G. Douglas
Summary reports on papers and posters presented at the Seed Orchard Conference, Umea Sept 26-28, 2007 for publication / distribution by Treebreedex:

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Seed orchard planning and management in Turkey
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Summary
The breeding activities were started in 1964 by establishment of first seed orchards. National tree breeding and seed production programme for target species (*Pinus brutia, Pinus sylvestris, Pinus nygra, Cedrus libani,* and *Fagus orientlis*) was started in 1994. By the end of 2006, there were 174 seed orchards covering 1200 ha, 92% of total for *Pinus brutia, Pinus nigra, Pinus sylvestris* and *Cedrus libani*. For *Pinus nigra* and *Pinus sylvestris* all seed demands can be met from seed orchards.
Two seed orchards of *Pinus brutia* were established in two breeding zones according to the first results of progeny tests. Plus tree selection of *Sorbus terminalis* were made and grafted in seed orchards.
Seed sources from seed stands and orchards were planned to fulfil a plant need for about 150000 ha/year (48200 ha for *Pinus brutia*, 45600 ha for *Pinus nigra* and 19700 ha for *Cedrus libani*). The seed capacity of seed stands and seed orchards is 20 and 44Kg/ha for *Pinus brutia,* respectively and 5 and 37Kg/ha for *Pinus nigra*, respectively.
Seed orchard management is mainly concerned with for protection from animals and insects, weed control, ensuring an isolation zone, counting male and female strobili, pruning, hormonal application and molecular genetics. For future development of the seed orchards there is a lack of information on mating system and pollen management in seed orchards so there is a need to expand knowledge with other research activities by increasing trained staff, cooperating and funding.

Synchronization and fertility variation among *Pinus nigra* clones in a clonal seed orchard.
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Summary
Synchronization of flowering and fertility variation among sixty *Pinus nigra* clones was studied in a clonal seed orchard in Greece for two consecutive years (2006-2007). The results indicated the negative effect that high temperatures and drought could have on synchronization among clones, as 2007 was an extremely dry and hot year, especially in April-May. It was also revealed that male flowering duration is strongly affected by environmental conditions, while female flowering initiation is under strong genetic control. The genetic control of earliness in flowering of male and females was strong. The deviation of receptive period is a rather weakly inherited trait. Significant variation was also detected among clones regarding their fertility, as heavy male and female strobili producing clones were identified.
The correlations coefficients among traits indicated the strong genetic control of female flowering initiation and commencement of different stages. Thus, the variation found and the strong genetic control indicate that selecting for flower synchronization in black pine will be highly effective with consequent results on the genetic composition of seed crops and realized genetic gain.

Using SYNCHRO.SAS, a programme to facilitate phenological data processing in a radiata pine seed orchard in northern Spain.

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Summary

Flowering process in a seed orchard is of great importance, since it affects the gene exchange between the clones and consequently the genetic composition of the seed produced. The knowledge of flowering phenology is of great importance for the successful operation of any seed orchard. Several different techniques have been developed for quantifying the degree of reproductive synchronization between all mating pairs of clones. A programme intended for SAS-pc (SYNCHRO.SAS) has recently been created to facilitate phenological data processing and to compute several phenological synchronization indices for each male-female combination and to enable construction of the male and female phenograms as well as other simple graphics that may help in the interpretation of phenological synchronization parameters. Reproductive phenology was studied in a radiata pine seed orchard, located in northern Spain. Timing of flowering was determined on the basis of data recorded by visual observations made three times a week in 2000, 2001 and 2002 flowering periods. In general, the flowering periods of the different clones overlapped. The male flowering clones that best synchronised with the females appeared to be those that started flowering earlier whereas the female clones that best synchronised with male clones were those with intermediate flowering periods. The phenological overlap index varied greatly among clones, whether male or female. SYNCHRO.SAS was a very useful tool to calculate the overlap indices and obtain phenological graphs.

Seed Orchard Management Strategies for Deployment of Intensively Selected Loblolly Pine Families in the Southern US

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Summary

As plantation forestry has become an integral component of the southern forest landscape in the last half century the North Carolina State University- Industry Cooperative Tree Improvement Program has led the way in developing genetically superior southern pines that enhance the health, productivity, sustainability, and profitability of forest stands. Through the application of sound scientific principles, tree breeders have developed families of loblolly pine that produce 30 to 50% more wood per acre than what was available 50 years ago. These families are more resistant to fusiform rust disease, have better wood quality due to enhancement in straightness and disease resistance, and are widely adapted to a range of site types and silvicultural systems. When the best genetic material is planted and given the necessary resources to grow, mean annual increments of 300 ft^3/acre/year can be readily achieved on many sites. Today's plantations are growing more than twice as fast as plantations of the previous rotation.

Tree improvement has been a standard silvicultural tool for foresters to use in southern pine regeneration programs for many years. In early 2000's, one billion of loblolly pine was planted annually, today we are planting around 850 million that come from tree improvement programs. The 59% of loblolly pine plantations are established as single open-pollinated family blocks and the 48% of the seedlings are used for market sales.

Synchronising tree breeding and seed orchard programs in Finland

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Summary
Tree improvement requires much time from the selection of plus trees in natural forests, with posterior testing of progeny and the mass production of genetically improved seeds in a seed orchard. But we want to improve forests as soon as possible, so the ongoing testing phase is essential step so that new generations of seed orchards can be established. In Finish conditions the breeding cycle for Scots pine is about 40 years and 25-30 years for Norway spruce. And the seed orchard life time is 55 years, 12-18 years in unproductive phase and 40 years as productive phase. At the present moment, there are 1.5 generation elite seed orchards for Scots pine (about 600 ha) and Norway spruce (about 300 ha) that provide all of the nursery need for those species. For Scots pine there is two step testing and selection strategy: phenotypic forward selection at age 13-17 and progeny testing. There are more than 300 full-sib families in pre-selection trials, several hundreds of 2nd generation and 26 seed orchards, also valuable for breeding as clone archives.
For Norway spruce, the current seed orchard programme is designed to meet all seed demand for decades.

Swedish seed orchards for Scots pine and Norway spruce

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Summary
Sweden is dominated by two species, Scots pine and Norway spruce, and 49 % of the planted spruces and 78 % of planted pines came from seed orchards (SO). SO will add a lot to future wood production. The 1st round of SO was established 1949-1971; selection of plus trees was mainly in mature natural forests of spruce, also in plantings with west-continental or Polish origin. Progeny testing was by crossings in SO, many matings (5) per parent, large progenies (200) on 5 sites, resulted in 50% systematic thinning. The 2nd round SOs were established in 1981–1994. Typically selections were carried out in young plantations (20-40yr), in spruce also in plantations of foreign origin. Progeny testing was by open pollination in the forest. Many of the 2nd SO use tested clones. 3rd round SOs established from 2004 used only tested clones from the first SOs and fewer clones, status number approx 18. In contrast to previous rounds forestry pays, no governmental support. The predicted genetic gain in production in the different rounds were typically 10% , 10-20% and 20-25%.Currently more than 60 percent of all planted plants come from seed orchards and the figure is increasing as new orchards start producing seeds. Establishment of a new round of SOs has been launched, which will lead to almost complete seed orchard supply for plant production with considerable higher genetic quality over what is used today.

A review of Finnish seed orchards of Scots pine and Norway spruce

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Summary
Finland is dominated by 2(3) species - Scots pine, Norway spruce (and Silver Birch). In 1963, the first seed orchard (SO) programme had the aim to produce all seed needed in SO, also for the northern parts. 1st generation SO were established 1950-70' with phenotypically selected plus trees.
In 1989 the SO programme for 1990-2025 was revised for the tree breeding programme; progeny testing of Norway spruce was started on a larger scale and planting of 1.5 generation SO used 20 % of the best tested material from the1st generation plus trees. In 1997 and 2004 revisions of SO programme and also revision of tree breeding programme (2004). State subsidies cover 85 % of the costs of establishing seed orchards, and the seed producer takes care of 15 % of the costs and buys the land. Genetic gain in tree height of pine and spruce SO (background pollinated material): pine was 3 % spruce 10 %, gain 10 % higher in 1.5 generation SO.

British Columbia's Provincial Seed Orchard Program: Multispecies Management with Integration to the End User

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Summary

Forestry in BC is mainly on public land (95%) and forest genetics started in 1951. First seed orchards (SO) established 1963. An increase of SO seed since 1963 means that 40-45% of plant needs come from SO today, with the goal of 75% by 2015. It is provincial government policy that improved seed must be used first before wild seed. About 67% of all SO's are Lodgepole Pine, White Spruce or Douglas-fir. Every parent in every seed orchard has a breeding value calculated from progeny tests and BC's 104 major SOs,(spread over 14 production sites)have an average of 57 parents in them. Additional progeny test results will reduce this number in the future; however seedlots must have an effective population size of 10 before they can be used in reforesting BC's public land base, so most orchards will probably maintain an average of 25 to 30 parents. The average genetic worth (in volume gain) of the seed is to be 20% by 2020. Currently, the average gain of the seed orchard production is 14%. BC has two Forest Service Branches - Research Branch (Forest Genetics, breeding) and Tree Improvement Branch (Seed Production, seed extraction, testing, storage; policy & planning). Seed is produced by both public (50%) & private (50%). SO's for the resistance program concentrate on six main species. SO seed use increases future timber supply, with gains from 11% to 14%, the gains increase harvest rates within 20 years of planting. The Mountain Pine Beetle has killed large areas of pine since 1999, especially SW of Prince George. Climate change will cause an expected northward shift of the species range for all native tree species.

Pest insects and pest management in spruce seed orchards

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Summary

In Sweden, seed orchards (SO) are established to produce high quality seeds for reforestation. SO seeds have a high market value. Norway spruce SO seed production is far below the demand. A low and unpredictable seed production is often caused by insect damage. Among the most serious pests are three lepidopteran species (spruce seed moth, spruce cone worm, spruce cone looper) and one dipteran species, (spruce cone maggot). Since 1996 Skogforsk has been working with pest management in SO trials with by spraying *Bacillus thuringiensis*. It gives good results against lepidopteran species. The biological insecticide reduced damage from the spruce cone worm from 85 to 15% and the spruce cone looper from about 60 % to 20 %, but did not affect the seed moth. To reduce damage of all insects trials with injections of systemic insecticides (imidacloprid and abemectin) have been started but are more expensive than spraying trees. Available results: The cone worm and the cone looper were reduced from about 25 % to 10 %.

The Swedish Scots pine seed orchard Västerhus

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Summary

The Scots pine seed orchard (SO) Västerhus was established in 1991 with 28 clones selected after progeny testing. When established linear deployment (LD) was used so that the clones with the highest breeding values were represented in higher numbers. Does LD remain since establishment? In summer of 2007, 16.1% of the grafts were dead and for 0.9% of the grafts, the root stock had replaced the grafted clone. The estimated gain by LD at establishment did not change much due to loss of grafts. The gain in breeding value by LD was initially estimated to approx 6% as compared to a comparable hypothetical seed orchard with the 20 best

clones in equal representation. Pollen contamination from the surrounding stands may have a larger and reducing effect on the genetic gain than loss of grafts and thus changed clone proportions.

Direct sowing of Scots pine seed orchard seed

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Summary
Comparison of stand seed and seed orchard (SO) seed in Finland. On two test sites, tests were established in 2002 and on four test sites tests were established in 2003 and 2004. No differences in germination the first year was observed, in contrast to Swedish studies. After the first year the seedlings were in average 2 cm, after two years 5 cm and after three years more than 10 cm. The SO seedlings were in average 20% higher than the average height of the stand seed material.

Functioning of Norway spruce seed orchards: do insects matter?

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Summary
Cones were collected in 2006 from a 1st generation *Picea abies* seed orchard (SO) to study if clones differed in their susceptibility to insects (*Megastigmus* or *Plemeliella*) and if the insects prefer the same clones each year. Data was also available for 1989 and 1995. In 2006 spruce clones differed in susceptibility to insects but damage was moderate and the genetic composition of the seed crop was not changed. The insect species preferred different host clones in the orchard and the genetic composition of the seed crops was not affected similarly each year.

Efficiency of genetic diversity capturing from seed stands vs seed orchards of *Pinus nigra* plantations in Turkey

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Summary
The impact of forest management activities on the genetic structure of newly established forests has been investigated. Conservation strategy for gene ressources are developed. Different seed sources have been compared. Differentiation between seed stands of black pine are low, as typical for forest trees (F_{ST} =0.06). Forestry practices have been carried out best in Hocalar location according to a Neighbour-Joining tree, where each seed source category was in the same proximity to each other. The genetic diversity is high in all studied seed sources and some differentiation has been found among them. The existing forest practice seems to capture the genetic diversity.

Planter's guide - a decision support tool for choice of regeneration material

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Summary
To choose the source of appropriate reforestation material an internet based decision making tool was presented. In Sweden. 332 million of seedlings were produced in 2006, of which 60% were Norway spruce (49% produced in SO) and 35% Scots pine (78% produced in SO). There was a clear demand for a standardized program to enlarge the target group and to install a user-friendly interface. This tool can be used e.g. to compare seed orchards and seed stands, to calculate height and survival as a response to the site conditions such as photoperiod and the index of yield. Known variables are species and site (indicated on a map). As one of the results it shows measures of performance of seed orchards. One of the functions is to select different seed orchards together with the area, where the material is suited for.

Paternity studies in Danish Conifer seed orchards

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Summary

Dysfunctions in clonal seed orchard were detected. It can be due to selfing, non-equal pollen contribution from parental trees, external pollen contamination and grafting/ labelling errors of clones. Paternity studies used 5 SSRs. In *Abies nordmannia* low pollen contamination in seed orchards was discovered. Moreover, clonal difference in selfing and highly skewed pollen contribution was found with one clone making a major pollen contribution. For *Abies alba* a clonal seed orchard consisting of 12 clones was investigated using 5 SSRs. Similar results as for *Abies nordmannia* were found. No errors were found in labelling or in the identity of grafted clones. Best 5-6 clones will be selected for establishing seed orchards for Christmas tree production. For *Larix kaempferi* paternity analysis revealed an even contribution of pollen from the other clones. Furthermore low selfing rates and low pollen contamination from outside the stand was found.

Pomotechnical treatments in the broadleaf clonal seed orchards

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Summary

In Croatia has 2.5m ha of forest covering 40% of the land. Most of the forest is state owned and there are 17,612 ha of registered seed stands and 62 ha of clonal seed orchards (SO). Seed orchards have been established on agricultural land. With *Fraxinus angustifolia,* SO material is important because of yield periodicity and seeds can not be stored for a longer period of times therefore a 3.5 ha SO was established using 56 clones and a cherry SO with 26 clones and for *Alnus glutinosa,* 2 SOs are established using 61 clones on 1.7 ha. In ash seed orchards, a spindle pyramid training system is adopted giving branches of 45^{O} angles or wider and a total height of 7 m for easier seed harvesting. For *Quercus robur,* plus trees have been selected according to 10 assessed traits. Three SOs were set up in 1996 with 40 clones on 15ha at 10m X 8m. Formative pruning for this species is to find a balance between growth and productivity with special emphasis on trunk-branch angle. To increase flowering of 15 yr old *Quercus robur* SO trees, a soil cut was made in a line 120cm from the tree trunk at 1.0m deep. Problems in seed orchard establishment are incompatibilities of rootstocks and grafts and small rodents. For old oak tree grafting, secondary grafts are used for higher survival.

Paternal gene flow in *Cryptomeria japonica* seed orchards as revealed by analysis of microsatellite markers

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Summary

Cryptomeria japonica is regenerated by seedlings and cuttings. Clonal seed orchards have been established in various parts of Japan by propagating superior clones. GA is very effective in promoting flowering in *C. japonica*. Seven seed orchards were investigated using microsatellite markers. Pollen contamination accounted for 35 – 66% of the analysed seeds. Improvements to avoid pollen contamination is SMP and indoor seed orchards but this would cause increase in cost and labour. In different types of seed orchards the same tendency of gene flow was revealed, as about 20% of the clones contributed to 60% of the paternal contribution to seeds and 30% of the clones made no contribution. Self-fertilization was no significant problem in the seed orchards (2-4%).

Challenges and Prospects of Seed Orchard Development in South China

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Summary
In Southern China for 20 species seed orchards were established and seeds for large scale planting were produced. Gain was lower than expected. Seed orchards are owned and managed by the state. Companies have their own seed orchards. The private sector concentrates on commercially important species and the state takes care about minor species, but both contribute to each other. The psychological threshold to accept new material from seed orchards is high. Low input seed orchards is considered positive for Southern China. For planting species there is no stable or long term demand on specific species. Until 1995 mainly pine was planted and from 1995 onwards eucalyptus trees dominated. Management and breeding are discussed in respect of conservation strategies. Plus tree selection does not cover the natural distribution of the species very well. A lot of early selection is lost, not tested or not deployed in seed orchards. Breeding programs are well developed for some species but for many species only plus tree selections exist. For the private sector future strategies are unclear. Breeding program includes genetic testing in provenence trials, half-sibs and clone testing for screening superior clones for plantations. To date it is popular in China to use cuttings and tissue culture for reproductive material and "no one wants to use seeds any more".

Practical implications for seed orchards and seed orchard crop deployment of after effects

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Summary
Offspring performance from two Norway spruce seed orchards, containing clones transferred from high altitudes to sea level and from northern to southern latitudes, were studied in early tests and field trials. Seedlings from both seed orchards developed frost hardiness later at the end of the growth season, flushed later in field trials and grew taller than seedlings from seeds produced in natural stands. They had the lowest mortality and lowest frequency of injuries in the field trials. Seedlings from two seed crops in the southern orchard, produced in years with a warm and a cold summer, behaved as they were two different provenances. We found no adverse effects of the changed seasonal growth rhythm. A long-term memory (an after effect), triggered by photoperiod and temperature at the orchard location, is formed during embryo development. This epigenetic memory affects the adaptive performance of the young trees, and inflates variation among provenances.

Mixing of seed crops from different years is an effective management strategy for enhancing effective population size in Eucalyptus seedling seed orchard crops

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Summary
Fertility variation among trees and effective population size were estimated for two successive years in four seedling seed orchards (eight-nine year old) of *Eucalyptus camaldulensis* and *E. tereticornis* established at a dry (Pudukkottai in Tamil nadu) and a moist (Panampally in Kerala state) locations in southern India. Fertility variation estimated as the sibling coefficient (Ψ), was high ($\Psi = 5$-13) in the orchards and varied between two successive years, except for the *E. camaldulensis* orchard ($\Psi = 2$ & 3) established on the moist site. Mixing of seed crops from two successive years reduced the fertility variation considerably, and the relative effective population size increased in all orchards by 31 – 48%. If seeds from different seed production years are mixed, seed orchard trees will contribute more equally to the seed crop.

Pollen contamination and after-effects in Scots pine

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Summary
To evaluate the effect of pollen contamination in translocated seed orchards of *Pinus sylvestris* on seedling frost hardiness in the autumn**,** separate estimates of quantitative genetic effects from southern outside pollen sources and short term epigenetic after effects of the seed orchard environment must be obtained. In this study, moveable grafts were used to quantify the effect of background pollination, where pollination took place at various sites and seed maturation took place in a common garden. Seeds from identical full-sib crosses performed at different sites along a south-north gradient were used to estimate the after effects of the seed production site. It is concluded that in young seed orchard, the genetic effects of background pollen is pronounced, and less so from older seed orchards, but the epigenetic after effect of the seed orchard environment is short lasting. High pollen contamination is due to a massive pollen release on a single day. Confounding the two effects is avoided by testing hardiness at older ages.

PROSAD; a tool for projecting and managing data about seed orchards

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Summary
PROSAD is a database program developed for projecting seed orchards and respective data management. It is also a useful tool for storing, managing and keeping track of data about clonal archives, stool-beds and various types of field trials, including provenance plots. The program provides powerful database functions for processing data about these objects and also various possibilities to export and import data into and from other data formats. The program is based on a relational database model, which is able to use free tables and provides a rich data management outfit for creating and managing tables in a relational database, it generates aggregated tables with help of the SQL language and creates versatile output reports. The software operates in MS Windows 2000 or later and is installed from CD or DVD drive. A 15 MB free space on hard disk (without user data) is needed for installation.

New advanced generations seed orchard designs

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Summary
In over 30 years of seed orchards establishment and management, the spatial configurations of clones remained unchanged creating a paradoxical state that is characterized by static seed orchard designs in a situation of constant changes driven by advancement in breeding programs. Additionally, the vast accumulation of knowledge in ecology and reproductive biology, including better understanding of mating systems, pollination biology, fertility variation, and contamination have changed our perception and assisted in rejecting of some seed orchards' myth. New breeding strategies (called "Breeding-Without-Breeding") that integrate classical breeding and pedigree reconstruction methods have emerged. Advanced generations breeding programs feature complicated relatedness structures, combinations of backward and forward selections, desire to capitalize on proportional deployment or exploiting assortative mating etc. We propose two novel seed orchard designs applicable to first and advanced generations where these issues are considered. The first design combines the benefits of randomization and systematic arrangement of ramets and their clones after considering their regional proximity to neighbouring clones from the same parent (Randomized, Replicated, Staggered Clonal-Row) facilitating easy crop harvest. The second design (Minimal Inbreeding) utilizes global assignment of clonal ramets within the entire orchard with the objective to

minimizing potential inbreeding in the seed crop. Many modifications to both designs are available, making them flexible, yet efficient in delivering genetic gain to operational forestry.

Combining production of improved seeds with genetic testing in seedling seed orchards

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Summary
The study discussed the advantages and disadvantages of seedling seed orchards management that is aimed at combining production of improved seeds with genetic testing and is applied in wide scale in Poland. The ANOVA of data on stem diameter, height, stem straightness, crown width, and branch diameter from 65 Scots pine families in seed orchard at age 12 years indicated the considerable differences among families ranging between the worst and the best families from 15% up to 45% depending on the traits. Family variance components ranged from 5.3 to 8.8%. Based on family and tree index values genetic thinning was planned with removing worst 7 families. The thinning resulted in decrease of the effective family size from 64.96 to 57.16 while the increase of traits means was minor. The special software - connected with Database of Forest Reproductive Material was created to make calculations and planning of the thinning. It was concluded, that this method requires the compromise between the testing and production requirements, however it still facilitates continuous genetic gain before seed orchards reach the biological phase of cone harvesting.

Temporal and Spatial Change of the Mating System in a Seed Orchard of *Pinus tabulaeformis* Carr

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Summary
Modern DNA marker technology provides an opportunity to gain an insight into understanding essential processes in seed orchards, temporal and spatial variation in outcrossing, selfing, inbreeding and contamination rates as well as on pollen dispersal distance. Open-pollination seeds were collected from the seed orchard of *Pinus tabulaeformis* for 7 years and analysed with aid of starch-gel electrophoresis at 10 enzyme loci and in SSR-PCR reaction system at 12 primer pairs. The multilocus rates of outcrossing in different years varied from 0.795 to 0.975, while the selfing coefficient varied from 0.025 to 0.205. After rouguing the seed orchard, the outcrossing decreased from 0.975 to 0.795, while the selfing increased from 0.038 to 0.205. The outcrossing rates for seeds from upper crown were slightly higher than those from lower positions, although it were slightly various for different ramets-clones. The proportion of clones with different outcrossing rates changed from year to year, as well as due to rouguing of seed orchard. The observed contamination rates varied from 0.326 to 0.532. Thus thinning affects the mating parameters in the seed orchard. 17.8% pollen camed within a radius of 7 m from the seed tree, 24.4% within a radius of 10 - 20 m and 55% within a radius of 20 - 30 m. The selfing and inbreeding rates in the seed orchard were smaller than in the stand and progeny plantation studied. All these data are of theoretical importance for sustainable, healthy development of seed orchards, although they are not sufficient and not accurate enough as expected.

Coancestry among wind pollinated progenies from a *Pinus pinaster* seed orchard in a progeny trial

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Summary

The aim of this study was to estimate the coancestry coefficient of the families present in a progeny trial originated from seed collected in a clonal seed orchard of *Pinus pinaster*, and how this affects the heritability estimations. 125 offspring from a sub sample of six families from a progeny test planted at Mata do Escaroupim were analyzed. Seeds for the progeny test were originated by open pollination of 46 plus trees clones in Escaroupim clonal seed orchard. Offsprings were genotyped for five highly polymorphic microsatellite markers: two chloroplast microsatellite loci and three nuclear microsatellites. The percentage of full-sibs slightly differed among families, being as low as 4% in the average. The mean value of the genetic covariance coefficient was 0.26. Differences between the unadjusted and adjusted heritability values were more pronounced in height (0.40 and 0.38, respectively) than in diameter (0.90 and 0.89, respectively), but they did not imply severe bias (<5%). It was concluded that in a *Pinus pinaster* open-pollinated family trial the associated error in heritability estimates due to the inclusion of full-sibs, when assuming a coefficient of relation amongst open pollinated sibs of ¼, is low.

Grain angle breeding values obtained from seed orchard clones and their progeny: a comparison

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Summary

The study compared breeding values for grain angle under bark obtain from Swedish progeny trials (28-years-old) with clone mean values of its parents in clonal seed orchard (49-years-old). Substantial heritabilities were observed for grain angle and stem diameter in the seed orchard and in all the progeny trials. G x E interaction among progeny trials was very weak. Genetic correlation between seed orchard and progeny trial was strong for grain angle (0.73) but weak for the stem diameter (0.09). Even though seed orchards are subjected to drastic establishment and management measures such as grafting, rouging, cone harvesting, fertilizing and flower stimulation, the results suggests that grain angle clonal values obtained from estimates in seed orchards clones could even substitute breeding values from their progeny and still be a fairy effective tree breeding tool. Possible implications could be genetic improvement of grain angle by genetic rouging of seed orchards or the cone harvest of specific clones even without completing genetic progeny tests as quantitative genetic evaluation of grain angle could be made on their parents themselves.

Pollen contamination effect on growth of Scots pine clone progenies

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Summary

The study aimed at investigating consequences of pollen contamination from neighbouring stands on growth of progenies from seed orchard clones. Different pollen mixes were used in crossing of 9 mother trees: pollen mix from slow growing clones, pollen mix from fast growing clones, and three pollen mixes from neighbouring stands of different quality. The analysis (SAS procedure Mixed) had shown that type of pollen mix had a significant effect on height and diameter of progenies at all measurement ages (6, 10, 18, 23 years). The progenies obtained from crossing with fast growing clones had best growth, followed by the progenies obtained in crossing with pollen mix from stands of 'Ka' and 'Ku' types. The progenies obtained from crossing with slow growing clones had better growth than progenies from crossing with pollen from neighbouring stands of 'Mis' type, indicating important influence of pollen contamination and neighbouring stand quality on growth of seed orchards progeny.

Seed orchards and seed collection stands of Scots pine in Turkey

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Summary

Scots pine is one of the five native pines (*Pinus brutia*, *P. nigra*, *P. sylvestris*, *P. pinea*, *P. halepensis*) in Turkey. Based on climatic and ecological conditions the natural range of the species was divided geographically into four breeding zones. Scots pine distribution area is increasing by afforestation. The main seed sources for this purpose are seed collection stands and seed orchards. There are currently 22 Scots pine seed orchards (SO) covering 116 ha and 36 seed collection stands covering 4813 ha. Seed sources (11 seed orchards with total area of 55 ha and 20 seed stands with total area of 2772 ha) are concentrated mainly in the first breeding zone, what corresponds with the highest distribution area of the species and highest demands of the seed in this breeding zone. The seed orchards are on average 21 years old with, 41 clones and 36 ramets per clone. The effective number of clones was on average 37.3, which is 91% of census number indicating that the clones are represented by similar number of ramets. More than 90 % of seed demand for forest plantation in Turkey is covered from the seed stands, but the contribution of seed orchard crops is rising.

Economic orchard replacement: The advancing-front orchard and its implications for group merit selection and half-sib family forestry in the southern USA

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Summary

Long breeding cycles, delayed sexual maturity of forest trees, the time value of money, and the uncertain size of future seed demands are a few issues that complicate decisions on the timing of orchard expansion and replacement. The Western Gulf Forest Tree Improvement Program (WGFTIP) has adopted advancing-front orchards as an operational strategy to balance these conflicting demands and to maintain program flexibility. Advanced-generation orchard blocks are added to the orchard complex at regular five-year intervals taking advantage of the best genetic material then available from the breeding population. Older blocks are removed from production as their clones become genetically obsolete the sites are reused for orchard replacement. Simulations of cone yields and historical harvest records suggest that loblolly pine seed orchard blocks in advancing-front orchards can be phased out at about 20 years of age as younger blocks take over commercial production.

A *de facto* system of linear deployment has developed as the result of grafting the best parents repeatedly in multiple cycles of orchard replacement. If relatives are incorporated within orchard blocks or, as is more likely, in subsequently established advanced-generation blocks, coancestry in the seed orchard population will increase. Mild levels of inbreeding will be more likely and as this will negatively impact genetic gain, concepts such as group merit selection to balance gain and diversity may become important tools. Both linear deployment of unrelated clones across orchard blocks and the use of relatives make it desirable to consider the effective population size of the orchard complex and the seed harvested for deployment. This is necessary in order to make explicit decisions about genetic diversity and productivity of regional reforestation programs.

Factors affecting effective population size estimation in a seed orchard: a case study of *Pinus sylvestris*

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Summary

Effective population size as a parameter closely correlating with the genetic and genotypic diversity of the seed orchard output is an important indicator of seed orchard functioning. It is determined by the variation of male and female gametic contributions of parental genotypes (including those outside the seed orchard), influenced by the variation in male and female gamete production, reproductive phenology, pollen dispersal within seed orchard and other factors. The assessment of fertility and phenological variation requires labour and finances. Authors of the study tested empirically what is the relative importance of these factors for effective population size (status number) estimation by gradual adding one-by-one in the order of labour requirements (female contribution, male contribution, reproductive phenology, pollen dispersal) in three Scots pine (*Pinus sylvestris* L.) seed orchards in central Slovakia. The results have shown that in old, fully fruiting seed orchards, effective number of clones is a satisfactory estimator of the effective population size, but the inclusion of female and male fertility variation improves the estimate of status number. On the other hand, phenological variation and spatially dependent pollen dispersal do not considerably affect N_S estimates and need not be assessed for practical purposes. In contrast, a young seed orchard proved to be unbalanced and phenologically not synchronized; consequently, effective number of clones was a poor estimator of the effective size and status number was affected by all factors (male and female fertility, phenology, spatial design).

Establishment of an elite Scots pine seed orchard in northern Sweden

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Summary

To meet future demands of genetically improved seeds in Sweden the third batch of seed orchards has been launched, aiming to increase long term wood production by 25% per area unit. There is a predicted shortage of improved seed for the costal area of the province of Västerbotten as a demand of increased focus towards improvement of quality traits. If the same climate region in Finland, Österbotten, is taken into consideration, the shortage of improved seeds will be even greater. To meet this requirement a small (5 hectare) elite seed orchard of Scots pine (*Pinus sylvestris* L.) will be established in Brån, outside Umeå. In the new seed orchards the general number of clones is set to 25, deployed at different frequencies according to their corresponding predicted breeding values by using linear deployment. If a smaller number of clones are deployed in the orchard, the selection intensity will be increased, and as a result, the genetic merit of seeds obtained from the orchard will possibly be increased. However, possible drawbacks of fewer clones are higher rates of pollen contamination and legislation restriction on commercial usage. The very best genotypes from two breeding populations will be selected and used as clones in the Brån seed orchard. A major problem when selecting clones from different breeding populations is to give a fair comparison between clones if production traits are considered (e.g. growth, survival). Due to the clinal adaptation of trees in northern Sweden, predicted breeding values of clones from different breeding populations are, in this study, transformed to a common scale by using well known transfer effects. High and early production of genetically good seed is a combination of intensive management and the design features of the seed orchard. Early flowering of both sexes is wanted. This spring, seedlings were planted at 2.5 m X 7 m in accordance to an optimal estimated number of grafts per hectare of 600. Later, field grafting will be used to deploy the clones into the orchard. Furthermore, the difference in flowering phenology between clones will be examined to possibly utilize early versus late flowering. Clones with highest predicted breeding values will be centrally placed in the seed orchard in order to minimize outside contamination.

Results from practical flower stimulation with $GA_{4/7}$ in *Picea abies* seed orchards in Sweden

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Summary

Flower stimulation using $GA_{4/7}$ treatment is regularly used to promote flowering to facilitate crossings in Swedish breeding populations. Seed orchard managers, however, have hesitated in using the method in seed orchards, especially in *P. abies,* due to its irregular and unpredictable flowering. The first practical attempt on flower stimulation with $GA_{4/7}$ in *P. abies* seed orchards was in 2005. Four seed orchards were treated, two old in the end of their production phase and two young in the beginning. Treatment was done at one single occasion in each orchard by a drill hole plus injector. To enable statistical assessment of the treatments every second row was left as untreated controls.Female and male flowering were scored during for a random sample of orchard trees in all four orchards in 2006. In the autumn the number of cones per orchard tree was counted in three orchards, and seed quality was assessed in two orchards.Results showed a positive statistical significant $GA_{4/7}$ effect on male flowering in the two young orchards, but not in the old orchards. Scores of

female flowering showed a statistically significant positive effect of $GA_{4/7}$ treatment in three of the orchards. In one of the old orchards, no effect on female flowering was observed. In one young orchard there was a positive significant $GA_{4/7}$ effect for the number of cones. Seed qualities were not affected by the $GA_{4/7}$ treatment.Even though a positive effect was not always obtained, economic calculations based on the cone count data show that $GA_{4/7}$ treatment is a cheap and highly profitable way to increase the seed production in *P. abies* seed orchards.

Linear deployment of unrelated sibs is an efficient strategy when large diversity is available.

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Summary

This study deals with how the deployed proportion of each candidate clone can be decided at the establishment of a seed orchard when the breeding values are available for each candidate in a population of half-sib families. The deployment strategies allowing and not allowing relatives were compared.. The genetic gain adjusted for predicted inbreeding depression (Net gain), gene diversity and effective clone number were considered as the main ranking criteria. The strategies optimizing the number of related individuals and the linear deployment strategy with restriction on relatedness returned the highest Net gain. If there is a large diversity to select from (the status number of the candidates is more than 8 times greater than the status number desired in the seed orchard), a relatively simple advice is to select the best individual within the certain number of the best families and deploy the clones linearly according to their breeding values (the number of families selected depends on the desired status number).

SEEDPLAN: a modular approach to seed orchard deployment

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Summary

Optimal allocation of seedlots to stands requires a knowledge of family expected genetic value (EGV), how families are put together into seedlots, and the economic characteristics of each stand to be planted. Family genetic values reflect the modelled contributions of pollen within the seed orchard and genetic groups outside the orchard, and interactions between genotypes that are naturally or artificially crossed. Family contributions to seedlots reflect how the manager has collected and bulked individual family lots. Differences in bio-economic characteristics such as productivity, haulage distance and harvesting costs as well as differences in expression of genes due to differences in scale and genotype by environment interaction, make each stand unique in the combinations of traits that will give the highest economic gain. Each seedlot thus has a different value for each stand. Optimal allocation of seedlots to stands will maximise the net profitability. SEEDPLAN® is a modular system that enables this optimisation (cMATCHER) as the last step in a series of modules that model family and seedlot composition (cORCHARD & cCOMPOSER) and availability, stand bio-economic characteristics (c$Index) and planting schedules. Each module will be linked by a standard data exchange format, so that modules can be independently updated and improved. In the simplest scenario, seedlot composition has already been fixed as the seedlots are already in the nursery, and the planting sites still to be planted are known. cMATCHER will optimise the allocation of these seedlots to stands to maximise company profitability. As planting moves further away in time, then there exists potential for optimisation of seedlot composition for anticipated planting through changes in harvesting and bulking, family value through crossing, culling and infusion, as well as ramet placement and management, and ultimately in seed orchard establishment. The Southern Tree Breeding Association (STBA) manages national breeding programs for *Pinus radiata* and *Eucalyptus globulus* in Australia. Collaborative research projects have developed bio-economic models which can be customised for each stand. TREEPLAN® is used to

estimate genotype and group breeding values and family specific combining abilities, which are combined into a genetic value for each family based on models of maternal and paternal contribution and the target site. Orchard pollination has been extensively modelled to enable estimation of family composition. With SEEDPLAN®, all these elements can be combined to optimise forest profitability.

Contribution of seed orchards to timber harvest in the short-run and in the long-run

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Summary

This study investigated the potential contribution of seed orchards to timber harvest in Sweden by comparing the optimal harvest volumes over time with and without access to genetically improved seeds from seed orchards. A real interest rate of 3% was used throughout the analysis. The price of timber becomes lower when genetically improved seeds are used in regeneration compared to the case when such seeds are not used. Since the demand function is by assumption constant over time, the decrease in timber price induced by large scale applications of genetically improved seeds becomes larger with time. With the iso-elastic demand function, the average timber price during the 200-year time horizon decreased by 18% if future forests grow 20% faster. A 40% improvement in future forest growth would lead to a 30% decrease of the average timber price. With a linear demand function the effect of improvement in future forest growth on timber price is smaller, but still significant. An important consequence of genetically improved seed usage is that more timber will be produced and traded at lower prices. Results from the current analysis show that forest owners' profits will drop by 5% if genetically improved seeds lead to a 20% increase in future forest growth. With a 40% increase in of future forest growth the profits of timber production would decrease by about 10%. Timber based industry, on the other hand, would benefit considerably. The inclusion of the non-timber benefits in the analysis may lead to different results about the impacts of applying genetically improved seeds on timber harvest and price similarly a possible increase in future timber demand.

Gene conservation through seed orchards - a case study of *Prunus spinosa* L.

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Summary

In Germany the plantating of indigenous shrub species of regional origin is important to compensate for the loss of natural habitats. The use of such material is based on the expectation of its high adaptedness and vitality. Changes in the patterns of land use and urbanization make it difficult to identify populations which correspond to such expectations. For some species gene flow between populations and hybridization with cultivars blur potential patterns of adaptation. Results of systematic provenance trials are missing for indigenous shrub species. Thus the use of regional material is a strategy to safeguard against unintentional change in the potential patterns of adaptation.

To contribute to this discussion we analysed 13 natural stands, two conservation seedling seed orchards and two seed lots of *Prunus spinosa* L. using isozyme gene markers.

This paper studies the following questions:

1. Are naturally occurring populations of *P. spinosa* L. genetically differentiated?
2. Is there any evidence for a link between genetics and spatial proximity?
3. Do the existing seed orchards of *P. spinosa* L. represent their source populations?
4. Are imported seed from southeast Europe (Hungary) significantly differentiated?
5. Do genetics support the hypothesis of naturally arisen source populations?

The natural stands are genetically differentiated. Evidence exists for a link between genetic differentiation and spatial proximity. The genotypes of the seed orchards represent the gene pool of the natural stands well. Minor genetic differentiation exists between the German study material and the seed lot from Hungary. Cluster analysis supports the hypothesis of naturally arisen source populations.

A review of the history and current situation in the Finnish Birch seed production program

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Summary

Genetic improvement of birch in Finland began in 1947 followed by intensive breeding in 1960s with progeny testing and establishment of extensive seed orchards (SO) in the 1970s. The development of indoor seed orchards had revolutionised the production of improved birch seeds to keep pace with seed demands and this production technology has been adopted in many other countries. Three first generation SOs were established in the 1970s for *Betula pendula,* second and third generation SO are now operational as well as a clonal programme. First generation SO are operational for *B. pubescens.* At the peak in seed demand in the early 1990s, over 300 kg of seed was produced from 18 SOs. Thanks to SO, the proportion of qualified grade *B. pendula* used by Finnish nurseries rose from 25% in 1991 to 95% today. There are now large stocks of improved seeds available and seven SO are in production. Using the indoor system, new SO of birch can be brought into production within 5 years if plant demand increases. Many tests of SO derived material have shown consistent genetic gains of 29% in wood volume, a reduction in relative stem taper of 13% and a 10% reduction in relative branch diameter.

Seed orchards for autochthonous gene conservation

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Summary

In Flanders (Belgium) the production of autochthonous forest reproductive material (FRM) is encouraged mainly through the creation of seed orchards. The term autochthonous denotes tree and shrub populations that have been growing locally for a significant amount of generations, from the last ice age. The need for autochthonous FRM is high. Autochthonous genetic resources of woody plants have become seriously endangered because of the particularly low and fragmented forest cover, centuries of intensive forest use in this highly populated area and the wide-spread usage of non-autochthonous planting stock in reforestation and landscape plantings. Intraspecific hybridisation between remnant autochthonous populations and foreign genotypes, which can show inadequate adaptation, may influence the autochthonous genetic constitution and fitness in the long term. The central aim is to maintain and create the necessary conditions for natural and flexible evolution of the genetic diversity of autochthonous trees and shrubs. Seed orchards are elaborated with basic material derived from an inventory survey that locates remaining autochthonous populations.

A new generation of clonal seed orchards of wild cherry. Selection of clones and spatial design.

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Summary

Forest policy in Flanders (Belgium) strongly promotes the use of indigenous hardwoods, among which is the entomophilous wild cherry *(Prunus avium L.),* for re- and afforestation and for stand conversion. This policy generates a strong demand for high quality forest reproductive material, which cannot be met by the currently available basic material. The selection and breeding programme attempts to remedy the discrepancy between supply and demand by creation of a new generation of clonal seed orchards characterised by (i) a high yield and (ii) a high genetic quality and diversity of the offspring. This goal was achieved by selection of 52 genotypes based on half-sib progeny trials. Yield and genetic quality of the offspring was enhanced to a further extent by adjusting the spatial design of the seed orchard to the phenologically and gametophyticaly cross-compatibility of the selected genotypes. Background pollination is reduced to a minimum (80% of

pollen from within the stand) by establishment of the seed orchard at a minimum distance of 400 m from other wild cherry populations and sweet cherry plantations. Paternity analysis revealed a small-scaled patch-like pollination pattern, neighbouring trees in SO should be phenologically compatible. Such cross-compatibility was revealed for 66 % of all possible combinations between the 52 selected accessions.

Do We Need Flower Stimulation In Seed Orchards?

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Summary
Managing a seed orchards should aim to achieve panmixis to promote genetic diversity in progeny. Experience with pine shows that only 25-50% of the clones may contribute to the bulk of the seed produced, due to differences in the sexes and flowering capacity of the clones. Timing of application of GA4/7 in Scots pine showed that early application stimulated male flowers and late application more female flowers, and this treatment was more effective when applied in the lower and middle areas of the crown. GA4/7 treatments was most effective in stimulating flowering on those clones which were poor at flowering. It is concluded that flower stimulation in pine seed orchards is desirable particularly when applied to clones which are poor to flower.

Direct seeding of orchard and stand seed.

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Summary
A comparison of the performance Scots pine seed which was derived either from seed orchards or from seed stands was made under conditions of direct seeding. Seed orchard derived seedlings did not survive at a higher rate than seedlings derived from seed stands. The germination on seeds from seed orchards seeds did not germinate at a higher rate than those seeds from stand seeds which had the same a priori capacity for germination. Direct seeding was compared to planting trees derived either from SO or from seed stands. There was a positive effect on seedling growth (height) by of using seeds from the seed orchard For direct seeding the effect of using SO material was greater than seed stand material compared to the difference in these sources when planted as trees. However, using SO seeds to generate planting stocks is more efficient. In a situation with a surplus of orchard seed, the most efficient way is to selectively harvest the best clones for restocking with plants, and the rest for restocking with direct seeding.

Seed orchard functioning in Danish hybrid larch seed orchards 2000-2007 - an overview of results and their implications

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Summary
The increased performance of hybrid larch is well known with hybrids growing twice as fast when measured at 18 yrs of age. However differences in the performance of material from the Hybrid Larch seed orchards (SO) in different years of seeds suggested a dysfunction. The genetic makeup hybrid larch seed orchard in Denmark differs with one clone of either *L. decidua* or *L. kaempferi* (clones for seed collection) and different genetic setup of the alternative species (pollen donor). The seed from different years from different seed orchards was examined using allozymes and cpDNA analyses. Seeds were tested for the presence of hybrids and selfed seeds over the years 1985 to 2006 (in total 15 seedlots). Variation from 10-91% hybrids was observed,

and for a given seed orchard, the percent of hybrid seeds was found to vary from 73% to 10% indicating sever dysfunctions in some years. Since the growth rate of hybrids is greater in the nursery there is the possibility to select out hybrids at that stage. However, it is highly recommended to check the hybrid percent for any single seed lot before sowing and seedling production. The studied showed that standardized sampling protocol are required for this purpose, because the hybrid seed germinated faster than selfed seed and testing based on an early germinating fraction may therefore bias the results substantially.

Problems with seed production of European larch in seed orchards in Poland

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Summary

European larch (*L. decidua* Mill.) is the most important conifer in Poland with 17 m planted in 2006. We have 40 clonal seed orchards (SO) on 252.11 ha, and 24 seedling seed orchards on 171.89 ha. In 2006, 62% of the seed needs came from SO, 26% from economic seed stands and 12% from selected seed stands. Production of empty seeds can be as high as 70% in some years, due to many reasons: a lack of pollination, poor development of gametophytes, lack of fertilization and embryo degeneration resulting from selfing. Weather conditions have a significant effect on the above events and on formation of viable seeds so great care must be taken in choosing an appropriate site for the SO. Selfing can be reduced by having as many clones as possible and maximal distances between grafts of the same clone. Research on flowering in a larch SO at Syców started in 2004, (south-western Poland); this confirmed the positive influence of girdling on cone bud production. Girdling should be applied during long shoot extension but before the end of this process. It was done when the long shoots had flushed and had already grown about 3-4 cm in length. Girdled trees had a 2-3-times higher mean grade of female flowering than control trees. Although girdling appears cheap and easy to stimulate flowering, it may make trees more susceptible to break in the girdle zone or to being blown down by wind. Further research is needed to predict poor flowering years so that flower stimulation on poor flowering trees can be applied. Similarly, research on managing tree height to optimize seed production and cone collection is desirable.

A review of the seed orchard programme in Poland

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Summary

Based on assumptions made for a long-term forest tree breeding programme, the share of an individual seed base used for forestry purposes cannot exceed 20 percent. Presently, seeds from seed orchards constitute, depending on the crop, 8 – 17 percent of the reproductive material used in forestry. Following these assumptions1962 hectares of seed orchards have been established so far within the State Forests National Forest Holding (State Forests NFH). The first conifer seed orchards in Poland today produce seeds and are used for the production of forest reproductive material, while most of the broadleaved seed orchards were established in the nineties of the past century and have only entered the seed production phase. The estimates show that the actual area of seed orchards should fully satisfy the demand for the reproductive material from this seed base category. Recently, the creation of a new category "tested" of forest reproductive material has started. The choice of tested trees will allow us to establish seed orchards of the known genetic value and to select individuals with specified breeding qualities to be used for special purposes. Actions of this type have been proposed in the new forest tree breeding programme prepared for the years 2010-2035 in the State Forests NFH.

NIR Spectroscopy as a Tool in Seed Orchard Management

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Summary

Seed quality is a multiple concept encompassing the physical, physiological, genetic, pathological and entomological attributes that affect seed lot performance. Seed orchards (SO) are a cost-effective way to supply genetically improved seeds but seed quality requires monitoring for insect infestation, pollination failure and post-zygotic degeneration; resulting in empty & dead-filled seeds as well as the level of pollen contamination. Thus, SO managers need a rapid technique. Near Infrared spectroscopy (NIRS) is the best candidate to monitor the production of quality seeds as the technique is rapid and inexpensive, non-destructive, and involves no sample preparation. It measures the chemical composition in biological materials based on the absorption of near infrared radiation by bonds between light atoms, such as C – H, O – H and N – H. Our findings showed that putative seed sources of Scots pine could be monitored rapidly and non-destructively using VIS+NIR spectroscopy. The technique could also be used for characterizing and sorting seeds according to their genotype (paternity) and to discriminate between filled, empty and infested seeds of Norway spruce, larch and pines. The technique offers an opportunity for SO managers to rapidly estimate filled seed production to facilitate management decisions. The efficacy of artificial pollination and the success of cultural treatments in reducing the quantity of empty seeds from SOs can also be effectively assessed with NIR spectroscopy. It will also enable SO managers to maintain the genetic quality of seed lots, on the one hand and for tree planters to avert the risk of genetic defects in future tree crops, on the other.

In the Footsteps of Forest Fires in Greece

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Summary

The summer of 2007 was the most catastrophic one in the recent history of Greece, regarding the loss of unique and valuable natural ecosystems, the loss of human lives and the loss of properties due to wild forest fires. A total area of more than 178.500 ha was destroyed, the 56% of which was forest land, the 46% farmland and the 2% urban area. From the end of June to early September, over 3000 forest fires were recorded across the nation, while the death toll stood at 84 people. The extremely hot temperatures that included three consecutive heat weaves of over 40°C and the severe drought facilitated the rapid expansion of the firestorms. The fires mainly affected southern Euboea as well as western and southern Peloponnese, areas where indigenous (ancient) lush forests of *Pinus halepensis*, *Pinus nigra, Pinus pinea* and *Abies x* hybridogenous were growing. Protected Natura 2000 sites, were completely or partially destroyed in the Peloponnese, as well as in Athens, given that great part of the protected Mt. Parnetha Natural Park was destroyed. The Park harboured in total 818 plant species, many of which were endangered, while among the fauna species, 11 were characterized as endangered and 8 as vulnerable. The recorded genetic variation and adaptive potential of forest tree populations growing in Greece are among the highest in Europe, as it has been proved both by molecular markers and field trials across the Mediterranean basin, for the species studied so far. The vital importance of seed orchards, and especially conservation seed orchards, in safeguarding the valuable genetic material of forest tree species that do not have mechanisms of regenerating after fire was revealed after the massive forest fires in the Peloponnese, as the *Pinus nigra* clonal seed orchard located in the region can readily provide seedlings of local origin for the reforestation of sites destroyed by fires. Thus, conservation seed orchards can contribute substantially to the dynamic conservation of valuable genetic material that might be at risk of total destruction.