Rasadničarska proizvodnja značajnijih vrsta drveća i grmlja hrvatskoga Sredozemlja

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RASADNIČARSKA PROIZVODNJA ZNAČAJNIJIH VRSTA DRVEĆA I GRMLJA HRVATSKOGA SREDOZEMLJA

NURSERY PRODUCTION OF SOME IMPORTANT TREE AND SHRUB SPECIES OF THE CROATIAN MEDITERRANEAN REGION

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UVOD

INTRODUCTION

Pošumljavanje krša u hrvatskom Sredozemlju ima tradiciju dugu oko 150 godina. Tako su prvi pokušaji unošenja borova na otoku Rabu zabilježeni u *Kronici* Franjevačkoga samostana Kampor na otoku Rabu, koju je pisao svećenik o. Odorik Badurina od 1936. do 1956. godine. U njoj je zabilježeno da je 1862. šumarski savjetnik Eugen Demiel poslao sjeme bora (*Pinus maritima*) na Rab. Sjeme je skupljeno na Korčuli, a posijano je na šumskim predjelima Dundo i Kalifront (Rauš i Matić 1987). Jedan od zadataka osnovanih šumskih ureda u pukovnijama na području Ogulina, Otočca i Gospića 1860. godine bio je i pošumljavanje krša, a odluka se temeljila na Zakonu o šumama iz 1852. koji je određivao da se sve starije čistine moraju pošumiti. Šumski ured u Ogulinu već 1865. pošumljavanjem osniva šumske branjevine (Ivančević 1979).

U stručnoj šumarskoj literaturi u Hrvatskoj se prije više pisalo o šumskom sjemenarstvu nego o šumskom rasadničarstvu. Prvi cjelovitiji stručni rad o šumskom rasadničarstvu objavio je u *Šumarskom listu* 1880. godine profesor na Šumarskom učilištu u Križevcima D. Hlava. Osim toga on opisuje jedan rasadnik u "Hrvatskom kotaru Macel" i opisuje radove od osnivanja, obrađivanja, rigolanja, sjetve, zaštite, presadnje, unutarnje podjele rasadnika, fertilizacije itd. (Matić 1976).

Naš prvi rasadnik za proizvodnju sadnica na kršu osnovan je 1879. u Svetom Mihovilu na području Senja, površine od 2 katastarska jutra i 1320 četvornih hvati. Godišnje se proizvodilo od 1,8 do 2,0 milijuna sadnica. Uglavnom su se proizvodile sadnice crnoga bora i nešto sadnica bjelogorice (Dokuš i dr. 1992.). Ubrzo nakon toga 1886. osniva se u Senjskoj drazi rasadnik Kesten koji u to vrijeme proizvodi od 0,8 do 1 milijun sadnica. U *Šumarskom listu* iz 1882. godine u članku "Šumarstvo Dalmacije" saznajemo da su osnovani veliki rasadnici u Kninu, Sinju i Kotoru i još čitav niz manjih rasadnika. Isto tako B. Kosović u članku "Pošumljavanje krša" 1909. godine detaljno opisuje rasadnik i sve faze radova u njemu. A. Kauders 1910. opisuje rasadnik "Podbadanj" u Crikvenici koji ima veliku ulogu pri pošumljavanju krša. Opisuje prostornu podjelu rasadnika, te posebno ističe da su u tom rasadniku obavljene kemijske analize tla te je utvrđena količina Ca, K_2O, P_2O_5 i N (Matić 1976). Godine 2008. rasadnik u Crikvenici obilježio je 100 godina neprekinutoga rada, što je u svakom slučaju u hrvatskom šumarstvu, a posebno u šumarstvu hrvatskoga Sredozemlja značajna obljetnica.

Uspjeh svakoga pošumljavanja pri osnivanju novih šuma ili sadnje prilikom umjetne obnove postojećih šuma ovisi o kakvoći sadnica koje se sade. Sadnice dobre kakvoće nužne su i pri podizanju hortikulturnih objekata, parkova, drvoreda i ostalih prostora koje želimo ozeleniti. Dobro uzgojene, zdrave, stručno odabrane i zasađene sadnice temelj su vrlo složenoga, osjetljivoga i istodobno otpornoga, a i dugotrajnoga šumskoga ekosustava.

Šumski je rasadnik posebno odabrano i uređeno zemljište koje služi za proizvodnju šumskih sadnica za podizanje novih šuma i za umjetnu obnovu postojećih šuma te drveća i grmlja za podizanje hortikulturnih objekata. Šumski se rasadnici dijele na stalne i privremene. Stalni se rasadnici osnivaju zbog stalne opskrbe većega područja sadnicama. U njima se nalazi čitav niz objekata nužnih za uspješnu i trajnu rasadničarsku proizvodnju (hladnjače za biljke i sjeme, nužna mehanizacija, objekt za svrstavanje i pakiranje biljaka, zgrade za različite potrebe, voda, kompostišta, ograde, ceste i dr.). U njemu mora biti zaposleno stalno i kvalificirano osoblje.

Privremeni se šumski rasadnik osniva u blizini velikih kompleksa za pošumljavanje. U njima se proizvode sadnice dok pošumljavanje traje, a nakon toga se rasadnik napušta.

S obzirom na način proizvodnje razlikuju se rasadnici u kojima se sadnice proizvode generativno (iz sjemena) i rasadnici s vegetativnom proizvodnjom (iz reznica). Rasadnici s generativnom proizvodnjom imaju dva odvojena dijela: sjemenište i rastilište. U sjemeništu se sjeme sije i proizvode se jednogodišnje ili višegodišnje sadnice koje se najčešće presađuju u rastilište. Presadnja u rastilištu ima zadatak da se sadnice pripreme (školuju) za sadnju na terenu.

Sadnice koje su u sjemeništu provele dvije, a u rastilištu tri godine nose oznaku 2+3, a one koje nisu školovane u rastilištu imaju oznaku 2+0.

Rasadnici s vegetativnom proizvodnjom (najčešće topola i vrba) imaju ožilište i rastilište. U ožilištu se reznice ožiljavaju, a nakon jedne godine korijen se ožiljenice sadi u rastilište, a od odrezanoga nadzemnoga dijela (pruta) izrađuju se reznice za ponovnu proizvodnju ožiljenica.

U rastilištu od korijena koji ima jednu godinu nakon dvije godine izraste sadnica kojoj je nadzemni dio u dobi od 2, a korijen od 3 godine. Takva sadnica nosi oznaku 2/3. One sadnice

koje se ne presađuju u rastilište nego 1 ili 2 godine ostaju u ožilištu nose oznaku 1/1 ili 2/2.

U posljednjih nekoliko desetljeća u suvremenu se rasadničarsku proizvodnju uključila proizvodnja sadnica s obloženim korijenskim sustavom (busenom) koje se uzgajaju u različitim posudama (kontejnerima). Takav je način proizvodnje poznat od početka šumske rasadničarske proizvodnje, kad se sjeme sijalo u dijelove stabljike suncokreta, u glinene posude ili posude napravljene od vrbova pruća. Danas postoje vrlo moderni mehanizirani načini punjenja kontejnera različitih supstrata, sjetve sjemena, oblika i materijala od kojih su izrađeni kontejneri te kontrolirani uvjeti razvoja sadnica u plastenicima i staklenicima s kontroliranom vlagom, svjetlom, temperaturom i prehranom sadnica.

Prednost kontejnerskoga sustava proizvodnje sadnica pred klasičnom je proizvodnjom očita, jer se kontejnerske sadnice mogu saditi tijekom cijele godine, velik je postotak primanja sadnica i brži je rast posađenih biljaka. Danas je poznat veći broj metoda i sustava u kontejnerskoj proizvodnji koji se svakim danom sve više usavršavaju. S obzirom na kontejnere i način sadnje mogu se svrstati u dva osnovna sustava (Matić, Prpić 1983):

1. Kontejneri koji se zajedno s biljkom sade u tlo. Ovdje se primjenjuju biomaterijali koji se sami razgrađuju ili materijali koje može prorasti korijenski sustav.
2. Kontejneri iz kojih se biljke vade neposredno prije sadnje. Tu razlikujemo dvije varijante i to pojedinačni kontejneri i tzv. zbirni kontejneri (multikontejneri).

Prednost prvog sustava je u tome što se rješavaju problemi s kontejnerima kao ambalažom, dok nedostatak sustava leži u činjenici da rast korijena kroz zidove kontejnera biva više ili manje ometan.

U Hrvatskoj je počela masovna proizvodnja sadnica obloženoga korijenskoga sustava 1981. godine kad su i počele masovne akcije pošumljavanja. Za takvu su se proizvodnju upotrebljavali kontejneri od tvrde plastike "Bosnaplast" i papirni lončići. Za njihovo punjenje supstratom i sjetvu sjemena nabavljena je 1982. godine mehanizirana linija. Nakon toga 1985. godine počinje proizvodnja takvih sadnica u plasteniku, što je u ono vrijeme bio korak naprijed u proizvodnji sadnica za pošumljavanje (Dokuš i dr. 1992).

Način proizvodnje ukrasnoga drveća i grmlja sličan je proizvodnji šumskih sadnica. Proizvodni je ciklus duži i može trajati i preko 10 godina. Tijekom proizvodnje biljke se više puta presađuju uz oblikovanje korijenskoga sustava i krošnje. Biljke se u pravilu proizvode u kontejnerima. Za razliku od proizvodnje šumskih sadnica ukrasno se drveće i grmlje uglavnom razmnožava vegetativno, za što moraju postojati odgovarajući tehnički uređaji.

DANAŠNJE STANJE RASADNIČARSTVA U HRVATSKOM SREDOZEMLJU

CURRENT STATUS OF NURSERY PRODUCTION IN THE CROATIAN MEDITERRANEAN REGION

Kad se određuje stanje i značenje šumskoga rasadničarstva u Republici Hrvatskoj, koja ima 2 688 687 ha šuma i šumskoga zemljišta, od čega je 78 % ili 2 106 917 ha u državnom vlasništvu, a 581 770 ha ili 22 % u vlasništvu privatnih šumoposjednika (Milković 2006), važno je odrediti površine koje je u interesu društva, zbog gospodarskih i općekorisnih razloga, nužno pošumljavati.

Nakon toga je nužno, na temelju realnih pokazatelja, odrediti vrijeme koje je potrebno da se pošumljavanje obavi i broj sadnica koji je potreban za određene površine i određeno razdoblje. Uspoređujući rasadničarsku proizvodnju danas, određenu na temelju stvarnih pokazatelja, s izračunatim brojem sadnica koje bi trebalo proizvoditi godišnje za pošumljavanje određenih površina u utvrđenom razdoblju, dobili bismo dobar pokazatelj potreba za sadnicama i stanja šumskoga rasadničarstva u nas.

Hrvatsko sredozemno područje rasprostire se na površini od približno 1 500 000 ha, od čega je oko jedan milijun hektara šumsko, a pola milijuna poljoprivredno zemljište. Od ukupno obrasle šumske površine, koja iznosi oko 670 000 ha, na oko 220 000 ha nalaze se gospodarske šume hrasta crnike, medunca, alepskoga, brucijskoga, crnoga i primorskoga bora i pinije visokoga i niskoga uzgojnoga oblika. Degradiranih šuma ima oko 455 000 ha, i to šikara 300 000 ha, šibljaka 75 000 ha, makije 55 000 ha i gariga 25 000 ha. Ostalih oko 330 000 ha odnosi se na obešumljene površine ili kamenjare, kraške goleti (Topić 1994, Topić 2003, Milković 2006).

Na većem je dijelu navedene šumske površine nužna njega, pomlađivanje i podizanje šuma. U svakom uzgojnom zahvatu više-manje, ovisno o stanju sastojine i vrsti zahvata, treba saditi biljke u postojećim šumama i pošumljavati obešumljene površine (njega popunjavanjem, umjetno pomlađivanje i pošumljavanje).

S obzirom na velike površine obešumljenih degradiranih prostora i raznolikih degradacijskih stadija degradiranih šuma te na površine šuma dobre kakvoće koje se moraju obnavljati, nužno je na njima pristupiti odgovarajućim uzgojnim radovima. To je u skladu s temeljnim važećim zakonskim propisima, obvezi šumarstva kao kvalificirane struke za gospodarenje šumama, potrebi društva za koristima koje mu šuma pruža u obliku općekorisnih funkcija (ekoloških i socijalnih), a posebno gospodarskih vrijednosti gdje drvo, kao izvor bioenergije, svakim danom postaje sve vrednije.

Da bi se prikazale godišnje potrebe za sadnicama u hrvatskom sredozemnom području, uzimajući u obzir pokazatelje o površinama uzgojnih oblika, degradacijskih stadija, obešumljenih površina i broja biljaka po hektaru potrebnih za sadnju i pošumljavanje različitim vrstama drveća u različitim sastojinskim i stanišnim uvjetima (Matić 1994), obavit će se obračun godišnje potrebe za sadnicama.

Sastojine alepskoga i crnoga bora visokoga uzgojnoga oblika koje zauzimaju površinu od približno 35 000 ha nalaze se na 40 % svoje površine po dobi iznad propisanih ophodnji od 60 odnosno 80 godina. To je površina od približno 14 000 ha koju treba prirodno pomladiti u budućih 10 godina, što godišnje iznosi 1400 ha. S obzirom na stanišne uvjete i vrstu drveća, umjetnu obnovu koju treba provesti po prirodnim načelima, planirat će se na 80 % površine ili na 1150 ha. Sa-

dnjom 2000 biljaka po hektaru trebalo bi za tu površinu godišnje 2 300 000 borovih sadnica.

Sastojine hrasta crnike i medunca visokoga i niskoga uzgojnoga oblika zauzimaju površine od približno 200 000 ha, pa će ih trebati u sljedećih 10 godina na najmanje 10 % površine obnoviti, što je površina od 20 000 ha ili 2000 ha godišnje. Kombinirajući prirodnu i umjetnu obnovu uz popunjavanje, treba predvidjeti 10 000 biljaka crnike i medunca po hektaru ili ukupno godišnje 20 000 000 biljaka.

Sastojine u različitim degradacijskim stadijima (šikare, makije, šibljaci i garizi) zauzimaju ukupnu površinu od 455 000 ha. U idućih 20 godina trebalo bi 30 % te površine podvrći uzgoju zbog njihova prelaska u kvalitetniji stadij i uzgojni oblik, što površinski iznosi oko 140 000 ha ili godišnje 7000 ha. Imajući na umu postojeću autohtonu prirodnu vegetaciju koja se već nalazi na tim površinama, nužno je u prosjeku unositi oko 2000 biljaka po hektaru pionirskih vrsta drveća crnogorice i bjelogorice, što je ukupno 14 000 000 biljaka godišnje.

Obešumljene površine ili kamenjare (goleti) zauzimaju površinu oko 330 000 ha. U idućih 20 godina trebalo bi 60 % navedene površine pošumiti pionirskim vrstama bjelogorice i crnogorice, što iznosi oko 200 000 ha ili 10 000 ha godišnje. Na 5000 ha trebalo bi obaviti pošumljavanje bjelogoricom i osigurati 10 000 sadnica po hektaru, što ukupno iznosi 50 000 000 biljaka. Za pošumljavanje preostalih 5000 ha godišnje crnogoricom nužno je osigurati 2000 biljaka po hektaru ili ukupno 10 000 000 biljaka. Ukupno, tijekom 20 godina treba godišnje osigurati za planirano pošumljavanje obešumljenih površina 60 000 000 biljaka crnogorice i bjelogorice.

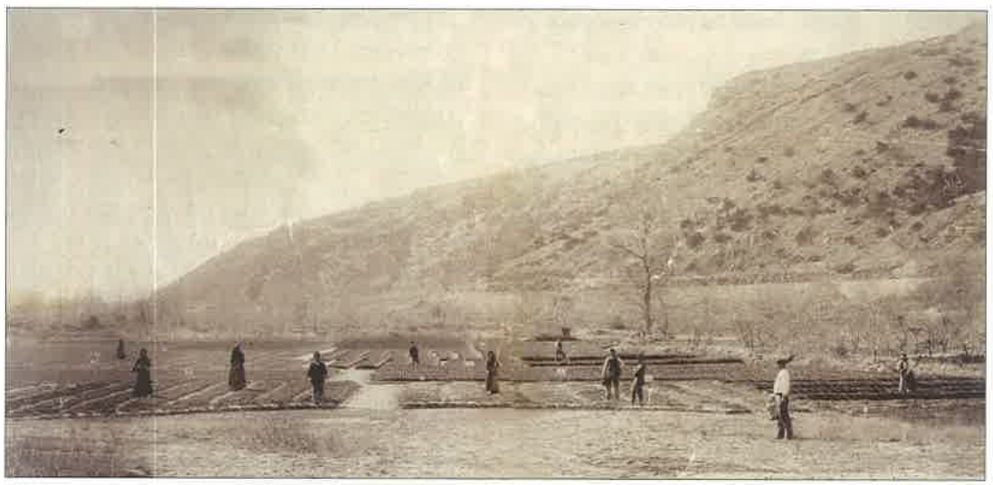
Prema tome, da bi se obavili planirani uzgojni radovi na određenoj površini sastojina visokoga i niskoga uzgojnoga oblika bjelogorice i crnogorice, te u degradiranim šumama u različitim degradacijskim stadijima i obešumljenim površinama kamenjara i goleti, potrebno je svake godine u rasadnicima proizvoditi ovaj broj sadnica:

1. Za obnovu i njegu zrelih sastojina alepskoga i crnoga bora	2 300 000 kom./god.
2. Za obnovu i njegu sastojina hrasta crnike i medunca	20 000 000 kom./god.
3. Za njegu degradiranih sastojina u svim stadijima	14 000 000 kom./god.
4. Za pošumljavanje obešumljenih površina	60 000 000 kom./god.
Ukupno	96 300 000 kom./god.

Hrvatsko šumarstvo na sredozemnom području raspolaže s 9 rasadnika ukupne površine od 35 ha, koji se nalaze u vlasništvu trgovačkoga društva "Hrvatske šume" d.o.o. Zagreb. Raspoređeni su regionalno tako da se u Istri nalaze 2, u Hrvatskom primorju 1 i u Dalmaciji 6 rasadnika.

Od svih rasadnika vrijedno je spomenuti rasadnik "Franceskija" Uprave šuma Buzet u Istri površine 18 ha i rasadnik "Piket" kraj Zemunika Donjega, bruto površine 11,7 ha. Ta su dva rasadnika suvremeno koncipirana s odgovarajućom opremom, mehanizacijom i ostalim nužnim uređajima te mogu

Slika 1. Rasadnik Slavinj – Omiš (UŠP Split, Šumarija Split)
Figure 1 Slavinj Nursery – Omiš (FA Split, Split Forest Office)



Slika 2. Rasadnik Podbadanj, Senj
Figure 2 Podbadanj Nursery in Senj

zadovoljiti sve načine tehnoloških procesa proizvodnje biljaka u rasadniku. Vrijedno je spomenuti i rasadnik "Podbadanj" koji se nalazi u Šumariji Crikvenica, Uprava šuma podružnica Senj, koji ove godine obilježava 100 godina neprekinutoga rada, što ga svrstava na prvo mjesto među svim rasadnicima u Hrvatskoj. On jedini održava kontinuitet prve rasadničarske proizvodnje koja je počela u rasadniku Sveti Mihovil, koji je osnovalo Nadzorništvo za pošumljavanje krša u Senju davne 1879. godine.

Preostalih 6 rasadnika manje su površine, klasičnoga tehnološkoga procesa proizvodnje sadnica koji zbog male potrebe za sadnicama vegetiraju i pomalo propadaju. Neki od tih rasadnika imaju izvrsne stanišne uvjete, posebno kad je u pitanju tlo i voda, te bi mogli kao i ostali rasadnici uz odgovarajuću opremu i kadar zadovoljavati u proizvodnji sadnica za pošumljavanje i ostale potrebe.

Opisat ćemo rasadnik "Piket" zbog toga jer predstavlja pažnje vrijedan objekt zbog moderne opreme i ostalih uvjeta koji mogu odgovoriti na sve zahtjeve moderne rasadničarske proizvodnje.

Rasadnik zauzima 11,70 ha bruto odnosno 10,90 ha neto površine. Tehnički se uređaji sastoje od plastenika s grijanjem površine 1686 m^2, drugoga plastenika od 1693 m^2, oba proizvedena u Finskoj, zatim kontejnerišta površine 4 x 2500 m^2 s kliznim sustavom za orošavanje, prihranu i biljnu zaštitu. Bazen za vodu ima površinu od 2963 m^2 u koji stane oko 3000 m^3 vode.

Upravni objekt ima površinu 246 m^2, a tehnološka zgrada 1300 m^2 u kojoj se nalazi hladnjača za sjeme i biljke, skladište kontejnera i supstrata, hala sa strojevima, stroj za pranje kontejnera, punjenje i strojnu sjetvu.

Slika 3. Uzgoj kontejnerskih sadnica crnoga bora u rasadniku "Piket"
Figure 3 Cultivation of containerised seedlings of black pine in Piket Nursery

Kontejneri su različitih veličina od 93 cm^3, 120 cm^3, 150 cm^3, 256 cm^3, s podloščima-nosačima s nožicama za "zračno podrezivanje" korijena. Raspoloživi su kontejneri dostatni za proizvodnju 2–3 milijuna sadnica u jednom turnusu, a trenutačno su neiskorišteni.

Slika 4. Rasadnik "Piket" u Zemuniku Donjem kod Zadra
Figure 4 "Piket" Nursery in Zemunik Donji near Zadar

Slika 5. Suvremeni plastenik s automatiziranim sustavom zagrijavanja/hlađenja i prskanja
Figure 5 Modern greenhouse with automated heating/cooling and sprinkle system

Slika 6. Suvremena linija za punjenje kontejnera
Figure 6 A modern container filling line

Slika 7. Sadnica obloženoga korijenskoga sustava
Figure 7 Containerised seedling

Slika 8. Sadnice uzgojene u kontejnerima od tvrde plastike
Figure 8 Seedlings raised in hard plastic containers

Slika 9. Inovativna naprava za sjetvu sjemena u kontejnere "Bosnaplast"
Figure 9 Innovative device for sowing seeds in "Bosnaplast" containers

Strojni se park sastoji od traktora 75 kW (utovar supstrata i viljuškar), linija za miješanje supstrata, pranje kontejnera, punjenje kontejnera i linije za pneumatsku sjetvu s pokretnom trakom. Sve su te navedene linije švedski proizvod i uvoz iz Švedske. U strojnom se parku nalazi i pokretni sustav za zalijevanje, odnosno orošavanje, sustav za naklijavanje i sustav za zasjenjivanje (mrežama).

U rasadniku rade četiri zaposlenika, prometnice su asfaltirane, ograda je od betonskih stupaca i žičanoga pletiva.

Ovo je moderni rasadnik za proizvodnju šumskih i ostalih sadnica u kontejnerima (blok-kontejneri), u prvom redu jednogodišnjih četinjača. Zbog, nažalost, smanjene potrebe za sadnicama i pošumljavanjem na našem Sredozemlju kapacitet se rasadnika iskorištava za proizvodnju sadnica ukrasnoga bilja i presadnica povrća.

Hrvatsko Sredozemlje ima prilično velike površine na kojima bi se mogle podizati stabilnije i produktivnije šume. Kako smo već naveli, pri njezi i obnovi šumskih površina u Sredozemlju sadnja biljaka i pošumljavanje bit će uvijek zastupljeni bilo da se radi o obešumljenim površinama, površinama s nekim od degradacijskih stadija ili šumama visokoga i niskoga uzgojnoga oblika koje pomlađujemo.

Iz podataka o proizvodnji sadnica u rasadnicima sredozemnoga područja u posljednjih 17 godina može se dobiti uvid o podizanju novih šuma pošumljavanjem ili obnovi i njezi postojećih.

Od 1991. do 1995. godine u rasadnicima je prosječno godišnje proizvedeno 845 000 sadnica, od 1996. do 2002. godine 1 817 000, a od 2003. do 2007. samo 541 000 sadnica godišnje. Ti podaci najbolje govore da se proizvodnja sadnica, a to znači i njihova upotreba stalno smanjuje. Pri tome ne smijemo ispustiti iz vida da se u pet ratnih godina proizvelo više sadnica nego u posljednjih pet godina.

Iz svega se može zaključiti da je potreba za sadnicama te za sadnjom i pošumljavanjem svakim danom sve veća, uzimajući u obzir općekorisnu i gospodarsku ulogu šume na Sredozemlju, a proizvodnja sadnica i njihova upotreba je sve manja.

Hrvatsko šumarstvo raspolaže dovoljnim brojem i površinama rasadnika te stručnim kadrom za potrebnu proizvodnju sadnica koje bi trebalo upotrijebiti za obnovu šuma i pošumljavanje obešumljenih šumskih površina.

U nastavku ćemo iznijeti podatke o rasadničarskoj proizvodnji za 29 vrsta drveća, poludrveća i grmlja zanimljivih za obnovu, pošumljavanje i hortikulturne potrebe u hrvatskom dijelu Sredozemlja.

Crnika, česmina, česvina – *Holm oak* (*Quercus ilex* L.)

Sjetva sjemena crnike može se obaviti u jesen odmah nakon skupljanja na onim područjima na kojima nema opasnosti od mraza. U suprotnome treba sjeme za proljetnu sjetvu stratificirati zimi. Stratifikacija se obično provodi na otvorenom (stratifikacijske jame) ili u prostoru s mogućnošću kontroliranja temperature (+1 do +5 °C).

Hladna se stratifikacija ne koristi zbog svladavanja dormantnosti sjemena (za sjeme mediteranskih vrsta iz roda *Quercus* smatra se da je dormantnost zanemariva ili da sjeme uopće nije dormantno), već zbog pomicanja klijavosti do proljeća. Drugim riječima, ako želimo da žir ne proklija u nepovoljno doba godine, koristimo hladnu stratifikaciju.

Ako se jesenska sjetva obavlja u hladnijim predjelima, zasijane se površine moraju zaštititi od glodavaca i malčirati odgovarajućim malčem. Supstrat za stratifikaciju miješa se sa žirom i kao takav mora se povremeno kontrolirati, pogotovo pred kraj zime, kako bi se mogao zaustaviti predsjetveni postupak prije nego što sjemenski korjenčić postane predugačak.

Ako se sije proklijali žir, optimalna duljina radikule (sjemenskoga korjenčića) iznosi 0,5–5 cm. Može se obaviti i sjetva žira s većom duljinom radikule od optimalne, ali u tom slučaju pri samoj sjetvi sjemena na gredice ili u kontejnere sjemenski se korjenčić mora skratiti na 3 cm, što neće negativno utjecati na preživljavanje (Piotto i Di Noi 2001). Prema Regentu (1980) moguća je sjetva proklijaloga žira kojemu su klice otkinute, ali biljke su slabije jer se mikoriza na korijenu slabije razvija. Isti autor spominje kako je kod hrasta crnike česta pojava dvostrukih (blizanci), pa i višestrukih biljaka.

Za normalan razvoj korijenskoga sustava i nadzemnoga dijela sadnice žir treba rasporediti u prirodan horizontalan položaj. To vrijedi jednako za žir u hladnoj stratifikaciji i prilikom sjetve. Sjeme se prekriva s 1–2 cm zemlje. Hrast crnika slično kao i druge vraste hrasta razvija dubok korijenski sustav. U jednogodišnje, nepodrezane sadnice hrasta crnike korijenski sustav može dosegnuti duljinu od 60 do 80 cm.

Sadnice hrasta crnike mogu se proizvoditi s golim i obloženim korijenskim sustavom. Sadnice s obloženim korijenom treba proizvoditi u prikladnim kontejnerima u kojima se ne deformira korijenski sustav. Ne preporučuje se uzgoj u kontejneru "Bosnaplast" 12 i 18 dulje od jedne vegetacije, a u kontejnerima s tuljcima od PVC-a (923 cm^3) jednu i pol do dvije vegetacije. Sadnice proizvedene u odgovarajućim kontejnerima dobre su kakvoće s mogućnošću za uspješan rast nakon sadnje. Za sadnju na terenu sposobne su jednogodišnje biljke gologa korijena.

Ukrasne forme razmnožavaju se kalemljenjem.

Crni jasen, krški jasen – *Manna ash* (*Fraxinus ornus* L.)

Nestratificirano sjeme crnoga jasena sije se u jesen ili se prethodno stratificira toplo-vlažnim postupkom i sije u proljeće. Sjeme se drži 2–8 tjedana (obično 3) na toploj, a nakon toga 8–15 tjedana na hladnoj stratifikaciji. Nakon svladavanja dormantnosti za klijavost sjemena veliko značenje imaju znatne temperaturne oscilacije (+25 °C/+5 °C), odnosno topli dani, a hladne noći. Ti su uvjeti istovjetni prirodnima, a događaju se krajem zime i početkom proljeća. Stalna temperatura od 20 °C može izazvati sekundarnu dormantnost i kod nedormantnoga sjemena.

Iz navedenoga izlazi da treba izbjegavati sjetvu u kasno proljeće kada je temperatura tla visoka (Piotto i Di Noi 2001). Kako su zaključili Dirr i Heuser Jr. (1987), nestratificirano sjeme crnoga jasena sije se u jesen ili se stratificira u trajanju 2–3 mjeseca i sije u proljeće.

Regent (1980) piše kako se sjeme vrsta *F. excelsior* i *F. ornus* stratificira toplo-vlažnim postupkom te sije u proljeće. Za takvo sjeme kaže da redovito klija. S druge strane, ako se sjeme tih dviju vrsta sije netretirano u proljeće ili ljeti, zasijane površine treba zaštititi sve do klijanja idućega proljeća. Prema Stilinoviću (1987) svježe skupljeno sjeme sije se u jesen ili se stratificira u trajanju 4–5 mjeseci i sije u proljeće. Napominje se učinkovitost toplo-vlažne stratifikacije na klijanje sjemena.

Sjeme se sije s krilcem. Dubina sjetve iznosi od 1,2 do 2,0 cm. Po dužnom metru brazde sije se oko 5–7 g sjemena. Prema Bonneru (1974) te Williamsu i Hanksu (1976) sjeme većine vrsta iz roda *Fraxinus* sije se u redove razmaknute 15 do 30 cm, a gustoća sjetve u tom slučaju iznosi 80 do 100 sjemenki po dužnom metru.

Drugi je način sjetva sjemena omaške, a optimalan broj sadnica iznosi 105–160 komada/m^2. Debljina prekrivanja sjemena iznosi 1–3 cm. Sjeme se prekriva rasadničkom zemljom, pijeskom ili mješavinom zemlja-pijesak.

Ponik je osjetljiv na kasni proljetni mraz. Bonner (1974) ističe kako je nakon klijanja gredice neko vrijeme poželjno držati pod zasjenom. Prema istomu autoru za sadnju na terenu europskih vrsta jasena, u koje se ubraja i crni jasen, koriste se školovane biljke u dobi 1+1 ili dvogodišnje sadnice 2+0.

Razmnožavanje reznicama pokazalo se praktično nemoguće osim u slučaju uzimanja reznica s mladih stabala. U budućnosti kao metoda razmnožavanja postoji šansa razmnožavanjem ove vrste i tehnikom kulture tkiva.

Medunac – *Pubescent oak* (*Quercus pubescens* Willd.)

Medunčeve sadnice proizvode se na sličan način kao i hrasta lužnjaka, kitnjaka i ostalih autohtonih vrsta hrasta uz napomenu da u proizvodnji sadnica pojedine vrste iz roda *Quercus* postoje određene specifičnosti u pogledu stanišnih uvjeta u rasadniku, bioloških svojstava i ekoloških zahtjeva vrste, tehničko-tehnološke opremljenosti rasadnika i sl. Ukrasne forme razmnožavaju se kalemljenjem.

Prema Beanu (1981) medunčeve sadnice za uspješan uzgoj traže duboka, plodna i ilovasta tla. Spomenuti autor piše kako se medunčev žir može čuvati preko zime u hladno-vlažnim uvjetima, iako ga je najbolje posijati u vanjske gredice odmah nakon sazrijevanja. Sjeme posijano u jesen mora se zaštititi protiv napada miševa i ostalih štetnika. Manje količine sjemena mogu se sijati u duboke kontejnere koji se postave u vanjske lijehe.

Medunčeve sadnice razvijaju duboku žilu srčanicu i potrebno ih je što prije presaditi na stalno mjesto. Sadnice uzgojene neposrednom sjetvom sjemena na terenu daju najbolje rezultate. Sadnice u dobi 2+0 treba izvaditi iz sjemeništa i posaditi na terenu. Ako ostanu dulje, treba očekivati loše primanje takvih sadnica.

Huxley (1992) ističe da medunčeve sadnice podnose umjerenu količinu bočne zasjene. Također navodi otpornost sadnica na umjerenu izloženost izravnomu sunčanomu svjetlu. Takve sadnice imaju visok postotak preživljavanja, no one su niže i deblje od sadnica uzgajanih pod zasjenom. Chittendon (1956) ističe da je uzgoj medunčevih sadnica vrlo sličan uzgoju sadnica hrasta kitnjaka. Korijenski sustav medunca slabo podnosi presadnju tako da se sadnice presađuju na stalno mjesto dok su mlade.

Oštrika, prnar, komorovac – *Kermes oak* (*Quercus coccifera* L.)

Rasadnička proizvodnja oštrike slična je rasadničkoj proizvodnji ostalih vrsta hrasta uz poštivanje određenih specifičnosti iznesenih u poglavlju o rasadničkoj proizvodnji medunca.

Bijeli grab, kukrika – *Oriental hornbeam* (*Carpinus orientalis* Mill.)

Idealne gredice za sjetvu sjemena graba morale bi biti stalno vlažne, a glinovito i hranjivima bogato tlo trebalo bi biti zaštićeno od ekstremnih atmosferskih kolebanja (Rudolf i Phipps 1974, Suszka i dr. 1966).

O rasadničkoj proizvodnji bijeloga graba Regent (1980) piše kako se nestratificirano sjeme sije u jesen ili prethodno stratificira i sije u proljeće te prekriva s otprilike 0,6 cm rasadničke zemlje. Preporučuje da se klijanci drže pod zasjenom. Prema Rudolfu i Phippsu (1974) sjeme se sije u dobro pripremljene gredice, a gustoća sjetve iznosi od 323 do 432 sjemenki/m^2. Dubina prekrivanja sjemena iznosi od 0,6 do 1,3 cm. Ako se sjeme sije omaške, preporučuje se malčiranje gredica (lijeha) grubom tkaninom, slamom ili drugim materijalom. Malč ostaje na gredicama sve do prestanka opasnosti od kasnoga proljetnoga mraza. Sve do završetka procesa klijanja površinski sloj tla u rasadniku trebao bi biti stalno vlažan. U prvoj godini uzgoja, a nakon nicanja, klijalište je potrebno držati pod laganom zasjenom.

Macdonald (1986) preporučuje gustoću sjetve od 250 sjemenki /m^2 ako se sije u redove, ili od 150 do 250 sjemenki/m^2 radi proizvodnje podloga za cijepljenje. Stilinović (1987) piše kako se po dužnom metru brazde sije oko 10 g sjemena i prekriva s 3–4 cm zemlje. Prema istomu autoru klijanci i mlade sadnice graba osjetljive su na mraz, sušu i pripeku pa se mora poduzeti odgovarajuća njega tijekom njihova uzgoja u klijalištu rasadnika.

Neki autori pišu kako se bijeli grab može razmnožavati osim generativnim i vegetativnim putem (cijepljenjem i reznicama), a neki ističu da nema podataka o razmnožavanju bijeloga graba reznicama. Prema Hartmannu i dr. (1990) grabovi kultivari mogu se cijepiti odvojenom grančicom ili okuliranjem na podloge tipične vrste uzgojene iz sjemena.

Neke mjere poput etiolacije ili savijanja sadnica potiču zakorjenjivanje reznica (Bassuk i dr. 1985, Maynard i Bassuk 1987, 1991, 1992, 1996). Stilinović (1987) također piše kako se varijeteti i forme grabova razmnožavaju kalemljenjem, a Vrgoč (1994) ističe kako se bijeli grab uspješno koristi i u uzgoju bonsaija.

Crni grab – *Hop hornbeam* (*Ostrya carpinifolia* Scop.)

Regent (1980) izvještava da se sjeme crnoga graba sije u jesen ili u proljeće, a može se primijeniti i ljetna sjetva (u kolovozu) s još nedozrelim sjemenom. Sjeme se pokriva s 0,5–0,6 cm zemlje. I Stilinović (1987) poput prethodnoga autora navodi kako se relativno dobar uspjeh može dobiti sjetvom sjemena koje se nalazi u stanju fiziološke zrelosti. Također piše kako se takvo sjeme mora odmah posijati i ne smije se stavljati na čuvanje. Prema njemu jesenska sjetva zreloga sjemena ima dosta lošu klijavost sljedećega proljeća.

Ako se sjeme sije u proljeće, potrebno ga je stratificirati, te uz povremenu kontrolu odlučiti da li će se iskoristiti za sjetvu ili će se sjeme ostaviti na stratifikaciji do idućega proljeća. Sjeme koje je prethodno stratificirano toplo-hladnim postupkom sije se krajem zime ili početkom proljeća (Piotto i Di Noi 2001). Sjeme se prije sjetve drži na toploj stratifikaciji 4–8 tjedana (ovisno o provenijenciji), a zatim na hladnoj stratifikaciji 16–23 tjedna.

Prije stavljanja sjemena na predsjetvenu pripremu (toplo-hladnu stratifikaciju) preporučljivo je potapanje sjemena u vodu kako bi se odvojilo šturo odnosno prazno sjeme. Šturo sjeme obično ispliva na površinu, a navedena metoda naziva se flotacija. Budući da sjeme crnoga graba obično klija na niskim temperaturama, pri kraju razdoblja hladne stratifikacije potrebno ga je češće kontrolirati. Stratificirano (nedormantno) sjeme ima bolju klijavost što su temperaturne oscilacije veće (niska temperatura noću, a visoka po danu). Iz tih razloga sjetvu sjemena crnoga graba valja izbjegavati u razdoblju kada ne postoje značajne razlike između noćnih i dnevnih temperatura zraka (kasno u proljeće ili početkom ljeta kad je temperatura tla relativno visoka). Sheat (1948) piše kako je sjeme najbolje posijati odmah nakon sazrijevanja. Sjeme se sije u vanjske lijehe i ono normalno proklija već sljedećega proljeća. Prema njemu klijavost je sjemena varijabilna, ali obično visoka. Zeleno se sjeme skuplja u trenutku kada je embrij potpuno razvijen, ali prije nego što očvrsne sjemena ljuska. Tako skupljeno sjeme posije se na vanjske gredice. Sjeme klija već sljedećega proljeća, a klijavost mu je jako dobra.

Huxley (1992) ističe kako skladišteno sjeme crnoga graba treba stratificirati. Sjeme se stratificira toplo-hladnim postupkom. Potrebna su mu 3 mjeseca tople i 5 mjeseci hladne stratifikacije. Tako stratificirano sjeme klija u visokom postotku, no klijavost može potrajati i 18 mjeseci.

Kada klijanci postanu dovoljno veliki da se mogu pikirati, ručno se presađuju u pojedinačne kontejnere ili lončiće koji se slažu na vanjske gredice, na kojima i ostaju prve zime. Na stalno mjesto presađuju se krajem proljeća ili početkom ljeta nakon što prestane opasnost od kasnoga proljetnoga mraza.

Stilinović (1987) navodi mogućnost vegetativnoga razmnožavanja crnoga graba. Pri cijepljenju se primjenjuje metoda bočnoga i sedlastoga spajanja, kozja noga ili ablaktacija (priljubljivanje). Cijepi se na podlogu tipične vrste iz sjemena (*Ostrya carpinifolia*) ili na podlogu običnoga graba (*Carpinus betulus*). Kalemi se u području korijenskoga vrata ili u krošnju. Preko zime cijepljenje se obavlja u stakleničkim uvjetima. Zelene reznice crnoga graba uzimaju se u lipnju i srpnju i tretiraju se fitohormonima (IBA, koncentracija 1–2 %). Tako pripremljene i tretirane reznice stavljaju se na zakorjenjivanje pod foliju, u uvjete s mogućnošću umjetnoga zamagljivanja.

Obični koprivić, košćela – *European nettle tree* (*Celtis australis* L.)

Nestratificirano sjeme običnoga koprivića sijemo u jesen ili ga stavimo na hladnu stratifikaciju 8–12 tjedana i sijemo u proljeće. Sjeme u stratifikatu treba često kontrolirati i postupak stratifikacije prekinuti čim sjeme počne klijati (Piotto i Di Noi 2001). Regent (1980) preporučuje držanje sjemena (plodova) 60–90 dana u stratifikatu na temperaturi od 5 °C. Na taj se način sjeme može čuvati i godinu dana, bez značajnijega gubitka vitalnosti. Ako sjeme nije naklijalo, valja produžiti sa stratifikacijom. Nestratificirano sjeme sije se u jesen ili prethodno stratificirano u proljeće.

Dubina sjetve iznosi 1 cm, a razmak između redova 20–30 cm. Prije sjetve dobro je sjeme močiti u vodi, a zasijanu površinu zaštititi sve do završetka klijanja i održavati ju stalno vlažnom. Nicanje je dosta neujednačeno i sporo, pa se preporučuje nastaviti stratifikaciju do sljedeće jeseni ili do drugoga proljeća.

Sije se oko 15 g sjemena po dužnom metru. Sjalište je poželjno malčirati i održavati ga dovoljno vlažnim. Huxley (1992) piše kako je sjeme koprivića najbolje posijati u vanjske gredice odmah nakon sazrijevanja. Ako se skladišti, onda ga treba stratificirati u trajanju 2–3 mjeseca, a sjetvu obaviti u stakleniku tijekom veljače i ožujka. Dirr i Heuser (1987) navode da je postotak klijavosti takva sjemena visok, iako skladištenom sjemenu treba 12 ili više mjeseci da proklija. Sjeme se može uspješno čuvati i više od pet godina.

Klijanci se pikiraju u pojedinačne kontejnere ili lončiće. Lišće je na klijancima često prošarano bijelim mrljama (bez klorofila). To je normalna pojava koja se poslije izgubi te starije biljke razvijaju normalne listove zelene boje.

Tijekom prve zime sadnice se drže u vanjskim gredicama, a presađuju se sljedeće godine, i to krajem proljeća ili početkom ljeta. Tijekom prve zime sadnice je potrebno zaštititi od hladnoće.

Veći broj autora spominje mogućnost razmnožavanja ove vrste i vegetativnim načinima (polijeganjem, cijepljenjem i zelenim reznicama). Kao podloga za cijepljenje služe sadnice vrsta *C. occidentalis* i *C. australis*. Cijepi se u osnovu podloge, a metode su: obično spajanje, kozja noga i bočno cijepljenje. Vrijeme cijepljenja ograničeno je na zimsko razdoblje (veljača), a moguće ga je provoditi jedino u stakleničkim uvjetima. Podloge se uzgajaju u posudama i moraju imati dobro razvijen korijenski sustav.

Žuti koprivić, košćela – *Oriental hackberry* (*Celtis tournefortii* Lam.)

Rasadnička proizvodnja žutoga koprivića jednaka je rasadničkoj proizvodnji običnoga koprivića uz uvažavanje određenih specifičnosti vezanih uz stanišne uvjete u rasadniku, biološka svojstava i ekološke zahtjeve vrste, tehničko-tehnološku opremljenost rasadnika i sl.

Maklen – *Montpelier maple* (*Acer monsspesulanum* L.)

Prema Regentovim (1980) podacima netretirano nedozrelo javorovo sjeme sije se kasno ljeti, a dozrelo u jesen ili se prethodno stratificira i sije u proljeće. Autor navodi dubinu sjetve javora od 0,6 do 2,5 cm (ovisno o krupnoći). Također naglašava kako klijanje u proljeće traje samo nekoliko tjedana.

Mlade biljke u rasadniku tijekom prve godine uzgoja valja držati pod zasjenom. Za sadnju na terenu sposobne su jednogodišnje biljke (1+0). Stilinović (1987) kaže da maklenovo sjeme treba posijati odmah nakon skupljanja ili stratificirati i sijati u proljeće. Predlaže gustoću sjetve od 10 g po dužnom metru, a dubinu sjetve oko 4 cm. Autor ističe osjetljivost maklenovih sadnica na kasni proljetni mraz.

Javorovo se sjeme sije s krilcima ili bez njih. Otkriljivanje u praksi nije toliko uobičajeno zbog toga što može imati negativan učinak na samu kakvoću sjemena.

Javorove se sadnice mogu proizvoditi obloženoga (kontejnerske biljke) ili gologa korijenskoga sustava. Kada se govori o većini vrsta iz roda *Acer,* tada je proizvodnja sadnica gologa korijena uobičajena metoda.

Predsjetvena priprema sjemena i vrijeme sjetve ovise o vrsti, uvjetima u rasadniku i iskustvu. Prema Carlu (1982b), Olsonu i Gabrielu (1974), Vertreesu (1987) i Yawneyu (1968) na 1 m^2 može se uzgojiti od 158 do 1520 sadnica. Čini se da je gustoća od 158 do 320 sadnica/m^2 zadovoljavajuća za proizvodnju vitalnih sadnica. Prema tim autorima sjeme se sije na dubinu od 0,6 do 2,5 cm, bez obzira na to da li se radi o sjetvi omaške ili u redove.

Gredice treba tretirati repelentima protiv ptica i miševa te fungicidima radi sprečavanja polijeganja ponika. Preporučuje se držanje gredica pod zasjenom sve do trenutka dok sadnice ne ojačaju.

Za sadnju na terenu mogu se koristiti sadnice u dobi 1+0, a često se koriste starije sadnice (2+0) ili presađenice (2+2). Općenito je pravilo, što su sadnice javora starije, to je njihovo preživljavanje na terenu bolje.

Kontejnerska proizvodnja sadnica javora nije toliko česta kao proizvodnja sadnica gologa korijena, no pojedini ju rasadničari ipak provode. Kontejnerske sadnice koje se uzgajaju u stakleniku obično postižu veće dimenzije od onih uzgajanih na polju ili na gredicama. Kontejnerska proizvodnja sadnica najbolja je u slučaju kada se upotrebljava stratificirano i naklijalo sjeme (vrste koje kliju za vrijeme stratifikacije). Danas se u proizvodnji javorovih sadnica upotrebljavaju kontejneri različitih veličina i tipova. Na primjer, neki proizvođači upotrebljavaju kontejnere promjera 4 cm i visine 15 cm. U takvim je kontejnerima moguće u jednoj vegetacijskoj sezoni proizvesti sadnice visine 30–40 cm. Takve se sadnice mogu presaditi na proizvodna polja u rasadniku ili u veće kontejnere radi proizvodnje većih biljaka koje će se koristiti u hortikulturne svrhe.

Željeni genotipovi javora mogu se razmnožavati i vegetativnim načinima, zakorjenjivanjem reznica od stabljika te različitim vrstama polijeganja (Dir i Heuser 1987).

Javor gluhać – *Italian maple* (*Acer obtusatum* Waldst. et Kit ex Willd.)

Rasadnička proizvodnja sadnica javora gluhaća jednaka je rasadničkoj proizvodnji maklena uz uvažavanje određenih specifičnosti vezanih uz stanišne uvjete u rasadniku, biološka svojstva i ekološke zahtjeva vrste, tehničko-tehnološku opremljenost rasadnika i sl.

Obična planika, jagodnjak – *Strawberry tree* (*Arbutus unedo* L.)

Neki autori predlažu jesensku sjetvu nestratificiranoga sjemena koje se sije u posude za sjetvu ili na gredice. Drugi je način proljetna sjetva stratificiranoga sjemena. Ako se dogodi da sjeme na gredicama ili u kontejnerima proklija pregusto, višak se klijanaca pročupava. Nakon toga klijanci se pažljivo presađuju i tijekom ljetnih mjeseci drže pod zasjenom.

U nekim slučajevima sjeme se sije neposredno u kontejnere kako bi se izbjegao šok biljke zbog presadnje. S obzirom na to da je sjeme obične planike vrlo sitno, poželjno ga je prekriti vrlo tankim slojem laganoga, poroznoga supstrata koji će propuštati dovoljne količine svjetla. Prisutnost svjetla kod ove vrste ima pozitivan učinak na klijanje sjemena.

Sukladno istraživanjima Beana (1981) i Huxleya (1992) obična planika traži dobro propusna tla koja su bogata hranjivima i koja zadržavaju vlagu i sunčane ili polusjenovite položaje zaklonjene od hladnih vjetrova, a pogotovo dok su biljke još male. Dobro raste na teškim glinama i na suhim tlima. Mnoge vrste iz ovoga roda ne podnose vapnenasta tla, no ova je vrsta vrlo tolerantna prema vapnu u tlu.

Sheat (1948) smatra da je najbolje vrijeme za sjetvu sjemena (površinsku) odmah nakon sazrijevanja. Skladišteno sjeme treba se močiti 5–6 dana u toploj vodi, a nakon toga sjeme posijati po površini na sjenovitom mjestu u stakleniku. Ne smije se dopustiti da se kompost osuši.

Istraživanja Rice (1988) pokazuju kako je za svladavanje dormantnosti potrebno 6 mjeseci hladne stratifikacije. Sjeme pri temperaturi od 20 °C obično proklija za 2–3 tjedna.

Klijanci obične planike osjetljivi su na polijeganje i najbolje je vrijeme za presadnju u pojedinačne posude ili kontejnere čim postanu dovoljno veliki za rukovanje. Sadnice se drže u jako prozračnim uvjetima. Tijekom prve vegetacije drže se u

stakleniku, a na otvoreno se presađuju krajem proljeća nakon prestanka opasnosti od kasnoga proljetnoga mraza.

Prema Regentu (1980) sjeme planike sije se u proljeće ili u jesen. Isti autor kaže kako se ona osim generativnim (sjeme) može razmnožavati i vegetativnim načinima (reznicama, korjenjacima i cijepljenjem). Šilić (2005) piše kako se obična planika razmnožava korjenjacima, reznicama iz prošlogodišnjih izbojaka i sjetvom. Autor nadalje ističe biološko svojstvo obične planike da ima jaku izbojnu snagu iz panja.

Razmnožavanje obične planike reznicama jedini je način razmnožavanja kad su u pitanju varijeteti. Koriste se zrele reznice duljine 15–20 cm. Uzimaju se s ovogodišnjih izbojaka u studenom i prosincu. Reznice se pikiraju u stolove za zakorjenjivanje s podnim grijanjem. Polako se zakorjenjuju, a postotak zakorjenjivanja često je nizak. Zanimljivo je kako se zakorjenjivanje reznica može povećati ako se reznice zalijevaju vodom u kojoj su močene vrbove grančice 24 sata. Vrbova kora sadrži hormone koji potiču zakorjenjivanje i potpomažu rizogenezu.

Ako imamo dovoljno niske grančice na stablu ili grmu obične planike, moguće je razmnožavanje položenicama. Načini se mali zasjek oštrim nožem na grani, a grana se savine u tlo. Nova se biljka dobije za dvije godine odvajanjem zakorijenjenoga dijela od matične biljke škarama. Grančica često pusti korijenje i može se odvojiti od matične biljke čim počne rasti.

Plod je ove vrste jestiv, sadrži do 10 % šećera, a služi za spravljanje pekmeza, rakije i likera (Šilić 2005).

Rogač – *Carob tree* (*Ceratonia siliqua* L.)

Zbog učinkovitosti sjetve sjemena rogača preporučuje se proljetna sjetva prethodno mehanički skarificiranoga sjemena. Preporučuje se sjetva sjemena u one tipove kontejnera u kojima se korijen neće spiralno uviti. Rogačeve sadnice teško podnose oštećenje korijena.

Rogač je moguće i vegetativno razmnožavati pomoću reznica i kulture tkiva. Pri uzimanju reznica bitni su ovi čimbenici: vrijeme skupljanja, vrsta reznice (važan je *topophysis*) i stanje matične biljke (postotak zakorjenjivanja razlikuje se s obzirom na pojedini genotip; Piotto i Di Noi 2001). Young i Young (1992) pišu kako se skarificirano sjeme rogača sije u tlo ili vermikulit, a zasijana površina drži se pod djelomičnom zasjenom. Sjeme se sije u proljeće ili jesen. Budući da klijanci razvijaju dugačku žilu srčanicu koja se vrlo lako može oštetiti, predlaže se uzgoj sadnica rogača u prikladnim kontejnerima. Jedna od mogućnosti koju opisuje Coit (1951) zasniva se na močenju mahuna rogača u vodi 2–3 dana nakon čega slijedi sjetva mahuna, bez odvajanja sjemena. Postotak je klijanja takva sjemena nizak.

Prema Jedlovskomu (1987) rogač se razmnožava sjemenom i vegetativno (na divlji rogač cijepi se pitomi). Sjeme se prije sjetve moči u vodi u trajanju 4–5 dana. Biljka ostaje u sijalištu 2 godine (2+0) i kao takva se sadi na terenu (s busenom). Sadnice rogača za dobivanje ploda sade se 5–6 godina nakon cijepljenja željenoga varijeteta na spavajući pup (u kolovozu).

Drijen – *Cornelian cherry* (*Cornus mas* L.)

Sjeme se drijena sije odmah nakon skupljanja (početkom ili sredinom jeseni) ili se sjeme stratificira toplo-vlažnim postupkom u trajanju 12–16 tjedana i sije krajem jeseni. U tom slučaju sjeme klija tek u proljeće druge godine. Može se koristiti i proljetna sjetva stratificiranim sjemenom. Sjeme se najprije drži na toploj stratifikaciji 16 tjedana, a nakon toga na hladnoj 4–6 tjedana. Prije toplo-hladne stratifikacije sjeme se može skarificirati (Piotto i Di Noi 2001). Prema Regentu (1980) sjeme ili plodovi drijena siju se u jesen ili prethodno stratificiraju i siju u proljeće (travanj ili početak svibnja). Sjeme se prekriva s 1 cm zemlje.

Drijen se može razmnožavati i vegetativnim načinom, reznicama i cijepljenjem. Koriste se zelene ili poluzrele reznice (u srpnju).

Prema Stilinoviću (1987) sjeme se sije odmah po skupljanju, oko 15 g sjemena po dužnom metru, na dubinu od približno 3–4 cm. Sjeme drijena najčešće preleži u toku cijele sljedeće godine. Sjeme treba stratificirati u trajanju od najmanje godinu dana i sjetvu obaviti iduće jeseni. Neki autori preporučuju stratifikaciju u trajanju od čak 18–24 mjeseca. Sadnice ostaju u klijalištu dvije godine (2+0), poslije čega se školuju iduće 2–3 godine. Prema podacima iz WSL Versuchsgarten (1991) klijanci u sijalištu ostaju jednu vegetaciju (1+0), a zatim se presađuju u rastilište gdje ostaju jednu (1+1) ili dvije (1+2) godine. Biljke iz rastilišta koriste se za sadnju na terenu. Za razmak između biljaka u sijalištu predlaže se 18 x 20 cm.

Obično judino drvo – *Judas tree* (*Cercis siliquastrum* L.)

Sjeme običnoga judina drva mehanički skarificirano sije se u proljeće i to je najbolji način sjetve. Moguće je i vegetativno razmnožavanje cijepljenjem, dok je razmnožavanje reznicama vrlo teško (Piotto i Di Noi 2001). Sjeme se pokriva s 0,6 cm slojem zemlje, a usjev se mora stalno zalijevati do kraja nicanja. Prema Frettu i Dirru (1979), Heitu (1967a), Lippittu (1996), Raulstonu (1990), Robertsonu (1976) i Smithu (1986) površinski prosušeno sjeme sije se u redove ili omaške i prekriva s 0,6 do 2,5 cm zemlje, pijeska, piljevine ili mljevene kore drveta.

Prema Lippittu (1996) sjeme se može sijati i u kontejnere tijekom jeseni kako bi dodatno bilo izvrgnuto prirodnoj stratifikaciji. Kontejneri s posijanim sjemenom preko zime drže se vani na nekom prekrivenom mjestu. Roy (1974) piše kako su sadnice običnoga judina drva, proizvedene sjetvom sjemena u rasadniku, veoma varijabilne.

Prema Stilinoviću (1987) moguće je proljetno razmnožavanje zelenim reznicama koje rastu na polju i koje su ljeti odsječene s forsiranih matičnih biljki ili s jedinki. Cijepljenje se provodi na podlogu tipične vrste, kozjom nogom ili triangulacijom u području vrata korijena. Cijepi se zimi (siječanj) u stakleniku.

Lovor – *Bay laurel* (*Laurus nobilis* L.)

Nestratificirano sjeme sije se u proljeće ili zimi. Drugi je način proljetna sjetva stratificiranoga sjemena. Nakon svladavanja dormantnosti čini se kako klijanje sjemena potiču promjenjive temperature od 20 °C (16 sati sa svjetlom) i 16 °C (8 sati u mraku) (Piotto i Di Noi 2001). Sjeme se može sijati odmah nakon čišćenja ili se stratificira i sije u proljeće u zaštićene lijehe. Postoji mogućnost da se lovorovo sjeme sije odmah nakon sazrijevanja ili u proljetnoj sjetvi.

Za sjetvu se koristi vlažan, ali ne vodom prezasićen kompost. Sjeme se sije na površinu i lagano prekriva suhim kompostom. Kontejneri se ostave na zamračeno mjesto, a idealna temperatura bila bi oko 21 °C. Za klijanje sjemena u navedenim uvjetima potrebna su oko 3 mjeseca, dok bi u drugim (normalnim) uvjetima bilo potrebno 3–4 mjeseca. Najveća je opasnost za sjeme, prije nego što proklija, njegova trulež u supstratu.

Prema Greenwoodu (1987), Hartmannu i dr. (2002) kod mediteranskih vrsta grmova koje se teško zakorjenjuju, zakorjenjivanje reznica može se povećati rejuvenizacijom, odnosno prijelazom biljke iz zreloga u juvenilni stadij. U istraživanju Pignattija i Crobeddua (2005) lovorove reznice uzete u travnju od zrele matične biljke nisu se zakorijenile, dok je zakorjenjivanje od 75 % (od 0 do 87,9 %) postignuto reznicama uzetim u kolovozu. S druge strane reznice uzete s rejuveniziranih jedinki jednako su se dobro zakorijenile (58,3 %, odnosno između 40,8 i 74,5 %), bez obzira na vrijeme uzimanja. U istom istraživanju, kod svih vrsta osim lovora, vjerojatnost zakorjenjivanja reznica koje su uzete u kolovozu bila je veća kod rejuveniziranih nego kod zrelih reznica.

Zaključak je kako se najbolje zakorjenjuju reznice većine vrsta mediteranskih grmova (osim lovora i lemprike) uzete u kolovozu. Reznice lemprike i lovora uzete s rejuveniziranih jedinki zakorjenjuju se više od 50 %.

Zasijano sjeme niče poslije 3–4 mjeseca, a ponekad i druge godine nakon sjetve. Ova se vrsta osim generativnim može razmnožavati i vegetativnim načinom.

O mogućnostima vegetativnoga razmnožavanja ove vrste pišu Piotto i Di Noi (2001) te Stilinović (1987) koji detaljno opisuje i postupak rada, smatrajući da se lovor razmnožava zrelim ili zimskim reznicam (od listopada do ožujka). Koriste se bočne grančice s kojih se odsijecaju komadi duljine 10 cm. Reznice se pikiraju u čisti riječni pijesak, u uvjetima umjerenoga zagrijavanja. Ožiljavanje reznica traje oko osam tjedana. Ožiljenice se presađuju u posude ili kontejnere i nakon što se dobro zakorijene, prenose se u negrijani staklenik u kojem ostaju do proljeća. U proljeće se posude zakopavaju u gredice (u treset i sl.), a zatim se pokrivaju plitkim slojem stajnjaka. Biljke treba češće prihranjivati i štititi od hladnoće i mraza. Vršni izbojak ne smije biti oštećen jer se teško razvija novi.

U drugoj godini sadnice se presađuju u posude promjera 10 cm, skidaju se bočni pupovi ili bočne grančice. U trećoj godini sadnice se ponovno presađuju, a u četvrtoj, kada narastu 100–120 cm, formira se krošnja. Presađivati treba samo onda kada je to nužno i uvijek u veće posude ili s većim busenom. Važno je naglasiti da lovorove sadnice mogu prezimiti u negrijanim prostorijama ako temperatura u njima ne padne ispod 0 °C. Korijenski se busen ne smije osušiti.

Najpogodniji je supstrat za punjenje posuda za uzgoj lovora, prema Stilinoviću (1987), mješavina komposta, stelje, treseta i pijeska u istom omjeru.

Prema nekim autorima reznice se lovora uzimaju krajem ljeta i početkom jeseni, a vrsta se teško zakorjenjuje. Nožem se režu zreli izbojci duljine od 9 do 15 cm, s tim da se na reznici ostavi dio glavne stabljike. Asimilacijska se površina smanji tako da na njoj ostanu samo 3–4 lista. Pripremljene se reznice pikiraju u lončiće maloga obujma ili u kontejnere napunjene supstratom za zakorjenjivanje. Sadnice je potrebno staviti na mjesto zaklonjeno od izravnoga sunčanoga svjetla (vanjske su gredice idealne). Ključan čimbenik za uspješno razmnožavanje reznicama na opisani način jest potreba za visokom zračnom vlagom. Lovorove bi se reznice trebale zakorijeniti za približno godinu dana.

Uskolisna zelenika – *Narrow-leaved phillyrea* (*Phillyrea angustifolia* L.)

Sjeme uskolisne zelenike nužno je prije sjetve mehaničkim ili kemijskim putem skarificirati (močenjem u koncentriranoj sumpornoj kiselini u trajanju od 30 minuta i ispiranjem pod tekućom vodom). Sjeme se sije odmah nakon skupljanja ili iduće proljeće. Moguće je i razmnožavanje reznicama (Piotto i Di Noi 2001).

Širokolisna zelenika – *Broad-leaved phillyrea* (*Phillyrea latifolia* L.)

Rasadnička proizvodnja širokolisne zelenike jednaka je rasadničkoj proizvodnji uskolisne zelenike, ali se moraju uzeti u obzir određene specifičnosti vezane uz stanišne uvjete u rasadniku, biološka svojstava i ekološke zahtjeve vrste, tehničko-tehnološku opremljenost rasadnika i sl. Šilić (2005) piše o mogućnostima generativnoga i vegetativnoga razmnožavanja ove vrste.

Obična mirta – *Common myrtle* (*Myrtus communis* L.)

Nestratificirano sjeme obične mirte sije se krajem jeseni, odnosno odmah nakon skupljanja. Drugi je način proljetna sjetva stratificiranim sjemenom (hladna stratifikacija). S obzirom na to da je sjeme jako sitno, prekriva se vrlo tankim slojem poroznoga i laganoga supstrata koji može propuštati dovoljne količine svjetla koje potiče klijavost sjemena. Sjeme se obične mirte uglavnom sije na gredice, a klijanci se zatim presađuju u kontejnere ili na proizvodna polja u rasadniku.

Sadnice obične mirte koje ranije niknu prilično su niže, a poslije pri njihovoj presadnji može doći do šoka. Zbog toga se predlaže da se tijekom proljeća i ljeta sadnice drže pod 60 postotnom zasjenom (Piotto i Di Noi 2001). Prema Regentu (1980) sjeme treba sijati u brazde razmaka 20–30 cm, u proljeće ili u kasno ljeto odnosno u jesen, ali tako da do zime ostane još barem 60 toplih dana. Autor preporučuje usjev pokriti slojem tla debljine oko 1,2 cm i zaštititi ga slamom ili sličnim malčem koji se skida u trenutku čim počne klijanje. Napominje kako se stratificirano sjeme u trajanju od jedne godine može posijati u jesen. U svim slučajevima sjeme klija tek idućega proljeća.

Šilić (2005) predlaže da se sjetva sjemena u rasadniku obavi u rano proljeće, na finom, sitnom i rastresitom tlu. Svi autori govore o mogućnostima vegetativnoga razmnožavanja obične mirte ljetnim reznicama i povaljenicama.

Očenašica – *Persian lilac* (*Melia azedarach* L.)

Prema Regentu (1980) plodovi (ili sjeme) očenašice siju se u jesen, odmah nakon skupljanja, ili u proljeće. Razmak redova iznosi 5–10 cm, a dubina sjetve oko 2,5 cm. U proljeće sjeme klija oko 3 tjedna nakon sjetve.

Za sadnju na terenu koriste se jednogodišnje sadnice (1+0). Kod starijih se sadnica mora reducirati krošnja i korijenje. Moguće je razmnožavanje ove vrste reznicama od stabljike ili korijena.

Mukinja – *Whitebeam* (*Sorbus aria* /L./ Crantz.)

Piotto i Di Noi (2001) pišu da se nestratificirano sjeme vrsta iz roda *Sorbus* sije u jesen odmah nakon skupljanja ili se stratificira toplo-hladnim postupkom (2–4 tjedna topla i 12–16 tjedana hladna stratifikacija) i sije krajem zime odnosno početkom proljeća. Autori navode kako se u većini slučajeva koristi samo prirodna stratifikacija (u jamama), a samo ponekad prije sjetve hladna stratifikacija u hladnjaku u trajanju 8–16 tjedana. Sjetva stratificiranoga sjemena obavlja se krajem zime i početkom proljeća kada postoje značajne temperaturne oscilacije (hladne noći/topli dani). Ako je temperatura tla previsoka, sjetva u kasno proljeće može izazvati sekundarnu dormantnost sjemena. Regent (1980) smatra da se sjeme može sijati u jesen ili kasnije, po snijegu, ili ga stratificirati i sijati u proljeće. Dubina sjetve iznosi oko 0,5 cm. Prema istomu autoru za sadnju na terenu najbolje su školovane biljke u dobi 1+1, često se koriste i dvogodišnje, nepikirane. Macdonald (1986) preporučuje gustoću sjetve 200–250 sjemenki/m^2. Slično Regentu pišu i Young i Young (1992) te ističu kako se sjeme vrsta iz roda *Sorbus* može sijati u jesen. Sjeme se plitko prekriva, a gredice se malčiraju. Navodi kako su sadnice svih vrsta iz roda *Sorbus* vrlo otporne i kako se lako uzgajaju.

Prema katalogu WSL Versuchsgarten (1991) sadnice mukinje uzgajaju se u sijalištu rasadnika jednu (1+0) ili dvije (2+0) vegetacije, a razmak biljaka iznosi 12–15 x 20 cm. Sadnice se školuju i prodaju kao 2+2 ili 2+3.

Prema Stilinoviću (1987) mukinja najsporije raste od ostalih vrsta iz roda *Sorbus,* iako ni ostale ne izrastu na kraju prve godine više od 10 do 20 cm. Predlaže uzgoj sadnica mukinje u sijalištu rasadnika dvije vegetacije, dok je za vrtne forme potrebno školovanje.

Brekinja – *Wild service tree* (*Sorbus torminalis* /L./ Crantz.)

Rasadnička proizvodnja brekinje jednaka je rasadničkoj proizvodnji mukinje uz uvažavanje određenih specifičnosti vezanih uz stanišne uvjete u rasadniku, biološka svojstava i ekološke zahtjeva vrste, tehničko-tehnološku opremljenost rasadnika i sl. Kausch-Blecken von Schmeling (1994) piše kako se sjeme odmah nakon čišćenja može sijati izravno u klijalište. Sjeme se prekriva s tankim slojem pijeska i zaštićuje od ptica. Na taj je način sjeme zimi izvrgnuto prirodnoj hladnoj stratifikaciji. Stratifikacija sjemena na umjetan način (u laboratoriju) uspješna je samo onda ako se sjeme neprekidno drži u važnim i hladnim uvjetima dva do tri mjeseca. Ako se nestratificirano sjeme sije u proljeće, ono klija tek sljedeće godine. Winkler (1999) preporučuje da se u plastične sanduke s 50 % perforiranim dnom, dimenzija 40 x 60 cm, sije oko 800 sjemenki. Nakon sjetve sjeme se prekriva s 0,5 cm pijeska. Ako se sjeme prekrije na veću dubinu, klijanci razvijaju previše dugačke vratove korijena, što otežava pikiranje i odražava se na samu kakvoću sadnica.

Kausch-Blecken von Schmeling (1994) naglašava kako se sjeme brekinje sije u trenutku kada u stratifikatu proklija 10–20 % sjemenki. Sjeme se plitko prekriva pijeskom, a gredica mora biti stalno vlažna. Gredice se u slučaju sunčanih dana zasjenjuju.

Jedna od obveznih mjera njege pri uzgoju sadnica brekinje jest podrezivanje korijenskoga sustava. Već na kraju prve godine sadnice mogu postići prodajne dimenzije, no ipak se češće prodaju u dobi od dvije, a ponekad i tri godine. Uzgoj stablašica brekinje istovjetan je kao i kod drugih vrsta. Ako se sadnicama ispravno podreže korijen, razvija se bogat korijenski sustav. Zbog prirodno snažnoga korijena njegovo je podrezivanje pomoću ašova puno teže u odnosu na druge načine podrezivanja (npr. mehanizirano, pomoću pluga).

Klijanci koji niknu na gredicama (na otvorenom) mogu se presaditi ili se sjeme sije u stakleniku (u kontejnere), a nakon nicanja biljčice se pikiraju. Pri pikiranju u male kontejnere od

treseta korijenski se sustav brzo razvija. Nakon toga biljke se iz kontejnera presađuju na otvoreno. Za jednu do najkasnije dvije godine sadnice su visine od 40/70 ili 50/80 cm i imaju dobro razvijen korijenski sustav.

Sadnice iz kontejnera Jiffypots mogu se presaditi na otvoreno ili u veće kontejnere od materijala koji može prorasti korijenski sustav. Sadnice uzgojene u kontejnerima mogu se u bilo koje vrijeme presaditi, a ako se radi o normalnim tlima, presadnja je uspješna. U budućnosti je potrebno istražiti jesu li sadnice gologa korijena bolje ako se sade u suha tla. Naime, spoznalo se da su kontejneri čije su stijenke rađene od treseta štetne ako se treset osuši.

Kausch-Blecken von Schmeling (1994) piše kako sadnice brekinje ne trebaju potporu štapom. Sadnice sporo rastu, a lignificiraju rano i dobro. Štap trebaju samo u slučaju ako vrlo brzo rastu. Dobra su iskustva s kontejnerskim uzgojem biljaka brekinje. Za punjenje kontejnera koristi se treset, a u ljeto se dodaje gnojivo s produženim djelovanjem. Od 1 kg sjemena brekinje može se proizvesti 10 000 do 20 000 sadnica odnosno iskoristivost je sjemena od 1/3 do 2/3. Autor naglašava kako je moguće dobiti i bolje rezultate iskoristivosti sjemena.

U literaturi se može pronaći zanimljiv način sjetve sjemena jarebike i brekinje: kokošinjac se dobro očisti i živina se hrani jedan dan plodovima ovih vrsta, a zatim se sljedećega dana gnojivo prikupi i rasije omaške po gredicama.

U katalogu WSL Versuchsgarten (1991) piše da se sadnice brekinje uzgajaju u sijalištu rasadnika jednu (1+0) ili dvije (2+0) vegetacije, a razmak biljaka iznosi 15 x 20 cm. Sadnice se zatim školuju i prodaju kao 1+1, 1+2 ili 2+1.

Divlja maslina – *Wild olive tree* (*Olea europaea* spp. *sylvestris* /Mill./ Rony)

Maslina se razmnožava sjemenom i vegetativno. Sadnice uzgojene iz sjemena služe kao podloga za cijepljenje. Cijepljenje metodom okuliranja ili u procijep provodi se kad sadnice dostignu 1,5 godinu. Reznice se masline teško zakorjenjuju, a moguće je razmnožavanje ove vrste i zagrtanjem.

Alepski bor – *Aleppo pine* (*Pinus halepensis* Mill.)

Borovo se sjeme sije obično u proljeće, rjeđe u jesen. Sitnije sjeme prekriva se s 0,6–0,7 cm zemlje, a krupnije (*P. cembra*, *P. pinea*) s oko 1–1,5 cm. Klijanje obično završava 30–40 dana nakon sjetve. Rasadnička klijavost kod bora iznosi 50–75 % od laboratorijske (Regent 1980). Piotto i Di Noi (2001) pišu kako je klasično vrijeme sjetve sjemena vrsta iz roda *Pinus* proljeće uz uvjet da se sjeme dormantnih vrsta stratificira na odgovarajući način.

Ukrasne borove forme i kultivari razmnožavaju se reznicama ili cijepljenjem.

Stilinović (1987) piše kako se po dužnom metru sije 8–10 g sjemena. Sjeme prije sjetve nije potrebno stratificirati, ali držanje sjemena u vodi u trajanju od 24 sata pomaže bržemu i ravnomjernijemu klijanju. Napominje kako sadnice već u prvoj godini razvijaju dugu žilu srčanicu (i do 50 cm).

Danas se u praksi najviše proizvode kontejnerske sadnice alepskoga bora. Za potrebe urbanoga šumarstva sadnice se školuju u rastilištu rasadnika 4–5 godina. Za sadnju na terenu upotrebljavaju se jednogodišnje sadnice alepskoga bora (1+0).

Brucijski bor – *Turkish pine* (*Pinus brutia* Ten.)

Rasadnička proizvodnja brucijskoga bora vrlo je slična rasadničkoj proizvodnji alepskoga bora uz uvažavanje određenih specifičnosti vezanih uz stanišne uvjete u rasadniku, biološka svojstava i ekološke zahtjeva vrste, tehničko-tehnološku opremljenost rasadnika i sl. Piotto i Di Noi (2001) pišu kako se stratificirano sjeme (4–8 tjedana) sije u proljeće. Hladna stratifikacija pokazala se posebno učinkovita kod sjemena skupljenoga u područjima s izrazito oštrim zimama.

Danas se u praksi najviše proizvode kontejnerske sadnice brucijskoga bora. Prema Regentu (1980), kao i kod alepskoga bora, za sadnju na terenu prikladne su jednogodišnje sadnice (1+0).

Pinija – *Stone pine* (*Pinus pinea* L.)

Rasadnička proizvodnja pinije vrlo je slična rasadničkoj proizvodnji ostalih, već spomenutih borovih vrsta uz uvažavanje određenih specifičnosti vezanih uz stanišne uvjete u rasadniku, biološka svojstava i ekološke zahtjeva vrste.

Piotto i Di Noi (2001) pišu kako se u vrućim, južnim područjima Italije sjeme pinije sije krajem ljeta, dok je u ostalim krajevima uobičajeno vrijeme sjetve u proljeće. Stilinović (1987) također navodi da se sjetva sjemena obavlja u proljeće u količini od oko 200 sjemenki po dužnom metru. Sjeme se prije sjetve drži jedan dan u vodi.

Zbog dugačke žile srčanice koju razvija već u prvoj godini i osjetljivosti na transport, za pošumljavanje je bolje koristiti sadnice obloženoga korijena. Danas se u praksi najviše i proizvode kontejnerske sadnice pinije.

Za potrebe urbanoga šumarstva sadnice se nekoliko godina uzgajaju u rastilištu rasadnika. Krošnja se sadnice prirodno formira, no ako se razviju dva terminalna izbojka, slabiji i nepravilnije razvijeni treba odrezati. Ako se pak ošteti terminalni izbojak, jedan bočni izbojak iz prvoga nižega pršljena treba ispraviti, vezati uz kolac i omogućiti mu da preuzme na sebe ulogu terminalnoga. Budući da u pršljenu nastaje praznina, grane iz toga pršljena treba povezati tako da budu pritegnute prema praznini i da ju ispune.

Razmnožavanje borova (vrsta, varijeteta, formi, kultivara i dr.) pomoću reznica vrlo se rijetko koristi u praksi zbog izrazito dugoga razdoblja zakorjenjivanja. Kalemljenje se mnogo češće primjenjuje u razmnožavanju formi čije generativno potomstvo ne zadržava željena svojstva one vrste i forme od kojih se ne može dobiti sjeme. Kalemi se tijekom zime, u stakleniku, a koristi se metoda bočnoga cijepljenja pri osnovi.

Prema Regentu (1980) za sadnju na terenu sposobne su jednogodišnje pinijeve sadnice (1+0).

Crni bor, bor lučika – *Black pine* (*Pinus nigra* J. F. Arnold)

Rasadnička proizvodnja crnoga bora vrlo je slična rasadničkoj proizvodnji ostalih, već spomenutih vrsta bora. Sjeme crnoga bora sije se ili u dunemannove lijehe ili u različite tipove kontejnera. Ako se sjeme crnoga bora sije u dunemannove lijehe, prvi je korak pripremiti tlo u gredici. Lijehe se pune 80 % šumskom zemljom uz dodatak 20 % treseta. Slijedi dezinfekcija tla, najčešće kemijskim načinom, biocidima. Danas se za dezinfekciju tla najčešće koristi Basamid Granulat u količini od 50 g/m^2. Tretirane površine prekrivaju se najlonom koji ostaje, ovisno o temperaturi tla. Što je temperatura tla veća, bazamid se brže razlaže i potrebno je kraće vrijeme za dezinfekciju. Nakon dezinfekcije najlon se skida, a tlo se prozračuje (freza se više puta dnevno) po prilici toliko dugo koliko je bilo pod najlonom. Slijedi kreso-test kojim se utvrđuje da li na tretiranim površinama ima ostataka plina dazometa (štetan za sjeme koje se sije).

Ako je kreso-test negativan, pristupa se sjetvi sjemena u količini od 4 dkg/m^2 ili oko 1 kg/25m^2. Rasadnička klijavost po domaćim iskustvima iznosi oko 60 % odnosno iz 1 kg sjemena proklija oko 1500 sjemenki. Sklop u sjalištu iznosi oko 620 biljaka/m^2 ili 25 % od ukupnoga broja sjemenki.

Klijanci se presađuju iz dunemannovih lijeha u rastilište rasadnika nakon jednu godinu (1+0). U rastilištu se najprije rasipačima rasipa mineralno gnojivo NPK 7:20:30 u količini od 350 kg/ha. Nakon toga slijedi osnovna obrada tla (oranje), a zatim i dopunska obrada (tanjuranje). Površine se najčešće tretiraju zemljišnim herbicidima. Nakon toga slijedi izrada gredica plugom gredičarem te u proljeće pikiranje sadnica uz pomoć sadilice.

Sklop u rastilištu iznosi 50 biljka/m^2, što znači da je razmak biljaka u redovima 10 cm, a razmak redova 20 cm. Ako se radi strojno, pomoću sadilice tada ima 5 redova koji su paralelni s dužom stranom gredice. U rastilištu se provode osnovni radovi na njezi sadnica poput navodnjavanja i kultiviranja međurednim kultivatorom s prihranom mineralnim gnojivima KAN 150–200 kg/ha. Provodi se i zaštita od korova međurednim tretiranjem herbicidima te zaštita od korova okopavanjem biljaka. Po potrebi provodi se i zaštita protiv biljnih bolesti i štetnika. Iduće vegetacije biljke se zalijevaju, kultiviraju i obavlja se zaštita od korova. Na kraju druge vegetacije u rastilištu (1+2) biljke se vade vibracijskim plugom, klasiraju i šalju na teren ili se čuvaju u hladnjačama pri niskim temperaturama.

Stilinović (1987) piše kako se sjeme crnoga bora sije u proljeće, najbolje odmah nakon skupljanja češera i trušenja sjemena, u količini 6–10 g po dužnom metru. Sjeme se prekriva s oko 3 cm zemlje. Prema istomu autoru svježe skupljeno sjeme nije potrebno stratificirati prije sjetve, ali držanje sjemena u vodi u trajanju od 24 sata pomaže bržemu i ravnomjernijemu klijanju.

Ponik je prilično otporan na kasni proljetni mraz i sušu. U slučaju dužega sušnoga razdoblja biljke treba zalijevati i eventualno zasjenjivati. Ako se proizvode sadnice gologa korijena, one ostaju u sjalištu rasadnika jednu ili češće dvije godine. U rastilište rasadnika mogu se presaditi i jednogodišnje sadnice (1+0) koje se uzgajaju iduće dvije godine (1+2) ili češće one dvogodišnje (2+0) koje u rastilištu ostaju jednu godinu (2+1).

Za potrebe hortikulture sadnice iz sjališta u dobi 1–2 godine presađuju se u školu u kojoj se uzgajaju idućih 4–5 godina. Dvogodišnje sadnice iz sjemeništa (2+0) mogu se već koristiti pri pošumljavanju. Regent (1980) za sadnju na terenu preporučuje dvogodišnje (ili starije) presađene biljke crnoga bora.

U katalogu WSL Versuchsgarten (1991) piše kako se sadnice crnoga bora uzgajaju u sjemeništu rasadnika jednu (1+0) ili dvije (2+0) vegetacije s razmakom biljaka od 15 x 20 cm. Sadnice se zatim školuju i šalju na teren u dobi 1+2 ili 2+2. Za pošumljavanja na području Sredozemlja danas se najviše proizvode kontejnerske sadnice crnoga bora u dobi 1+0.

Obični čempres – *Italian cypress* (*Cupressus semervirens* L.)

Regent (1980) piše kako se sjeme dormantnih vrsta čempresa može sijati netretirano u jesen ili (bolje) stratificirano u proljeće kada se sije i sjeme nedormantnih vrsta. Sjeme se prekriva s 0,3–0,5 cm zemlje ili 0,6–0,7 cm pijeska. Zasijano u proljeće, sjeme nedormantnih vrsta, kao što je obični čempres, isklija brzo i ujednačeno za 2–3 tjedna. Usjev treba redovito dovoljno zalijevati i držati pod zasjenom sve do potpunoga klijanja. U suprotnom, klijanje će kasniti i do dvadesetak dana, neujednačeno je, a i postotak dobivenih biljaka značajno je manji. Piotto i Di Noi (2001) kažu da se sjeme sije u proljeće, a po mogućnosti dobro ga je držati na hladnoj stratifikaciji 3–4 tjedna. Ako sjeme nije prošlo stratifikaciju, dobro ga je prije sjetve močiti u vodi 2–3 dana.

Kad klijanci postignu dovoljne dimenzije, presađuju se u kontejnere ili gredice na otvorenom. Presadnja klijanaca može se izbjeći u slučaju kad sjeme stratificiramo i pustimo ga da naklija, a zatim ga sijemo izravno u kontejnere. U početnoj fazi razvoja, zbog osjetljivosti klijanaca na nedostatak vlage, preko zasijanih površina stavlja se sjenilo.

Young i Young (1992) preporučuju jesensku sjetvu nestratificiranoga ili proljetnu sjetvu hladno stratificiranoga sjemena. Sjeme se sije omaške i prekriva tankim slojem zemlje. Gustoća sadnica na gredicama kreće se između 310 i 630 biljaka/m^2. Za malčiranje gredica koristi se raspadnuti granit. Spominje se kako su čempresovi klijanci u uvjetima visoke vlage podložni propadanju zbog gljivičnih bolesti. Stilinović

(1987) piše kako se u zavisnosti od klime sjeme može sijati na otvorenim gredicama ili u sanducima pod staklom. Sjetva se obavlja u proljeće na dubini oko 5 mm, a zatim se gredice malčiraju. Sjeme klija nakon 2–3 tjedna. Za sjetvu sjemena u sanduke autor preporučuje mješavinu sastavljenu od dva dijela ilovaste zemlje, jednoga dijela treseta i jednoga dijela pijeska. Sanduke treba ispuniti do 1–1,5 cm od gornjega ruba, zatim sjeme posijati na malu dubinu (5–6 mm), dobro zaliti i eventualnu prekriti papirom dok ne počne klijanje.

Kad ponik naraste 1–2 cm u visinu, sanduci se prenesu iz staklenika u hladno klijalište i pokriju staklom, a kad biljčice ojačaju, treba ih prenijeti pod zasjenu. Sadnice su vrlo osjetljive na nedostatak vlage, tako da se ni u jednom trenutku tlo ne smije osušiti. Preko jeseni i zime biljke se na vanjskim gredicama malčiraju slamom ili drugim zaštitnim materijalom. Sadnice se mogu proizvoditi u raznim tipovima kontejnera. One ostaju u sjemeništu 1–2 godine, dok se sadnice za potrebe urbanoga šumarstva uzgajaju u rastilištu, u prvoj školi, 4–5 godina.

Iz sjemena skupljenoga s varijeteta s izraženim piramidalnim rastom dobiju se i sadnice s otklonjenim granama. Ako je isključivi cilj proizvodnja sadnica piramidalne krošnje, u prvu se školu presađuju samo one željenoga fenotipa. Na terenu se koriste sadnice čempresa u dobi 1+0 ili 2+0. Jednogodišnje sadnice imaju samo juvenilno lišće.

Regent (1980) za sadnju na terenu preporučuje školovane dvogodišnje biljke (1+1).

Piotto i Di Noi (2001) kao i Regent (1980) spominju mogućnost vegetativnoga razmnožavanja ove vrste reznicama i cijepljenjem. Prema Dirr i Heuser Jr. (1987) reznice arizonskoga čempresa uzimaju se s mladih biljaka, tretiraju od 2000 do 5000 ppm IBA hormona. Najbolje se zakorjenjuju reznice uzete u studenom ili u prosincu. Reznice običnoga čempresa uzete u travnju zakorjenjuju se bez problema. Kultivari za potrebe hortikulture najčešće se cijepe na podloge dobivene iz sjemena (Dirr i Heuser Jr. 1987).

Prema Stilinoviću (1987) var. *sempervirens* može se razmnožavati reznicama uzetim od prosinca do siječnja. Ožiljavanje reznica bez upotrebe hormona dosta je teško. Tretiranje reznica s IBA kiselinom u trajanju od 24 sata potiče zakorjenjivanje. Biljke se cijepe ljeti, u stakleniku, metodom bočnoga cijepljenja, nisko, na osnovi podloge tipične vrste (posađene u posudi). Pri zalijevanju cijepljenih biljaka potrebno je izbjegavati kvašenje iglica. Mora se održavati umjerena vlažna atmosfera. Nakon stvaranja kalusa skida se zasjena, a podloga se prikraćuje.

Dirr i Heuser Jr. (1987) pišu kako se reznice običnoga čempresa uzimaju u travnju, zakorjenjuju se bez primjene hormona 100 %. Reznice uzete u svibnju bez primjene hormona zakorjenjuju se 80 %, a uz primjenu IBA 100 %. Reznice uzete u veljači, ožujku, lipnju i srpnju bez primjene hormona zakorjenjuju se 60, 50, 45 i 65 %. Primjena IBA hormona povećava postotak zakorjenjivanja na 50, 70, i 80 %.

Pukinja, ljuskavac – *Prickly juniper* (*Juniperus oxycedrus* L. Ball. syn. *J. macrocarpa* /Sm./ Ball.)

Sjeme pukinje sije se u jesen, odmah nakon skupljanja. Sjeme klija 4–6 tjedana nakon sjetve. Nakon 4–5 ili 12 mjeseci klijanci se presađuju u veće kontejnere ili na gredice u rasadniku. U proizvodnom procesu pukinje sama je presadnja najrizičnija i mora joj se posvetiti posebna pažnja (Piotto i Di Noi 2001).

Prema Regentu (1980) sjeme borovica sije se u jesen ili proljeće, nakon prethodnoga tretiranja. Usjev se pokriva s 0,5–0,7 cm zemlje ili pijeska i zaštićuje slamom i rešetkom sve do početka klijanja. Stratificirano sjeme posijano u proljeće počinje klijati nakon 6–10 dana od sjetve, a završava za 4–5 tjedana. Preporučuje tretiranje klijanaca pukinje protiv napada gljive *Phomopsis juniperovora*. Tretiranje se obavlja bordoškom juhom ili koloidnim sumporom, početkom proljeća, u razmacima 2–3 tjedna. Zaražene biljke treba spaliti. Za sadnju na terenu prikladne su dvogodišnje ili starije presađene i nepresađene sadnice.

Stilinović (1987) piše kako se stratificirano sjeme ne smije osušiti jer ponovo postaje dormantno (sekundarna dormantnost). Preporučuje jesensku sjetvu kao zamjenu za stratifikaciju. Sjeme se prije jesenske sjetve tretira sumpornom kiselinom u trajanju od 30 minuta.

U primjeni tople stratifikcije treba imati na umu i mišljenje pojedinih istraživača koji smatraju da temperatura iznad 18 °C usporava klijanje nestratificiranoga sjemena. Zbog toga je sporno da li sjeme treba stratificirati na temperaturi iznad 10 °C. Klijavost sjemena ovisi o načinu tretiranja i varijabilna je s obzirom na godine, no prosječno se može očekivati oko 50 % klijavosti. Sjeme se sije na dubinu od 1,5 cm u količini koja jamči da do kraja vegetacije na gredicama ostane oko 50 lijepo razvijenih sadnica. Za prekrivanje sjemena preporučuje se pijesak ili treset (oko 5 mm), a iznad toga stavi se sloj polurazloženih iglica.

Klijanci i mlade biljke pukinje otporne su na hladnoću, ali traže nešto vlažnije tlo. Biljke se u početku lagano zasjenjuju. U sjemeništu rasadnika biljke ostaju 3–4 godine, a u rastilištu (za grmolike vrste) ostaju još toliko. Za potrebe šumarstva mogu se koristiti sadnice iz sjemeništa ili se školuju, ali kraće vrijeme nego u slučaju kod parkovnih sadnica. Vidaković i Franjić (2004) smatraju da se pukinja može razmnožavati drvenastim (zimskim) reznicama, povaljenicama i cijepljenjem. Uzgaja se također kao hortikulturna biljka te postoji nekoliko varijeteta i kultivara.

Gluhač, primorska somina – *Phoenician juniper* (*Juniperus phoenicea* L.)

Rasadnička proizvodnja gluhača vrlo je slična rasadničkoj proizvodnji pukinje uz uvažavanje određenih specifičnosti vezanih uz tu vrstu i uvjeta u rasadniku.

Sjeme se gluhača sije na gredice. Nakon svladavanja dormantnosti sjeme najbolje klija pri temperaturama oko +15 °C, dok viša temperatura (+20 °C/+25 °C) nije pogodna.

NURSERY PRODUCTION OF SOME IMPORTANT TREE AND SHRUB SPECIES OF THE CROATIAN MEDITERRANEAN REGION

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INTRODUCTION

Karst afforestation in the Croatian Mediterranean region has a tradition of 150 years. The first attempts to introduce pines on the island of Rab were recorded in the Chronicles of the Franciscan monastery of Kampor on the island of Rab, written by Father O. Odorik Badurina from 1936 to 1956. According to the Chronicles, the forestry counsellor Eugen Demiel sent the seeds of "*Pinus maritima*" to Rab in 1862. The seeds, collected on the island of Korčula, were sown in the forest regions of Dundo and Kalifront (Rauš, Matić 1987). One of the tasks of the established forest offices in the area of Ogulin, Otočac and Gospić in 1869 was to afforest karst. The decision was based on the Forest Law of 1852, which stipulated that all older clearings were to be afforested. The forest office in Ogulin established young forests with afforestation as early as 1865 (Ivančević 1979).

Earlier specialist forestry literature in Croatia was more focused on forest seed production than forest nursery production. The first comprehensive specialist work dealing with forest nursery production was written by D. Hlava, a professor at the Forestry School in Križevci, and published in Forestry Journal in 1889. Among other issues, the author deals with a nursery in the "Croatian County of Macel" and describes different activities, including nursery establishment, cultivation, trenching, sowing, protection, outplanting, nursery layout, fertilisation, etc. (Matić 1976).

The first Croatian nursery for the production of seedlings on karst was set up in Sveti Mihovil in the area of Senj in 1879. Covering an area of a total area of about 1.5 ha, it produced 1.8 to 2.0 million seedlings per year. The majority of the production related to seedlings of black pine, but some broadleaved seedlings were also cultivated (Dokuš et al. 1992). Shortly after that, in 1886, the second nursery called Kesten was established in Senjska Draga, whose production varied from 0.8 to 1 million seedlings. The article "Forestry in Dalmatia", published in Forestry Journal in 1882, lists large nurseries set up in Knin, Sinj and Kotor, as well as a number of smaller nurseries. In the article "Karst afforestation" of 1909, B. Kosović gives a detailed description of the nursery and all stages of nursery activities. In 1910, A. Kauda describes the nursery "Podbadanj" in Crikvenica, which played an important role in karst afforestation. He gives the spatial layout of the nursery and points out that the chemical analyses of the nursery soil revealed large quantities of Ca, K_2O_2, P_2O_5 and N (Matić 1976). This year, the nursery in Crikvenica marks 100 years of continuous work, which is an important anniversary both for the forestry of the Croatian Mediterranean and for the forestry of Croatia in general.

The success of afforestation for the establishment of new forests or for planting for the purpose of the artificial regeneration of existing forests depends on the quality of the seedlings used. Good quality seedlings are also indispensable for the establishment of horticultural amenities, parks, avenues and other spaces to be improved with greenery. Professionally selected and planted seedlings of good quality are essential parts of a complex, sensitive but also resistant and enduring forest ecosystem.

A forest nursery is a specially chosen and cultivated site where forest seedlings are produced for the purpose of establishing new and artificially regenerating existing forests. It is also a site where trees and shrubs are raised for horticultural needs. Forest nurseries are divided into permanent and temporary nurseries.

A permanent nursery is established with the goal of permanently supplying larger areas with seedlings. It contains a number of amenities necessary for good quality and permanent nursery production (cold stores for plants and seeds, machinery, classifying and packing facilities, multi-purpose buildings, water, compost sites, fences, roads, etc.). Nurseries employ qualified, full-time staff.

A temporary forest nursery is established in the proximity of large complexes to be afforested. It produces seedlings while the afforestation programme is underway, but once it is completed, the nursery ceases to operate.

In terms of production methods, there are nurseries in which seedlings are produced generatively (from seed) and those where they are produced vegetatively (from cuttings).

Nurseries with generative production have two separate parts: seedbeds and seedling stool beds. The seedbed is a part where the seeds are sown and one-year and several-year seedlings are raised, which are usually transplanted in the seedling stool bed. The objective of transplanting seedlings in the seedling stool bed is to prepare (train) the seedlings for outplanting.

Seedlings which have been in the seedbed for two and in the seedling stool bed for three years are marked 2+3 and those which have not been trained in the seedling stool bed are labelled 2+0.

Nurseries with vegetative production (generally poplar and willow) have rooted cutting stool beds and rooting stool beds. In the rooted cutting stool bed, the cuttings are rooted, and after one year the rooted cutting is planted in the rooting stool beds while the cuttings for the renewed production of rooted cuttings are produced from the part cut above the ground (cane).

After two years in the rooting stool bed, a one-year-old root produces a seedling whose above-ground part is aged 2 and the root 3 years. Such a seedling is labelled 2/3. Seedlings which are not transplanted in the rooting stool bedsbut remain in the rooted cutting stool bed for 1 or 2 years are labelled 1/1 or 2/2.

In the past few decades, modern nursery production has embarked on the production of container seedlings (root plug), which are cultivated in different containers. Such a production method has been known since the beginning of forestry nursery production, when seeds were sown in a variety of receptacles: parts of sunflower stalks, clay pots or containers made of willow wicker. Current nursery production uses up-to-date technologies of filling the containers with potting media, a variety of media types, advanced seed sowing techniques, different shapes and materials from which containers are made, and the production of seedlings in greenhouses and glasshouses with controlled humidity, light, temperature and seedling nutrition.

The advantages of containerised seedling production compared to classical production are evident: container seedlings can be planted throughout the year, the rooting percentage is very high and the growth of the planted seedlings is faster. There are numerous methods and systems of container production which are being improved on an almost daily basis.

In terms of containers and planting methods, they can be divided into two basic systems (Matić and Prpić, 1983):

1. Containers that are planted into the soil together with the seedlings. The containers can be made of biomaterial that is self-dissolving or of material which the root system penetrates after outplanting.
2. Containers from which the plants are lifted immediately before outplanting. There are two variants: single containers and so-called multi-containers.

The mass production of container seedlings in Croatia began in 1981 with the launching of extensive afforestation campaigns. Hard plastic "Bosnaplast" containers and paper pots were used for such production. A mechanised line for filling the containers with potting media and planting seeds was purchased in 1982. In 1985, another step was made towards modernising seedling production for the needs of afforestation with the greenhouse production of seedlings (Dokuš et al. 1992).

The technology of producing ornamental trees and shrubs is similar to the production of forest seedlings. The production cycle is longer and may take over 10 years. During production, the plant is transplanted several times and its root system and crown are shaped. As a rule, plants are produced in containers. Unlike forest seedling production, ornamental trees and shrubs are mostly propagated vegetatively, which requires suitable technical machinery.

CURRENT STATUS OF NURSERY PRODUCTION IN THE CROATIAN MEDITERRANEAN REGION

In estimating the status and importance of forest nursery production in the Republic of Croatia, which has 2,688,687 ha of forests and forestland, of which 78% or 2,106,917 ha are state-owned and 581,770 ha or 22% are in private ownership (Milković, 2006), it is important to identify areas to be afforested for economic reasons or for general benefit.

Based on realistic indicators, the next step is to allocate the time needed for afforestation and the number of seedlings needed for certain areas and time periods. By comparing the current nursery production, assessed on the basis of realistic indicators, with the calculated number of seedlings to be produced annually for afforesting certain areas in a given time period, we obtain a good indicator of the quantity of the planting material needed and the status of forest nursery production in Croatia.

The Croatian Mediterranean area covers about 1,500,000 ha, of which forests account for about 1 million ha and agricultural land for about 0.5 million ha.

Of the total forested area of about 670,000 ha, about 220,000 ha relate to managed forests of holm oak, pubescent oak, Aleppo pine, Turkish, black, maritime and umbrella pine of a high and coppice silvicultural form. Degraded forests cover about 455,000 ha, of which scrub accounts for 300,000 ha, thickets for 75,000 ha, maquis for 55,000 ha and garrigues for 25,000 ha. The remaining 330,000 ha relate to deforested areas and bare karst areas (Topić 1994, Topić 2003, Milković 2006).

Silvicultural treatments of tending, regeneration and reforestation should be applied over the major part of these forest areas. Each of such silvicultural treatments involves, to a greater or lesser extent and depending on the stand condition and type of treatment, the planting of seedlings in existing forests and reforesting deforested areas (tending with restocking, artificial regeneration and reforestation).

The large size of deforested and degraded areas, different degradation stages of forests, as well as areas of good quality forests that should be regenerated require the application of suitable silvicultural activities. This complies with the valid legal regulations, with the forestry profession's role in forest management, as well as society's demand for the ecological and social functions of forests, and particularly for economic benefits, where timber as a source of bioenergy is gaining in importance.

In order to calculate the annual need for plant material in the Mediterranean area, the following indicators should be taken into consideration: areas covered with different silvicultural forms, degradation stages, deforested areas and the number of plants of different tree species per ha needed for planting and reforestation in diverse stand and site conditions (Matić 1994).

In terms of age, stands of Aleppo pine and black pine of a high silvicultural form, which cover about 35,000 ha, are above the prescribed rotation of 60 and 80 years respectively on 40% of the area. This is about 14,000 ha that must be naturally regenerated in the next 10 years, which amounts to 1,400 ha annually. With regard to site conditions and tree species, ar-

tificial regeneration to be applied according to natural principles will be planned over 80% of the area, or about 1,150 ha. By planting 2,000 plants per ha, an annual amount of 2,300,000 pine plants will be needed for the above area.

Stands of holm oak and pubescent oak of a high and coppice silvicultural form cover about 200,000 ha. In the next 10 years, at least 10% of the area will have to be regenerated, which is an area of 20,000 ha or 2,000 ha annually. Combined natural and artificial regeneration and tending with restocking require 10,000 plants of holm oak and pubescent oak per ha, or 20,000,000 plants annually.

Stands in different degradation stages (scrub, maquis, thickets and garrigues) cover a total area of 455,000 ha. In the next 20 years, 30% of this area should be silviculturally treated in order to convert it to more qualitative stages and silvicultural forms, which is about 140,000 ha or 7,000 ha annually. With regard to the existing autochthonous natural vegetation in the area, it is necessary to introduce about 2,000 plants per ha of pioneer conifer and broadleaved tree species, which is a total of 14,000,000 plants annually.

Deforested areas or bare karst cover about 330,000 ha. In the next 20 years, 60% of this area, or about 200,000 ha or 10,000 ha annually, should be afforested with pioneer broadleaved and conifer species. About 5,000 ha should be afforested with broadleaved species, requiring 10,000 seedlings per ha or 50,000,000 plants in all. To afforest the remaining 5,000 ha annually with conifers, 2,000 plants per ha or 10,000,000 plants in all are needed. Overall, 60,000,000 conifer and deciduous plants are needed to afforest the above deforested areas over the next 20 years.

Accordingly, in order to execute the planned silvicultural activities in broadleaved and conifer stands of high and coppice silvicultural forms, in degraded forests in different degradation stages and in deforested bare karst areas, the following number of seedlings should be nursery produced annually:

1. Regeneration and tending of mature stands of Aleppo and black pine	2,300,000 pcs/year
2. Regeneration and tending of stands of holm oak and pubescent oak	20,000,000 pcs/year
3. Tending of degraded stands in all stages	14,000,000 pcs/year
4. Reforesting deforested areas	60,000,000 pcs/year
Total	96,300,000 pcs/year

In the Croatian Mediterranean region there are 9 nurseries owned by the company Hrvatske Šume, Zagreb, which cover a total of 35 ha. They are distributed regionally: two are in Istria, one in the Croatian Littoral, and six in Dalmatia.

Of these nurseries, special mention should be made of the "Frančeskija" nursery in the Buzet forest administration, Istria, covering 18 ha, and the "Piket" nursery near Zemunik Donji, a total area of 11.7 ha. These two nurseries with a modern layout and suitable equipment, mechanisation and other necessary facilities can satisfy all the technological processes of nursery plant production. Another nursery deserving mention is "Podbadanj" in the forest office of Crikvenica, Senj forest administration. This year, it marks 100 years of continuous work, which puts it in first place among all the nurseries in Croatia. This is the only nursery to maintain the continuity of first nursery production, which began in the nursery of Sveti Mihovil established by the Inspectorate for Karst Afforstation in Senj in the distant year of 1879.

The remaining 6 nurseries are smaller in size and apply classical technological processes of seedling production. These nurseries are on the brink of collapse due to the low demand for seedlings. Several of these nurseries have excellent site conditions, especially in terms of soil and water, and could, given adequate equipment and staff, provide seedlings for afforestation and other needs.

We will describe the "Piket" nursery because it is a noteworthy facility with up-to-date equipment and other conditions that can respond to the needs of modern nursery production.

The nursery covers a gross area of 11.79 ha or a net area of 10.90 ha. Technical facilities include a heated greenhouse of 1,686 m², another greenhouse of 1,693 m², both made in Finland, then a container block covering 4 x 2,500 m² with a mist unit, nutrition and phyto-protection. A water tank of 2,963 m² can store about 3,000 m³ water.

The administrative building covers an area of 264 m² and the technological facility of over 1,300 m² contains a cold storage facility for seeds and plants, storage for containers and potting media, a machinery hall, and a machine for washing and filling containers and machine sowing.

Containers of different sizes ranging from 93 m³, 120 m³, 150 m³, to 256 m³ are equipped with "legs" to allow "aerial trimming" of roots. The containers are capable of producing about 2 to 3 million seedlings in one turn, but are currently not used.

The machinery consists of a 75kW tractor (loading of potting media and forklift truck), a line for mixing the potting media, washing the containers, filling the containers and a line for pneumatic sowing with a movable track. All these lines were made in Sweden and imported from there. The machinery also includes a mobile pre-germination system and a shading system (with nets).

There are four employees. The roads are asphalted and the fence is made of concrete pillars and mesh wire.

This modern nursery produces containerised forest seedlings, in the first place one-year conifers, and other seedlings (block containers). However, due to the falling need for plant material and afforestation in the Croatian part of the Mediterranean, the nursery is obliged to produce ornamental seedlings and vegetable seedlings.

There are relatively large areas in the Croatian Mediterranean where stable and productive forests could be raised. As has already been stated, in all silvicultural treatments of the tending and regeneration of Mediterranean forest areas, plant-

ing seedlings and afforestation will always have their place, whether these are deforested areas, areas with some degradation stage or areas with forests of high and coppice silvicultural forms that are being regenerated.

Data on nursery seedling production in the Mediterranean area in the past 17 years relate to the establishment of new forests with afforestation or regeneration and tending of existing forests.

From 1991 to 1995 (5-year period), 845,000 seedlings on average were nursery produced, from 1996 to 2002 (7-year period) the number of plants amounted to 1,817,000, while in the last 5 years, from 2003 to 2007, only 541,000 plants per annum were produced. This shows that the production of seedlings and their use is constantly declining. We should not forget that more seedlings were produced during the war than in the same time periods in the last 5 years.

It conclusion, there is growing demand for seedlings, planting and afforestation due to the non-wood and economic roles of forests in the Mediterranean, while on the other hand, the production of seedlings and their use are on the decline.

In Croatia, there is a sufficient number of nurseries and professional staff engaged in the production of seedlings for the purpose of forest regeneration and for the afforestation of deforested forest areas in Croatia.

Below, we will give data for the nursery production of 29 species of trees, semi-trees and shrubs that are of interest for regeneration and reforestation in the Croatian Mediterranean and for its horticultural needs.

Holm oak (*Quercus ilex* L.)

In frost-free areas, sowing is done in autumn immediately after collection. Otherwise, sowing takes place in spring using acorns stratified during the winter, usually in the open (stratification pits) or in temperature-regulated environments (+1 °C to +5 °C).

The aim of cold stratification is not to overcome seed dormancy (considered negligible or non-existent in Mediterranean species of the genus *Quercus* sp.), but to delay germination until the following spring. In other words, unless we want the acorns to germinate in the unfavourable part of the year, cold stratification should be applied.

In colder regions, autumn sown seeds should be protected from rodents and mulched with suitable mulching mediums. The stratification medium is mixed with acorns and must be checked periodically, particularly at the end of winter, to interrupt the pre-treatment before the tap root has grown too long.

To sow pre-germinated acorns, the optimal length of the radicle (tap root) is 0.5–5 cm, but seeds with radicles can also be sown; when they are placed in the seedbeds or in containers, these roots may be cut down to 3 cm without this having any negative effect on survival (Piotto and Di Noi, 2001). According to Regent (1980), it is also possible to sow pre-germinated acorns, whose shoots have been removed, but in this case the plants are weaker since the mycorrhiza on the root is less well developed. The above author states that twin or even multiple plants may frequently occur in holm oak.

In order for the root system and the above-ground seedling part to develop normally, acorns should be spread in a natural horizontal position. The same should be done with acorns during cold stratification and sowing. The seeds are covered with a 1–2 cm soil layer. Holm oak, similar to other oaks, develops a deep root system. The root system of a 1-year-old, untrimmed seedling of holm oak may grow to a length of 60–80 cm.

Seedlings of holm oak may be produced with bare or balled root systems. Container seedlings should be raised in suitable containers in which the root system will not be deformed. Production in Bosnaplast 12 and 18 containers is not recommended for longer than one vegetation season, and in PVC tubes (923 cm^3) for one and a half to two vegetation seasons. Seeds raised in suitable containers are of good quality and manifest satisfactory growth potential after planting. One-year bare root plants can be outplanted.

Ornamental forms are propagated with grafting.

Manna ash (*Fraxinus ornus* L.)

Unstratified seeds of manna ash are autumn sown or are previously warm-moist stratified and then sown in spring. The seeds are warm stratified for 2–8 weeks (usually 3) and then cold stratified for 8–15 weeks. After dormancy has been overcome, germination is favoured by marked alternating temperatures of +25 °C/+5 °C (warm day – cold night). Under natural conditions, this corresponds to late winter and early spring. Constant temperatures of +20 °C may induce secondary dormancy in non-dormant seeds. Accordingly, late sowing, when the soil temperature is high, should be avoided (Piotto and Di Noi, 2001). According to Dirr and Heuser, Jr. (1987), unstratified seeds of manna ash are sown in autumn or are stratified for 2–3 months and then sown in spring.

Regent (1980) claims that seeds of the species *F. excelsior* and *F. ornus* are stratified with a warm-moist procedure and sown in spring. Such seeds are considered to germinate regularly. On the other hand, if the seeds of these two species are sown untreated in spring or summer, the sown areas should be protected until germination takes place the following spring. According to Stilinović (1987), freshly collected seeds are sown in autumn or are stratified for 4–5 months and sown in spring. The favourable effect of warm-moist stratification on seed germination should be pointed out.

The seeds are sown with wings. The sowing depth is 1.2 to 2.0 cm. About 5–7 seeds are sown per metre in a row. According to Bonner (1974) and Williams and Hanks (1976), the seeds of the majority of species of the genus *Fraxinus* sp. are sown in lines spaced 15 to 30 cm apart. In this case, sowing density is 80 to 100 seeds per metre.

The second seed-sowing method is broadcasting, with the optimal number of seedlings ranging from 105 to 160 pieces/m^2. The seeds are covered with a 1–3 cm soil layer. The cover may be nursery soil, sand or a soil-sand mixture.

The seedlings are very sensitive to late spring frosts. Bonner (1974) points out that the seedbeds should be shaded for some time after germination. According to the same author, the outplanting of European ash species, which include manna ash, requires trained plants aged 1+1 or two-year seedlings 2+0.

Propagation with cuttings has proven to be practically impossible, except in cases where cuttings are taken from young trees. In the future, one of the propagation methods could involve the use of tissue culture.

Pubescent oak (*Quercus pubescens* Willd.)

Seedlings of pubescent oak are produced in a similar way to those of pedunculate oak, sessile oak and other autochthonous oaks. It should be pointed out, however, that the production of seedlings of some species of the *Quercus* genus involves certain specific features in terms of the site conditions in a nursery, the biological properties and ecological requirements of the species, the technical-technological equipment in the nursery, and similar features. Ornamental forms are propagated with grafting.

According to Bean (1981), to grow successfully, seedlings of pubescent oak require deep, fertile and loamy soils. This author holds that acorns of pubescent oak may be stored over winter in cold and moist conditions, although it is best to sow them in open seedbeds immediately upon ripening. Autumn sown seeds must be protected from mice and other pests. Smaller quantities of seeds may be sown in deep containers placed in outside beds.

Seedlings of pubescent oak develop a deep taproot and should consequently be transplanted in a permanent place as soon as possible. Seedlings produced from direct seed sowing in the open give the best results. Seedlings aged 2+0 should be lifted from the seedbed and outplanted. Seedlings that are left in the seedbed for longer will manifest poor rooting.

Huxley (1992) points out that seedlings of pubescent oak tolerate moderate quantities of lateral shade. He also mentions that the seedlings are resistant to moderate exposure to direct sunlight. Such seedlings have a high survival rate, but they are shorter and thicker than seedlings raised in the shade. Chittendon (1956) emphasises that the production of pubescent oak seedlings is very similar to the production of sessile oak seedlings. The root system of pubescent oak shows poor tolerance to transplanting, so the seedlings are outplanted in a permanent place while young.

Kermes oak (*Quercus coccifera* L.)

The nursery production of kermes oak is similar to the nursery production of other oaks provided that the specificities mentioned for the nursery production of pubescent oak are followed.

Oriental hornbeam (*Carpinus orientalis* Mill.)

Beds ideal for the sowing of hornbeam seeds should be permanently moist, and clayey and nutrient-rich soil should be protected from extreme atmospheric oscillations (Rudolf and Phipps, 1974; Suszka et al, 1966).

With reference to the nursery production of oriental hornbeam, Regent (1980) writes that unstratified seed is autumn sown, while pre-stratified seed is spring sown and is covered with approximately 0.6 cm of nursery soil. It is advisable to keep the seedlings in the shade. According to Rudolf and Phipps (1974), the seeds are sown in well-prepared beds, with sowing density varying from 323 to 4342 seeds/m^2. The depth of the cover layer is from 0.6 to 1.3 cm. If the seeds are broadcast, the beds should be mulched with rough fabric, straw or some other material. Mulch should remain on the beds until the risk of frost in late spring has passed. The surface soil layer in the nursery should be permanently moist until germination is completed. During the first year of production, and after germination, the seedbed should be protected with light shade.

MacDonald (1986) recommends a sowing density of 250 seeds/m^2 if sowing is done in rows, or a density of 150 to 250 seeds/m^2 for the production of rootstock. Stilinović (1987) states that about 10 g of seeds are sown per metre of the row and are covered with a 3–4 cm soil layer. According to the same author, seedlings and young plants of hornbeam are sensitive to frost, drought and sunscald, so suitable tending measures must be undertaken during their growth in the nursery seedbed.

Several authors write that oriental hornbeam can be propagated both generatively and vegetatively (grafting and cuttings), while others point out that no data exist on the propagation of oriental hornbeam with cuttings. According to Hartmann et al. (1990), hornbeam cultivars may be grafted with a separate twig (laterally) or with budding on the rootstock of a typical seed-raised species.

Some measures, such as etiolation or bending the seedlings, encourage the rooting of the cuttings (Bassuk et al. 1985; Maynard and Bassuk 1987, 1991, 1992, 1996). Stilinović (1987) also writes that varieties and forms of hornbeams are propagated with grafting, while Vrgoč (1994) points out that oriental hornbeam is also successfully used in bonsai techniques.

Hop hornbeam (*Ostrya carpinifolia* Scop.)

According to Regent (1980), the seed of hop hornbeam is autumn or spring sown, but summer sowing (in August) can also be performed with immature seeds. The seeds are covered with a soil layer of 0.5–0.6 cm. Stilinović (1987), like Regent, also writes that relatively good success can be achieved by sowing physiologically mature seeds. He also points out that such seeds must be sown immediately and should not be stored. According to this author, autumn sowing of mature seeds shows relatively poor germination the following spring.

Seeds sown in spring should be stratified and checked periodically in order to decide whether the seed will be sown or kept stratified until the following spring. According to Piotto

and Di Noi (2001), seeds previously subjected to a warm-cold procedure are sown in late winter or early spring. Before sowing, the seeds are warm stratified for 4–8 weeks (depending on the provenance) and cold stratified for 16–23 weeks.

Before commencing pre-treatment (warm-cold stratification), it is advisable to immerse the seeds in water in order to separate the empty seeds, which will usually float. This method is called flotation. Hop hornbeam seeds will usually germinate at low temperatures; therefore, they should be checked more frequently at the end of the cold stratification period. The higher the temperature oscillations are (low temperatures by night and high temperatures by day), the better germinability is of the stratified (non-dormant) seed. For these reasons, sowing of hop hornbeam seeds should be avoided in periods where there are no great differences between night and day air temperatures (late spring or early summer, when the soil temperature is relatively high). Sheat (1948) believes seeds are best sown immediately after maturing. The seeds are sown in beds in the open, where they usually germinate the following spring. Seed germinability is variable, but is usually high. Green seeds are collected at the moment when the embryo is completely developed, but before the seed coat turns hard. The collected seeds are sown in open beds. The seeds will germinate the following spring and the germination rate is very good.

Huxley (1992) points out that the stored seeds of hop hornbeam should be stratified. The seeds are stratified with a warm-cold procedure. They require 3 months of warm and 5 months of cold stratification. The germination rate of the stratified seeds is very high, but germinability may even last for 18 months.

When the seedlings are big enough to be pricked out, they are transplanted by hand in individual containers or pots which are then arranged in outer beds and left over the first winter. They are transplanted in a permanent place at the end of spring or the beginning of summer, after the danger of late spring frosts has passed.

Stilinović (1987) mentions the possibility of vegetative propagation of hop hornbeam. Different grafting methods can be used: side and saddle joints, ablactation (inarching). The stock may be a typical species developed from the seed (*Ostrya carpinifolia*) or it may be common hornbeam (*Carpinus betulus*). Grafting is performed in the area of the root neck or in the crown. During winter, grafting is done in greenhouse conditions. Green scions of hop hornbeam are taken in June and July and treated with phytohormones (IBA, concentration 1–2 %). The prepared and treated scions are covered with a plastic sheet to root, and facilities for artificial fog should be provided.

European nettle tree (*Celtis australis* L.)

Unstratified seeds of the nettle tree are sown in autumn, or cold stratified for 8–12 weeks and sown in spring. Stratified seeds should be checked frequently and the stratification process should be stopped as soon as the seeds begin to germinate (Piotto and Di Noi 2001). Regent (1980) recommends stratifying the seeds (fruits) for 60–90 days at a temperature of +5 °C. Such seeds may be stored for up to one year without any loss of vitality. If the seeds are not pre-germinated, stratification should be prolonged. Unstratified seeds are sown in autumn, but pre-stratified seeds are sown in spring.

The sowing depth is 1 cm and spacing between the rows is 20–30 cm. Before sowing, it is advisable to soak the seeds in water. The sown area should be protected until germination is completed and should be kept permanently moist. Germination is relatively uneven and slow, so it is advisable to continue with stratification until the following autumn or spring.

About 15 g of seeds are sown per metre. It is advisable to mulch the sowing area and to keep it sufficiently moist. Huxley (1992) writes that the seeds of the nettle tree are best sown in open beds immediately upon ripening. If stored, they should be stratified for 2–3 months and sown in a greenhouse during February and March. According to Dirr and Heuser (1987), the germination rate of such seeds is very high, although it takes 12 or more months for the stored seeds to germinate. The seeds may be successfully stored for more than five years.

The germinants are pricked out into single containers or pots. The leaves on the cotyledons are often covered with white smudges (no chlorophyll). This is a normal occurrence that later disappears and the older plants develop normal green leaves.

During the first winter, the seedlings are kept in open beds and transplanted in late spring or early summer of the following year. They should also be protected from the cold.

A number of authors mention the possibility of the vegetative propagation of this species (layering, grafting and green scions). Seedlings of the species *C. occidentalis* and *C. australis* may be used as the grafting stock. The grafting period is limited to winter time (February). Grafting can only be done in greenhouse conditions. The stock is raised in pots and must have a well-developed root system.

Oriental hackberry (*Celtis tournefortii* Lam.)

The nursery production of oriental hackberry is identical to the nursery production of the nettle tree. The specific features of the site conditions in a nursery, the biological properties and ecological requirements of the species, the technical-technological status of the nursery, etc., should be taken into account.

Montpelier maple (*Acer monsspesulanum* L.)

According to data provided by Regent (1980), untreated, immature maple seeds are sown in late summer, while mature seeds are sown in autumn. Alternatively, the seeds are stratified and sown in spring. The sowing depth ranges from 0.6 cm to 2.5 cm (depending on seed size). The author points out that spring germination lasts for only a few weeks.

During the first year, the young nursery plants should be kept in the shade. One-year plants (1+0) are capable of being

outplanted. Stilinović (1987) says that seeds of Montpelier maple should be sown immediately after collection, or they should be stratified and sown in the spring. He recommends a sowing density of 10 g.per metre at a sowing depth of about 4 cm. The author stresses that seedlings of Montpelier maple are highly vulnerable to late spring frosts.

Maple seed is sown with or without wings. Dewinging is not a common practice as it may adversely affect the quality of the seed.

Maple seedlings may be produced with balled (container plants) and bare roots. For the majority of the species from the genus *Acer*, the seedlings are commonly produced with bare roots.

Pre-sowing seed preparation and the sowing period depend on the species, nursery conditions and experience. According to Carl (1982b), Olson and Gabriel (1974), Vertrees (1987) and Yawney (1968), 158 to 1,520 seedlings can be raised per 1 m^2. The best density for the production of vital seedlings seems to range between 158 and 320 seedlings per m^2. According to the same authors, the seeds are sown at depths from 0.6 to 2.5 cm, regardless of whether the seeds are broadcast or sown in rows.

In order to prevent damping off, the beds should be treated with repellents against birds and mice, as well as with fungicides. It is advisable to keep the beds in the shade until the seedlings become sufficiently strong.

Seedlings aged 1+0 can be used for outplanting, but older seedlings (2+0) or transplants (2+2) are also frequently used. As a general rule, the older the maple seedlings are, the better their survival in the field.

The container production of maple seedlings is not as common as the production of bare root seedlings, but some nurseries do practise the former. Container seedlings raised in a greenhouse are usually of larger dimensions than those raised in the field or in beds. Container seedling production is best in cases where stratified and pre-germinated seeds are used (species that germinate during stratification). Containers of different sizes and types are used for the production of maple seedlings. For example, some nurseries use containers with diameters of 4 cm and heights of 15 cm. In one vegetation season, such containers may produce seedlings of 30–40 cm in height. To raise larger plants for use in horticulture, these seedlings can be transplanted into the production block in the nursery or in larger containers.

The desired maple genotypes can also be propagated vegetatively by rooting the cuttings taken from the plants and by using different types of layering (Dir and Heuser, 1987).

Italian maple (*Acer obtusatum* Waldst. et Kit ex Willd.)

The nursery production of seedlings of Italian maple is identical to the nursery production of Montpellier maple, taking into account certain specific features related to site conditions in the nursery, the biological properties and ecological requirements of the species, the technical-technological status of the nursery, and similar features.

Strawberry tree (*Arbutus unedo* L.)

Some authors recommend autumn sowing of unstratified seeds in sowing pots or in beds. The second method entails spring sowing of stratified seeds. Should the seeds in beds or in containers sprout too densely, the surplus seedlings are removed. Then, the germinants are carefully transplanted and kept in the shade during the summer months.

In some cases, the seeds are sown directly into containers to avoid shock caused by transplanting. Since the seeds of the strawberry tree are minuscule, it is advisable to cover them with a very thin layer of a light, permeable medium which will allow sufficient quantities of light through. The presence of light in this species has a positive effect on seed germination.

According to research by Bean (1981) and Huxley (1992), the strawberry tree requires nutrient-rich, well-permeable soils that retain moisture, as well as sunny or semi-shaded positions sheltered from cold winds, especially when the plants are still small. The species grows well on heavy and dry soils. Many species of this genus do not tolerate calcareous soils, but this species is very tolerant to lime in the soil.

According to Sheat (1948), the best time for sowing the seeds (surface sowing) is immediately after they have matured. The stored seeds should be soaked in warm water for 5–6 days, after which the seeds are sown in a shaded place in the greenhouse. The compost should not be allowed to dry out.

Research by Rice (1988) shows that in order to overcome dormancy the seeds should be cold stratified for 6 months. At a temperature of +20 °C, the seeds usually germinate within 2–3 weeks.

Germinants of the strawberry tree are very sensitive to damping off. The best time for transplanting in individual pots or containers is when they are big enough to be handled. The seedlings are kept in well-aerated conditions. During the first vegetation period they are kept in a greenhouse, and are transplanted in the open at the end of spring, when the danger of late spring frost has passed.

According to Regent (1980), strawberry tree seeds are sown in spring or autumn. Apart from being propagated generatively (seeds), the species can also be propagated vegetatively (cuttings, rooted cuttings and grafting). Šilić (2005) writes that the strawberry tree is propagated with rooted cuttings, cuttings from last year's shoots and by seed sowing. The author stresses that the strawberry tree has a strong shooting vigour from the stump.

In the case of varieties, the only method of propagating a strawberry tree is with cuttings. Mature cuttings of 15–20 cm in length are usually used. They are taken in November or December from the shoots of the current year. The cuttings are pricked out on rooting benches with floor heating. They root slowly, and the rooting percentage is frequently low. Interestingly, the rooting percentage may be increased if water in which willow twigs have been soaked for 24 hours is used to water the cuttings. Willow bark contains hormones that encourage rooting and contribute to the process of rhizogenesis.

If the branches of the strawberry tree or shrub are sufficiently low, propagation may also be performed by means of layering. A small cut is made on the branch with a sharp knife and the branch is bent towards the ground. A new plant is obtained in two years by cutting the rooted part from the parent plant with secateurs. A small branch often sprouts roots and may be separated from the parent plant as soon as it starts growing.

The fruit of this species is edible. It contains up to 10 % sugar, and is used for making jams, brandy and liqueur (Šilić, 2005).

Carob tree (*Ceratonia siliqua* L.)

To ensure effective pre-treatment, spring sowing is preferred, using mechanically scarified seeds. Moreover, for nursery growing, it is advisable to use containers that prevent root coiling. The seedlings do not bear damage to the roots.

Vegetative propagation with cuttings and tissue culture is also possible. The following factors should be taken into account for successful rooting: the period of collection, the type of cutting (topophysis is important) and the character of the mother plant (the rooting capacity varies according to the genotype) (Piotto and Di Noi, 2001). According to Young and Young (1992), the scarified seeds of the carob tree are sown in the soil or vermiculite, and the sown area is kept in partial shade. The seeds are sown in spring or autumn. Since the seedlings develop a very long taproot which may easily be damaged, it is advisable to raise carob tree seedlings in appropriate containers. One of the possibilities described by Coit (1951) is based on soaking carob tree pods in water for 2–3 days, after which the pods are sown together with the seeds. The germination percentage of such seeds is low.

According to Jedlovski (1987), the carob tree is propagated generatively with seeds and vegetatively (a cultivated carob tree is grafted on a wild one). Prior to sowing, the seeds are soaked in water for 4–5 days. The plant remains in the seedbed for two years (2+0) and is then outplanted (with the plug). Carob tree seedlings intended for fruit production are planted 5 – 6 years after the desired variety is grafted on a dormant bud (in August).

Cornelian cherry (*Cornus mas* L.)

Sowing takes place immediately after collection (in early or mid autumn), or in late autumn using seeds warm-stratified for 12–16 weeks. In the former case, germination does not take place during the following spring but in the second spring after sowing. In the case of spring sowing, seeds warm-stratified for 16 weeks and then cold-stratified for 4–6 weeks have to be used. It may be useful to scarify the seeds before the warm-cold stratification (Piotto and Di Noi, 2001). According to Regent (1980), seeds or fruits of cornelian cherry are sown in autumn or are pre-stratified and sown in spring (April or early May). Seeds are covered with a 1 cm soil layer.

Cornelian cherry can also be propagated vegetatively by means of cuttings and by grafting. Green or semi-hardened cuttings (taken in July) are used.

According to Stilinović (1987), the seeds are sown immediately after collection. About 15 g per metre are sown at a depth of 3–4 cm. The seeds usually remain dormant throughout the following year. The seeds should be stratified for at least one year and sown the following autumn. Some authors recommend stratification lasting as long as 18–24 months. The seedlings remain in the seedbed for two years (2+0), after which they are trained for another 2–3 years. According to the data from WSL Vesruchsgarten (1991), the germinants remain in the seedbed for one vegetation (1+0) and are then transplanted in the seedling stool bed where they remain for one (1+1) or two (1+2) years. Plants grown in the seedling stool bed are used for outplanting. The best distance between the plants in the seedbed is 18 x 20 cm.

Judas tree (*Cercis siliquastrum* L.)

Mechanically scarified seeds of the Judas tree are sown in spring. This is the best sowing method. Vegetative propagation by means of grafting is also possible, while propagation by means of cuttings is very difficult (Piotto and Di Noi, 2001). The seeds are covered with a 0.6 cm soil layer and should be constantly watered until germination is completed. According to Frett and Dirr (1979), Heit (1967a), Lippitt (1996), Raulston (1990), Robertson (1976) and Smith (1986), surface dried seeds are sown in rows or randomly broadcast and are covered with a 0.6 to 2.5 cm layer of soil, sand, sawdust or ground tree bark.

According to Lippitt (1996), seeds can also be sown in containers during autumn and are thus subjected to natural stratification. Over winter, the containers with the sown seeds are kept in a sheltered place in the open. Roy (1974) writes that Judas tree seedlings obtained by sowing the seeds in a greenhouse are very variable.

According to Stilinović (1987), spring propagation is also possible with green cuttings taken from forced parent trees or summer propagation with cuttings taken from field-growing individuals. Grafting is done on a rootstock of a typical species using the inarching or the root triangulation method. Grafting is performed in a greenhouse in winter (January).

Bay laurel (*Laurus nobilis* L.)

Unstratified seeds are autumn or winter sown, while pretreated seeds are spring sown. After dormancy has been overcome, alternating temperatures of +20 °C (16 hours with light) and +16 °C (8 hours in the dark) seem to stimulate germination (Piotto and Di Noi, 2001). Seeds can be sown immediately after cleaning or are stratified and spring sown in sheltered beds. Seeds of bay laurel may also be sown immediately upon ripening or may be spring sown.

The best sowing medium is moist compost, but it should not be overly saturated with water. The seeds are surface sown and lightly covered with dry compost. The containers are left in a dark place at an ideal temperature of about 21 °C. In these conditions it takes about 3 months for the seeds to germinate, while in other (normal) conditions, germination takes about 3–4 months. The greatest danger for the seeds before they germinate is rotting in the medium.

According to Greenwood (1987) and Hartmann et al. (2002), in Mediterranean shrub species that are difficult to root the rooting percentage of cuttings can be increased with rejuvenation, or the transition of a plant from the mature into the juvenile stage. In research by Pignatti and Crobeddu (2005), bay laurel cuttings taken from a mature parent plant in April did not root, while a rooting percentage of 75 % (from 0 % to 87.9 %) was obtained with the cuttings taken in August. On the other hand, the cuttings taken from rejuvenated individuals exhibited an equally good percentage (58.3 %, or between 40.8 % and 74.5 %), regardless of the period in which the cuttings were taken. In the same research, in all the species except for bay laurel, the rooting probability of cuttings taken in August was higher in rejuvenated than in mature cuttings.

It was concluded that the cuttings of the majority of Mediterranean shrub species (with the exception of bay laurel and laurustinus) taken in August show the best rooting percentage. Cuttings of laurustinus and bay laurel taken from rejuvenated plants manifest a rooting percentage of over 50 %.

The sown seeds germinate after 3–4 months, and sometimes in the second year after sowing. Apart from being generatively propagated, this species can also be propagated by vegetative means.

The possibility for the vegetative propagation of this species is treated by Piotto and Di Noi (2001), and also by Stilinović (1987) who gives a detailed description of the method. According to this author, bay laurel is propagated with mature or winter cuttings (taken from October to March). Lateral branches are used, from which pieces of 10 cm are cut off. The cuttings are pricked out in pure river sand and are moderately heated. It takes about 8 weeks for the cuttings to root. The rooted cuttings are transplanted into pots or containers, and after being firmly rooted they are taken into an unheated greenhouse, where they remain until spring. In spring, the pots or containers are put into beds (peat and similar types) and covered with a thin layer of manure. The plants should be additionally fed and protected from the cold and frost. The terminal bud must not be damaged because a new one develops with great difficulty.

In the second year, the seedlings are transplanted into pots of 10 cm in diameter and the lateral buds or twigs are removed. In the third year, the seedlings are transplanted again, and in the fourth, when they grow to 100–120 cm, the crowns are formed. Transplantation is only done when necessary, always in bigger pots or with a bigger root plug. It should be emphasised that bay laurel seedlings can overwinter in unheated rooms provided the temperature does not drop below 0 °C. The root plug must not dry out.

The most suitable potting medium is, according to Stilinović (1987), a mixture of compost, litter bedding, peat and sand mixed in equal amounts.

A number of authors believe that cuttings of bay laurel should be taken in late summer and early autumn. The species roots with difficulty. Mature, 9 to 15 cm shoots are cut with a sharp knife. The main part of the plant must be left on the cutting. The assimilation cutting area is reduced so that only 3–4 leaves are left on it. The prepared cuttings are pricked out in small volume pots or in containers filled with rooting media. The seedlings are placed sheltered from direct sunlight (open beds are ideal). The key factor for successful propagation with cuttings in the described way is high air moisture. Bay laurel cuttings should root in about one year.

Narrow-leaved phillyrea (*Phillyrea angustifolia* L.)

Before sowing, the seeds must be scarified mechanically or chemically (by immersion in concentrated sulphuric acid for 30 minutes, followed by thorough washing). The seeds are sown immediately after collection or in the following spring. Vegetative propagation is also possible (Piotto and Di Noi, 2001).

Broad-leaved phillyrea (*Phyllirea latifolia* L.)

The nursery production of broad-leaved phillyrea is identical to the nursery production of narrow-leaved phillyrea, taking into account certain specific features related to site conditions in the greenhouse, the biological properties and ecological requirements of the species, the technical-technological status of the nursery and similar features. Šilić (2005) writes about the possibilities of the generative and vegetative propagation of this species.

Common myrtle (*Myrtus communis* L.)

Sowing generally takes place in late autumn, immediately after collection, without any pre-treatment of the seeds. Alternatively, it may be performed in spring using cold-stratified seeds. Considering their tiny size, the seeds ought to be covered with a very thin layer of porous and light substrate, which will allow the light to stimulate germination. The seeds are very often sown in seedbeds and then transplanted in containers or in open seedbeds.

Early developed seedlings are relatively shorter, and subsequent transplanting leads to considerable stress; therefore, 60% shade is often applied in the nursery in spring and summer (Piotto and Di Noi, 2001). According to Regent (1980), seeds should be sown in rows spaced 20–30 cm apart, in spring, late summer or autumn, but taking care that there are at least 60 warm days before winter. He recommends covering the crops with a soil layer of about 1.2 cm and protecting it with straw or similar mulch, which should be removed as soon as the seeds start to germinate. He points out that the seeds stratified for one year can be sown in autumn. In all these cases, the seeds will not germinate until the following spring.

Šilić (2005) recommends sowing the seed in a nursery in early spring. The soil should be finely grained and friable. All these authors also mention the possibility of the vegetative propagation of common myrtle with summer cuttings and layers.

Persian lilac (*Melia azedarach* L.)

According to Regent (1980), the fruits (or seeds) of Persian lilac are sown in autumn, immediately after collection, or in spring. The rows are spaced 5–10 cm apart, and the sowing depth is about 2.5 cm. In spring, the seeds germinate about 3 weeks after sowing.

One-year-old seedlings (1+0) are used for outplanting. Older seedlings require crown and root reduction. This species can also be propagated with cuttings taken from the stem or the root.

Whitebeam (*Sorbus aria* /L./ Crantz.)

According to Piotto and Di Noi (2001), sowing is done immediately after collection, without any pre-treatment to the seeds, or in late winter – early spring, using seeds warm stratified for 2–4 weeks and cold stratified for 12–16 weeks. In many cases, only open air stratification (stratification pits) is performed after collection until sowing, or only cold stratification in a temperature-controlled environment for 8–16 weeks before sowing. Sowing of stratified seeds is done in periods of the year (late winter – early spring) with marked temperature fluctuations (cold nights/warm days). Late spring sowing may cause secondary dormancy in the seed if the ground temperature is too high. Regent (1980) writes that the seeds can be sown in autumn or later, in snowy conditions, or they can be stratified and sown in spring. The sowing depth is about 0.5 cm. In this author's view, the best material for outplanting is trained plants aged 1+1, but two-year-old, unpricked plants can also be used. Macdonald (1986) recommends a sowing density of 200–250 seeds/m^2. Similar to Regent, Young and Young (1992) also point out that the seeds of the species from the genus *Sorbus* can be sown in autumn. The seeds are lightly covered and the beds are mulched. The seedlings of all species from the genus *Sorbus* are very resistant and are easy to cultivate.

According to the WSL Versuchsgarten catalogue (1991), seedlings of whitebeam are produced in the seedbed part of the nursery for one (1+0) or two (2+9) growing seasons. Spacing between the plants is 12–15 x 20 cm. The seedlings are trained and sold as 2+2 or 2+3 seedlings.

According to Stilinović (1987), whitebeam is the slowest-growing species of the genus *Sorbus*, although others do not grow taller than 10–20 cm at the end of the first year. He recommends growing whitebeam seedlings in the seedbed for two vegetations, while garden varieties require training.

Wild service tree (*Sorbus torminalis* /L./ Crantz.)

The nursery production of the wild service tree is identical to that of whitebeam, taking into consideration certain specific features related to site conditions in the nursery, the biological properties and ecological requirements of the species, the technical-technological status of the nursery, etc. Kausch-Blecken von Schmeling (1994) writes that the seeds, shortly after cleaning, can be sown directly into the germination bed. The seeds are covered with a thin layer of sand and are protected from birds. In this way, the seeds are subjected to natural cold stratification over winter. Artificial seed stratification (in the laboratory) is successful only when the seeds are permanently kept in moist and cold conditions for two to three months. If unstratified seeds are sown in spring, they will germinate only the following year. Winkler (1999) writes that about 800 seeds are sown in 40 cm x 60 cm plastic boxes with 50 % perforated bottoms. After sowing, the seeds are covered with 0.5 cm of sand. If the seeds are sown more deeply, the root necks of the seedlings will grow too long, thus affecting the ease of pricking and having a negative effect on the quality of the seedlings.

Kausch-Blecken von Schmeling (1994) stresses that the seeds of the wild service tree are sown when about 10–20 % of the seeds germinate in the stratification medium. The seeds are covered with a thin layer of sand and the beds are kept moist at all times. During sunny days, the beds must be shaded.

One of the compulsory tending measures in the production of wild service tree seedlings involves trimming the root system. The seedlings may reach selling dimensions as early as the end of the first year, but they are generally sold at the age of two, or sometimes three. The cultivation of wild service trees is identical to that of other species. If the root of the seedling is adequately trimmed, it will develop a very rich root system. The naturally strong root makes trimming with a shovel difficult compared to other trimming methods (e.g. mechanised trimming, using a plough).

Seedlings that sprout in open beds can be transplanted. Alternatively, the seeds are sown in greenhouses (in containers). The young seedlings are pricked out after sprouting. When they are pricked in small peat containers, the root system develops very quickly. After this, the plants are lifted from the containers and planted out in the open. In one or two years at the most, the seedlings reach 40/70 cm or 50/80 cm and have a very well-developed root system.

Seedlings grown in Jiffypot containers can be outplanted or transplanted in larger containers made of material which the root system can penetrate. Container seedlings can be transplanted at any time, and if the soils are normal the success of transplanting is good. In the future, we should investigate whether bare root seedlings are better for planting in dry soils. It was found that containers with peat sides are harmful if the peat dries out.

According to Kausch-Blecken von Schmeling (1994), seedlings of the wild service tree need not be supported with poles. The seedlings grow slowly and lignify early and well. They need a support only in the event of distinctly rapid growth. We have good experience with the container production of the wild service tree. The potting medium is peat enriched with fer-

tiliser with prolonged action in the summer. About 10,000 to 20,000 seedlings may be obtained from 1 kg of seeds; in other words, seed usability ranges from 1/2 to 1/3. The author points out that even better seed usability can be obtained.

The literature mentions a very interesting method of sowing rowan and wild service tree seeds: a hen-coop is thoroughly cleaned and the poultry is fed with the fruits of these two species. The next day, the chicken manure is collected and broadcast over the beds.

According to the WSL Versuchsgarten catalogue (1991), seedlings of the wild service tree are produced in the seedbed part of the nursery for one (1+0) or two (2+0) growing seasons. Spacing between the plants is 15cm x 20 cm. The seedlings are then trained and sold at 1+1, 1+2 or 2+1.

Wild olive tree (*Olea europaea* spp. *sylvestris* /Mill./ Rony)

The olive tree can be propagated by seeds or vegetatively. Seed-grown seedlings are used as the rootstock for grafting. Grafting using the budding method or the cleft graft method is performed when the seedlings are one and a half years old. Cuttings of the olive tree do not root easily. This species can also be propagated by covering up with earth.

Aleppo pine (*Pinus halepensis* Mill.)

The seeds of Aleppo pine are usually sown in spring and less commonly in autumn. Smaller seeds are covered with 0.6–0.7 cm of soil, and larger seeds (*P. cembra, P. pinea*) with about 1.0–1.5 cm of soil. Germination is usually completed 30 to 40 days after sowing. The nursery germination rate in pines is usually 50–75 % of the laboratory germination rate (Regent, 1980). Piotto and Di Noi (2001) write that the sowing period for the species of the genus *Pinus* is typically in spring, provided that the seeds of the dormant species are appropriately stratified.

Ornamental forms and pine cultivars are propagated with cuttings or by means of grafting.

According to Stilinović (1987), 8–10 g of seeds per metre are sown. The seeds need not be stratified before sowing, but keeping the seeds in water for 24 hours helps them to germinate more rapidly and evenly. He also points out that the seedlings develop a very long taproot as early as the first year (up to 50 cm).

Current practice involves the production of container seedlings of Aleppo pine. For use in urban forestry, the seedlings are trained in the nursery seedling stool bed for 4–5 years. One-year-old seedlings of Aleppo pine are used for outplanting (1+0).

Turkish pine (*Pinus brutia* Ten.)

The nursery production of Turkish pine is very similar to the nursery production of Aleppo pine, taking into account certain specific features related to site conditions in the greenhouse, the biological properties and ecological requirements of the species, the technical-technological status of the nursery, and similar features. Piotto and Di Noi (2001) write that seeds stratified for 4 – 8 weeks are sown in spring. Cold stratification has proven to be particularly effective for seeds collected in areas characterised by hard winters.

Current practice involves the production of container seedlings of Turkish pine. According to Regent (1980), similar to Aleppo pine, seedlings suitable for outplanting are one year old (1+0).

Stone pine (*Pinus pinea* L.)

The nursery production of stone pine is very similar to the nursery production of other already mentioned pine species, taking into account certain specific features related to site conditions in the nursery, and the biological properties and ecological requirements of the species.

According to Piotto and Di Noi (2001), in hot, southern parts of Italy, the seeds of stone pine are sown in late summer, while in other regions the typical sowing time is spring. Stilinović (1987) also points out that seeds are sown in spring, with about 200 seeds per metre. Prior to sowing, the seeds are kept in water for one day.

Due to the long taproot which the seedling develops in the first year, and on account of its vulnerability to transport, it is better to use containerised seedlings for afforestation purposes. In practice, the majority of pine stone seedlings are container produced.

For the needs of urban forestry, the seedlings are grown in the nursery seedling stool bed for several years. The crown of the seedling is naturally formed, but if two terminal shoots develop, the weaker and more irregular one should be cut off. If, however, the terminal shoot is damaged, one lateral shoot from the first lower whorl should be straightened, tied to the pole and allowed to take over the role of the terminal shoot. Since an empty space is created in the whorl, branches from that whorl should be tightened and directed towards the empty space in order to fill it out.

The propagation of pines (species, varieties, forms, cultivars, etc.) by means of cuttings is very rarely used in practice due to the distinctly long rooting period. Grafting is much more commonly used for propagating forms whose generative progeny does not retain desirable characteristics or forms which do not put forward any seed. Grafting is done in nurseries in winter, using the method of side grafting at the base.

According to Regent (1980), seedlings suitable for outplanting are one year old (1+0).

Black pine (*Pinus nigra* J. F. Arnold)

The nursery production of black pine is very similar to the nursery production of other already mentioned pine species. The seeds of black pine are sown either in Dunemann beds or in different types of containers. If black pine seeds are sown in Dunemann beds, the first step is to prepare the soil in the bed. The beds are filled with 80 % forest soil and 20 % peat. The soil must then be disinfected, usually chemically - with biocides. The most commonly used soil disinfectant today is Basamid Granulat in a quantity of 50 g/m^2. The treated areas are covered with plastic sheets that are kept on depending on the soil temperature. The higher the temperature, the faster the basamid dissolves and the shorter the disinfectant period is. After disinfection, the nylon sheets are removed and the soil is aerated (it is milled several times a day) for about as long as it was under the nylon sheets. What follows is a cress test to check if the soil in the treated areas is polluted with the gas dazomet (harmful for the seeds).

If the cress test is negative, the next step is to sow the seeds in a quantity of 4 decagrams/m^2 or about 1 kg/25m^2. In Croatian experience, the nursery germination rate is about 60 %; in other words, of 1 kg of seeds, 1,500 seeds will germinate. The sowing density in the seedbed is about 620 plants /m^2, or 25 % of the total number of seeds.

After one year (1+0), the germinants are transplanted from Dunemann beds into the nursery seedling stool bed. The seedling stool bed is first treated with about 350 kg/ha of mineral fertiliser NPK 7:20:30. After this, the soil is ploughed and then harrowed. The areas are usually treated with soil herbicides. Beds are then made using bed forming machinery. The seedlings are pricked out in the spring using planting machines.

The density in the seedling stool bed is 50 plants/m^2. This means that plants in rows are spaced 10 cm apart and the rows are spaced 20 cm apart. If planting is done with machines, then 5 rows are made parallel to the longer side of the bed. The seedlings in the seedling stool bed are subjected to basic tending treatments, such as watering and cultivating with inter-row cultivators and fertilising with KAN mineral fertilisers 150–200 kg/ha. To protect the plants from weeds, inter-row herbicide application is also provided and the plants are hoed. If necessary, protection against plant diseases and pests is also provided. In the following vegetation, the plants are watered, cultivated and protected against weeds. At the end of the second vegetation in the nursery (1+2), the plants are lifted with vibration ploughs, classified and delivered to the field or are stored in refrigerators at low temperatures.

According to Stilinović (1987), the seeds of black pine are sown in spring, preferably immediately after cone collection and seed rubbing. The quantity to be sown per metre is 6–10 g. The seeds are covered with about 3 cm of soil According to the same author, freshly collected seed requires stratification before sowing, but soaking the seed in water for 24 hours stimulates faster and more uniform germination.

The young seedlings are relatively resistant to late spring frosts and drought. In cases of longer dry periods, the plants should be watered and possibly shaded. If bare root seedlings are produced, they remain in the nursery seedbed for one or, more commonly, two years. One-year seedlings can be transplanted in the nursery seedling stool bed (1+0), where they are cultivated for the next two years (1+2), but it is more common to transplant two-year-old seedlings (2+0), which remain in the seedling stool bed for one year (2+1).

For horticultural purposes 1–2-year-old seedlings from the germination bed are transplanted into the nursery seedbed where they are trained for the next 4–5 years. Two-year-old seedlings from the germination bed (2+0) can already be used for afforestation. Regent (1980) recommends that two-year-old (or older) transplanted seedlings of black pine be outplanted.

According to the WSL Versuchsgarten catalogue (1991), black pine seedlings are cultivated in the nursery seedbed for one (1+0) or two (2+0) vegetations seasons, with 15 x 20 cm spacing between the plants. The seedlings are then trained and delivered to the field as 1+2 or 2+2 year-old plants. The most commonly used plants for afforesting the Mediterranean region are container seedlings of black pine aged 1+0.

Italian cypress (*Cupressus sempervirens* L.)

Regent (1980) writes that untreated seeds of dormant cypress species can be sown in autumn, or (even better) stratified seeds can be sown in spring, when the seeds of non-dormant species are also sown. The seeds are covered with 0.3–0.5 cm of soil or 0.6–0.7 cm of sand. Sown in spring, the seeds of non-dormant species such as the Italian cypress germinate rapidly and uniformly in 2–3 weeks. The crop should be regularly watered and kept under shade until germination is completed. Otherwise, germination will be delayed by up to 20 days, it will be uneven and the percentage of the obtained plants will be significantly lower. According to Piotto and Di Noi (2001), the seeds are sown in spring. If possible, they should be cold stratified for 3–4 weeks. If the seeds have not been stratified, it is advisable to soak them in water for 2–3 days.

When the seedlings reach sufficient dimensions, they are transplanted into containers or open beds. Seedling transplantation can be avoided if the seeds are stratified and allowed to pre-germinate and are then sown directly into containers. In the initial developmental stage, the sown areas are shaded to protect the sensitive seedlings from moisture loss.

Young and Young (1992) recommend autumn sowing of untreated seeds or spring sowing of cold stratified seeds. The seed is broadcast and covered with a thin layer of soil. The seedling density on the beds ranges from 310 to 630 plants/m^2. Dissolved granite is used to mulch the beds. When humidity is excessive, the seedlings of Italian cypress are prone to mortality due to fungal diseases. Stilinović (1987) writes that, depending on the climate, the seeds can be sown in open beds or in boxes covered with glass. Sowing is done in spring at a depth of about 5 mm and then the beds are mulched. The seeds germinate after 2–3 weeks. To sow the seeds in boxes, the author recommends a mixture composed of two parts loamy sand, one part peat and one part sand. The boxes should be filled to 1–1.5 cm from the

upper edge. The seeds are then sown at a small depth (5–6 mm) and should be well watered and possibly covered with paper until the beginning of germination.

When the seedlings reach 1–2 cm in height, the boxes are taken from the greenhouse to the cold germination bed and covered with glass. When the young plants become stronger, they should be placed in the shade. The seedlings are very vulnerable to the loss of moisture; therefore, at no moment should the soil be allowed to dry out. Over the autumn and winter, the plants in the open beds are mulched with straw or some other protective material. The seedlings can be produced in different types of containers. They remain in the seedbed for 1–2 years, while seedlings intended for urban forestry are raised in the seedling stool bed for 4–5 years.

Seedlings with more horizontally arranged branches are obtained from the seed collected from varieties with distinct pyramidal growth. If the exclusive goal is to produce seedlings with pyramidal crowns, only those of the desired phenotype are transplanted in the seedling stool bed. Cypress seedlings aged 1+0 or 2+0 are used in the field. One-year seedlings have only juvenile leaves.

Regent (1980) recommends that trained plants aged two (1+1) be used for outplanting.

Similar to Regent, Piotto and Di Noi (2001) also mention the possibility of vegetative propagation of this species by means of cuttings and by grafting. According to Dirr and Heuser, Jr. (1897), cuttings of Arizona cypress are taken from young plants and are treated with 2,000 to 5,000 ppm of the IBA hormone. Cuttings taken in November or December have the best rooting percentage. Cuttings of Italian cypress taken in April will root without any problems. Cultivars used in horticulture are generally grafted on a rootstock obtained from the seed (Dirr and Heuser, Jr., 1987).

According to Stilinović (1987), var. *sempervirens* can be propagated with cuttings taken from December to January. The cuttings will not root easily without the application of the hormone. Treating the cuttings with IBA acid for 24 hours stimulates rooting. The plants are grafted in summer, in the greenhouse, using the side grafting method. The rootstock is a typical species (planted in a pot). When watering the grafted plants, we should avoid wetting the needles. A moderately humid atmosphere should be maintained. After callus has been formed, the shade is removed and the rooting stock shortened.

Dirr and Heuser, Jr. (1987) write that cuttings of Italian cypress are taken in April and are rooted to a percentage of 100% without the application of any hormone. The rooting percentage of cuttings taken in May is 80% if no hormone is used and 100% if IBA is applied. Cuttings taken in February, March, June and July manifest a rooting percentage of 60, 50, 45 and 65 % if no hormone is used. The application of the IBA hormone increases the rooting percentage to 50, 70 and 80 %.

Prickly juniper (*Juniperus oxydecrus* L. Ball, syn. *J. macrocarpa* /Sm./ Ball.)

Seeds of prickly juniper are sown in autumn, immediately after collection. The seeds germinate 4–6 weeks after sowing. Seedlings may be transplanted into bigger containers or in open nursery beds after 4–5 or 12 months. Transplanting is a critical moment in the growing process and must therefore be performed with utmost care (Piotto and Di Noi, 2001).

According to Regent (1980), seeds of prickly juniper are sown in autumn or spring, after being pre-treated. The crop is covered with 0.5–0.7 cm of soil or sand and is protected with straw and mesh wire until the beginning of germination. Stratified seeds sown in spring begin to germinate 6–10 days after sowing. Germination is completed after 4–5 weeks. It is advisable to treat the seedlings against infection from the fungus *Phomopsis juniperovora*. Treatment with a Bordeaux mixture or colloidal sulphur is applied every 2–3 weeks at the beginning of spring. The infested plants should be burnt. Two-year or older transplanted and non-transplanted seedlings are suitable for outplanting.

Stilinović (1987) writes that stratified seed should not be allowed to dry because it will regain dormancy (secondary dormancy). He recommends autumn sowing as a substitute for stratification. Before autumn sowing, the seed is treated with sulphuric acid for 30 minutes.

When applying warm stratification, it is important to observe the recommendations of some researchers who claim that temperatures above +18 °C slow down the germination of unstratified seeds. Therefore, seed stratification at temperatures above +10 °C is open for discussion. Seed germinability depends on the method of treatment and is variable with regard to years, but on average a germination percentage of about 59 % can be expected. The seeds are sown at a depth of 1.5 cm in quantities which guarantee the production of about 50 well-developed seedlings on the beds by the end of vegetation. It is advisable to cover the seeds with sand or peat (about 5 mm), and overtop this with a layer of semi-decomposed needles.

Seedlings and young plants of prickly juniper are resistant to the cold but require slightly moister soil. The plants are lightly shaded in the beginning. The plants remain in the nursery seedbed for 3–4 years, and spend an equal amount of time in the seedling stool bed (shrub-like species). Seedlings from the seedbed can be used for forestry purposes, as can trained seedlings, but the latter are trained for shorter periods than those used for parks. Vidaković and Franjić (2004) write that prickly juniper can also be propagated with woody (winter) cuttings, layers and by means of grafting. This species is also cultivated as a horticultural plant in the form of several varieties and cultivars.

Phoenician juniper (*Juniperus phoenicea* L.)

The nursery production of Phoenician juniper is very similar to the nursery production of prickly juniper, taking into account certain specific features related to the species and nursery conditions.

The seeds of Phoenician juniper are sown in seedbeds. After dormancy has been overcome, germination may be encouraged with temperatures of about +15 °C, while higher temperatures (+20 °C/+25 °C) are not suitable.