertiary fruit are of a good size. 'Rumba' is easy to harvest and requires relatively little sorting. The harvest can be forced by protecting the plants with a cover. This allows the harvest date to be advanced by 4 to 7 days.

Susceptibility to diseases

'Rumba' is only minimally susceptible to disease. The plant is very vigorous; thus so far there have not been virtually problems with diseases. Nor have soil diseases such as crown rot (*Phytophthora cactorum*) and wilting (*Verticilliumdahliae*) led to many problems.

Growing experience

The cultivation of 'Rumba' often begins with frigo plants. Then 'Rumba' produces a healthy crop which does not grow too large. The variety flourishes with a plant spacing of 35 cm in a row. By the second year 'Rumba' has produced a good ground cover. The yield is excellent then as well. Though the fruit clusters extend sufficiently far out of the plant, they are not very long. This provides some protection during night frost and heavy rain. It also accepts forcing and is particularly suited for early open air cultivation.

In normal cultivation (planting late July to early August) 'Rumba' is an attractive and inviting product to place on the market early. On average the harvest begins 7 days earlier than that of 'Sonata' or 'Elsanta'. However, 'Rumba' has a larger chilling requirement than 'Clery'. Therefore, the development in spring largely influenced by the amount of chilling that 'Rumba' has collected during the winter. With sufficient chilling 'Rumba' is as early as or even earlier than 'Clery' and 'Honeoye'. However, with insufficient chilling it is slightly later than 'Clery' and 'Honeoye'.

The results with 'Rumba' are positive in tunnel cultivation. The fruit is large and attractive and the harvest starts shortly after that of 'Clery' and 'Honeoye'. However, after the first harvest 'Rumba' produces more strawberries than 'Clery' or 'Honeoye'. Because 'Rumba' is also rather resistant to winter frost, the variety is also cultivated in Scandinavia. 'Rumba' is being planted there with increasing frequency as a replacement for 'Honeoye'. However, the plants do need to be protected with a fleece cover in the winter there.

There are some indications that 'Rumba' should not be given too much boron, because this trace element is probably absorbed very easily, quickly resulting in a surplus. Otherwise 'Rumba' requires no specific treatments and the variety is relatively easy to grow.

Mid-Season

Sonata, the perfect composition of taste and looks

Blossoming and harvest period

'Sonata' has an exceptionally good flower quality throughout the season. Since 'Sonata' produces a great deal of pollen, the percentage of deformed fruit is very low. The flowering and harvest period are very similar to those of 'Elsanta'. Although as a rule, harvest of 'Sonata' is better distributed. The inflorescences usually remain below the leaves. The optimal moment for picking is when the fruits have an orange red colour. After picking the fruits will continue gaining colour, ending up as bright red.

'Sonata' is a mid-late season short-day cultivar with fruit of exceptionally good flavour. Besides the good taste, the strong point of 'Sonata' is the abundant setting of uniform fruits which are easy to pick. This makes 'Sonata' in many cases an excellent alternative to 'Elsanta'.

Fruit quality

'Sonata' produces juicy strawberries with a sweet taste and a clear strawberry aroma. Its robust, uniform fruit has a conical shape and a bright red colour, light red on the inside. The pretty crown and the lovely shine, which are retained even after storage, are typical. The average fruit weight is higher than that of 'Elsanta'. The fruit is firm, but sometimes a bit sensitive to damage due to pressure. This might show up at high temperatures, but can keep under control by an adequate picking frequency. 'Sonata' strawberries are quite resistant to rain and do not split easily.

Productivity

In general yield of 'Sonata' is comparable to 'Elsanta', or slightly better. Although, the number of first quality fruits is clearly higher. 'Sonata' is easy to pick as the fruit easily breaks off from the inflorescences. The sorting costs are lower than 'Elsanta' thanks to the high percentage of first quality fruits. Early forcing of 'Sonata' hardly causes any loss in yield and quality.

Susceptibility to diseases

'Sonata' is susceptible to crown rot (*Phytophthora cactorum*) and root rot (*Rhizoctonia*). 'Sonata' is rather insensitive to mildew (*Podosphaera aphanis*). Propagators of 'Sonata' plants must pay special attention to crown rot. Preventive measures have to be carried out carefully. The planting of 'Sonata' requires attention, because the relatively short rhizome causes growth to be hampered when planted too deep.

Growing experiences

'Sonata' develops heavy vegetation when planted in August under a normal cropping system or as a frigo plant in spring. A planting distance of 35 to 40 cm is in many cases desirable. The inflorescences are relatively hidden under the foliage, which protects the flowers from late night frost and later from solarisation. Preventive spraying against *Botrytis* and *Rhizoctonia* is very important at that time.

'Sonata' is very suited for forcing either by covering it with plastic or in a plastic tunnel. In early glasshouse forcing cultures 'Sonata' is usually grown in spring by planting fresh plants in winter. As 'Sonata' rarely produces deformed fruits, it is very suitable for this culture. 'Sonata' is not so much used in a continuous culture in glasshouses because of the moderate colour in autumn, especially in periods with low light intensity.

However, 'Sonata' is most widely used in outdoor cropping systems. 'Sonata' is suitable for the colder climate zones of Western Europe, chiefly north of the Alps. 'Sonata' is particularly suitable for early cultivation and for use in the spring plantings of 60-day crops. It is barely sensitive to frost and thus is also suitable for cultivation in Scandinavia, where the variety is widely used at the moment. However, it must be covered there in winter with a fleece. 'Sonata' is less suitable for delayed production by straw covering.

'Sonata' requires a great deal of magnesium due to a slow uptake. Compared to 'Elsanta', 'Sonata' easily requires 20% more of magnesium in both propagation and production fields. Nitrogen supply also requires attention, when magnesium in the plant is at a right level, nitrogen supply should be limited. A balanced amount of trace elements (iron, manganese) is essential. It is evident that it is important to keep an eye on the nutrient level of the crop.

Figaro, spectacular in its bite and intensity

Blossoming and harvest period

'Figaro' develops a robust and sturdy plant with long, slightly hairy leaf stalks. The big leaves have a distinctive light green colour. 'Figaro' blooms at almost the same time as 'Sonata'. The quality of the flowers is good. The flowers, which are big just like the fruit, produce sufficient pollen. The flower clusters are long and sturdy and clearly sturdier than those of 'Sonata'. There are fewer flowers per cluster. Because the clusters partly extend to above the leaves, the flowers are a bit sensitive to night frost. The harvest is almost simultaneous to that of 'Sonata'.

Fruit quality

'Figaro' produces large, slightly chunky and rounded conical fruits. They are rather glossy and orange-red in colour. The first fruits can develop into a very big, slightly grooved product. The subsequent fruits are usually beautifully shaped and fairly thick. At the end of the season, the fruits are round and have an upright calyx. The average fruit weight is fairly large in comparison with other midseason varieties. Small strawberries at the end of the harvest are rare. The firmness of the fruit is significantly better than that of 'Sonata'. The fruit usually has quite a good flavour, especially in very sunny periods. If it rains, sometimes a white neck is formed.

Productivity

'Figaro' is usually somewhat less productive than 'Sonata', but there are exceptions. Indeed, in some years, many clusters form. Then 'Figaro' can be at least as productive and yield a splendid harvest with beautiful large fruit. 'Figaro' makes relatively few small fruits, making its class 1 share high. Because of the large fruit size and the fact that the fruits are easy to find, the picking performance is generally fairly good. Thanks to the firmness of the strawberries and their strong skin, bruising is never a problem. The strawberries are also very easy to sort.

Susceptibility to disease

'Figaro' develops a robust and sturdy crop that is minimally sensitive to powdery mildew (*Podosphaera aphanis*) and moderately susceptible to crown rot (*Phytophthora cactorum*). 'Figaro' is, however, susceptible to wilt (*Verticillium dahliae*) and fruit rot (*Botrytis cinerea*). 'Figaro' also seems susceptible to the bacterial disease *Xanthomonas fragariae*. It is also susceptible to fruit rot under the sepals. This occurs especially in wet weather conditions. Therefore, preventive spraying against fruit rot during flowering is very important.

Growing experience

'Figaro' produces a large crop and is particularly suitable for cultivation in summer conditions. The light orange-red, firm fruits allow a somewhat lower harvest frequency. Thus the fruits grow even more exuberantly. This results in improved fruit size and higher production. The first fruits are sometimes on a fairly thick stem and are therefore somewhat difficult to pick. The foliage of the plants offers the fruit good protection against sun damage.

The firmness, orange-red colour and good vigour of the crop make 'Figaro' ideal for a 60-day culture in summer conditions. 'Figaro' also gives good results in tunnel cultures and greenhouse cultivation which is not intended for early production. The variety also does well in frigo culture. Highest production is realized in the second harvest year. ¹

Vivaldi, a sparkling jewel

Blossoming and harvest period

Flower quality of 'Vivaldi' is good. The flowers are of medium size and produce sufficient amounts of pollen, giving rise to a low percentage of misshapen fruits. Many composite flower trusses tend to develop simultaneously, which can result in smaller berries and a shorter more intensive picking period. Flower trusses are normally positioned below the leaf canopy. When cultivated under glass, the flower trusses must be sufficiently spread out. The harvest period of 'Vivaldi' is on average 2 days earlier compared to 'Sonata'.

Fruit quality

'Vivaldi' produces attractive, medium to short conical bright shiny fruits, which are juicy and have a pleasant taste. Berries generated by 'Vivaldi' are slightly smaller than those of 'Sonata'. Berry texture is clearly different due to its notable firmness and has a good taste. They are uniform in shape and seeds are superficially located as opposed to deeply embedded. Bruising is not typical of this variety and if present not easily visible. Shelf life is considered excellent. At high temperatures, fruits may become dark. The fruit of 'Vivaldi' is mildly resistant to mildew.

Productivity

The yield and fruit size of 'Vivaldi' is almost as good as that of 'Sonata'. Fruits are typically easy to pick, comparable to 'Sonata'. Growers should aim for cultural practices that lead to a slow uniform flower differentiation which will result in an extended flowering period and subsequent increase in average fruit size.

Susceptibility to diseases

'Vivaldi' produces a vigorous erect plant that can become susceptible to powdery mildew (*Podosphaera aphanis*) towards the end of harvest, however to date mildew has not been observed on the fruits themselves, yet. 'Vivaldi' is fairly resistant to crown rot (*Phytophthora cactorum*) as well as to fruit rot (*Botrytis cinerea*). The vulnerability to wilt (*Verticillium dahliae*), angular leaf spot (*Xanthomonas fragariae*) and anthracnose (*Colletotrichum acutatum*) is not known yet, because these diseases have not been observed up to now.

Growing experiences

There is still only limited experience available with regard to the cultivation of 'Vivaldi', although it is clear that 'Vivaldi' does have a high chilling requirement, which should be taken into consideration when it is cultivated early in the season in tunnels or greenhouses. In that case, a longer period of chilling and additional night break lighting is required. Berries can turn dark at higher temperatures in the summer, consequently, 'Vivaldi' is most suited to early-season production in greenhouses and tunnels, table top systems and

outdoor production in soil. Due to its long shelf life, the variety is suited to shipping long distances, making it a good alternative to 'Sonata' in normal and frigo cultures. Because of its firmness, 'Vivaldi' is potentially also an interesting variety for programmed summer production with waiting bed plants and greenhouse production. However, the fruit size could become a draw back.

Late

Salsa, a rich experience of flavour and fullness

Blossoming and harvest period

'Salsa' makes a robust plant that blooms rather late. Because 'Salsa' also blooms under the foliage, there is less chance of damage from late frost. The quality of the flowers is very good. The flowers, which are very big like the fruit, produce more than enough pollen. The harvest of 'Salsa' is about 1 week after that of 'Sonata'.

Fruit quality

'Salsa' produces very large, conical, orange-red fruit with an often slightly upright calyx. The strawberries are glossy, have somewhat sunken seeds and often a white collar. As a result of vigorous growth, the first fruits can develop into very large, slightly grooved fruits. This always makes the fruits remarkable and easy to recognize. The average fruit weight is usually between 25 and 30 grams. The strawberries are juicy and have an excellent flavour in comparison with other late varieties. The fruits are easy to pick. However, this must be done carefully to prevent bruising.

Productivity

'Salsa' is very productive and gives a good yield comparable to that of 'Florence'. Because of the large fruit size and the fact that the fruits are easy to find and to snap off, the picking performance is generally good. They are also very easy to sort.

Susceptibility to disease

'Salsa' produces very robust plants, which unlike plants of many other varieties are hardly susceptible to wilt (*Verticilliumdahiae*). 'Salsa' plants also have little trouble with powdery mildew (*Podosphaeraaphanis*) and crown rot (*Phytophthora cactorum*). This makes the variety useful in areas not suitable for many other varieties. 'Salsa' is, however, sensitive to fruit rot (*Botrytis cinerea*). Therefore, preventive spraying against fruit rot during flowering is very important, partly because 'Salsa' can develop a relatively dense plant.

Growing experience

'Salsa' does well in somewhat colder growing regions in northern and central Europe. There, experience has shown that the variety is not very sensitive to diseases and frost in winter. Due to the late flowering, however, extra attention should be paid to the control of the strawberry blossom weevil (*Anthonomusrubi*). The variety is well suited for a perennial crop, especially since both yield and fruit weight remain good in later years. 'Salsa' is also a good option for cultivation in older soil, where strawberries have already been grown for many

years and soil sterilisation is not possible. Because of the vulnerability of the berries, 'Salsa' is grown mainly at companies that have short distribution lines and at "pick your own" farms. The large fruits are often an eye-catcher there.

In an open field cultivation and cultivation with frigo plants, 'Salsa' develops a heavy to very heavy crop. Therefore, a planting density of 40 to 45 cm is often recommended. After a sluggish start, the flower trusses emerge from the plant well and are clearly visible. The plants also often tend to produce runners, and this requires the necessary attention during cultivation. Apart from that, 'Salsa' is a variety that can be cultivated fairly well with standard fertilization. However, care should be taken regarding the quantities of nitrogen and phosphorus. If it receives too much fertilizer, 'Salsa' will develop an excessively heavy crop. This can result in problems with fruit rot and also may decrease the firmness of the strawberries. When covered with straw, the harvest of 'Salsa' will be delayed by 7 to 10 days. This will cause some reduction in production and fruit size, but this reduction is less strong in 'Salsa' than in 'Florence'.

Jive, step forward to perfection

Blossoming and harvest period

The quality of the flowers produced by 'Jive' is one of its strong features. The flowers are characterised by a large amount of pollen and a fertile receptacle resulting in a low percentage of misshapen fruits. The flowering period is clearly later than 'Sonata'. The number of flowers per truss is lower, however, this is compensated by the fact that 'Jive' produces more flower trusses. This results in an extended harvest period that is evenly distributed. The flower trusses usually remain just beneath the leaves. The optimum harvest time is when the fruits turn orange-red, which starts on average 7 to 10 days later than 'Sonata'.

Fruit quality

'Jive' forms large fleshy fruits with an attractive strawberry aroma. Its berries are typically uniform and elongated with a somewhat broad and flattened nose. The shiny orange-red appearance is striking and unique amongst current late-bearing varieties.

The slow ripening of the fruits results in an average fruit weight that is significantly greater than that of 'Sonata'. Fruits are also firmer and less susceptible to bruising. Fruits at maturation remain at a marketable vibrant red colour for a longer period making it possible to delay harvest if required to suit marketing demands. The strawberries are also fairly resistant to rain. However, the berries do suffer substantially when exposed too long wet periods. Therefore many growers prefer to grow 'Jive' in a tunnel rather than in the open.

Productivity

The yield of 'Jive' is significantly higher than 'Sonata'. The strawberries do not snap off as easily as 'Sonata' because the flower stems of 'Jive' are more rigid. However, the picking speed is better due to the higher average berry weight and the open plant type. 'Jive' does not require much work for fruit grading because of the good berry size, the uniform shape, the low percentage of misshapen and the firm texture of the berries.

Susceptibility to diseases

'Jive' is slightly more susceptible to powdery mildew (*Podosphaera aphanis*) than 'Sonata', but clearly more tolerant than 'Elsanta'. Jive's susceptibility to crown rot (*Phytophthora cactorum*) is similar to 'Elsanta'. However, 'Jive' is more susceptible to fruit rot (*Botrytis cinerea*) even under tunnels. The extended flowering period demands an accurate preventive fungicide treatment.

Growing experience

'Jive' is suited to cooler and warmer climates of Western Europe, primarily north of the Alps. It is an alternative to 'Florence' in normal and frigo cultures. However, it is a very interesting variety for summer waiting bed and table top productions. In these types of cultivations it is an excellent alternative for 'Elsanta' and 'Sonata' during the warm summer months. The plant is relatively compact and robust and has typical dark-green leaves. 'Jive' has shown to have greater resistance to heat stress than 'Sonata' and 'Elsanta' and develops a sufficient canopy before the plant starts flowering. It also forms runners very late, which results in the fact that most of the plant's energy is put into the development of flower trusses and berries. Due to these characteristics 'Jive' bears fruits of consistent size enabling efficient harvest throughout the whole season.

New advanced selections

Fresh Forward is testing an alternative to 'Elsanta' for continuous greenhouse cultivation. At the moment this advanced selection (FF-1203) is in its test stage with several growers. Fresh Forward, however, is confident that the results will be positive. FF-1203 has rather long inflorescences, making it very easy to handle in a glasshouse production system. It produces rather big conical uniform fruits, which reduces picking costs significantly. Due to its abundant pollen production, fruit set is better than for 'Elsanta' which often has many misshapen fruits in spring. These characteristics make that the percentage of first class fruits is very high. If all tests remain positive introduction of FF-1203 is foreseen in 2016.

Fresh Forward started with the development of varieties for Southern Europe and everbearers about 15 years ago. Now we are on the edge of releasing new varieties for those markets. For Southern Europe FF-1201 is tested as advanced selection by a small number of growers. Its main virtues are a somewhat softer texture and a superior taste. In addition, Fresh Forward has selected three everbearing genotypes, which vary for taste, colour, yield and resistance to crown rot. In the near future we will set up grower's trials to identify which selection is most suited for commercialization.

Conclusion

Fresh Forward has gone through a rapid development. It has proven to be able to stand on its own and has an impressive list of cultivars, which are widely grown. We have good prospects on a new cultivar for the South of Europe (Mediterranean area), which allows us to further develop new cultivars for this market. The introduction of everbearing or day-neutral cultivars is slightly further away, but Fresh Forward believes that within a few years they will have a cultivar that can compete on this market.

It is essential for all breeding programmes to have trials on different locations and to have a good understanding on the demands of growers, retailers and consumers. Breeding strawberries is a very dynamic activity, which involves skill, insight and dedication. As a

breeder it is necessary to foresee future developments and to anticipate what is needed in 10 to 15 years time.

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