Seed Orchard Management

1. Colangeli, A.M., L. McAuley and J.N. Owens. 1990. Seasonal occurrence of potential ice-nucleating bacteria on Douglas fir foliage and seed cones. New-Forests 4(1): 55-61.

Keywords: seed orchard management
tree/stand protection
tree/stand health
reproduction

Abstract: Plant frost damage can involve interactions between certain surface bacteria and low temperatures. The bacteria contain glycoproteins, which can nucleate ice above -5 degrees C, thus making the plants on which they live more susceptible to freezing. Preliminary studies to determine if bacteria were present on Douglas fir (Pseudotsuga menziesii), and whether they exhibited ice-nucleating properties, are reported. Total bacteria and fluorescent Pseudomonas populations were monitored on buds, conelets and foliage of five trees in a Douglas fir seed orchard on Vancouver Island, Canada, in April 1986 and between October 1986 and May 1987, over periods that spanned two pollination seasons. Seasonal variation in bacterial numbers was observed, with highest numbers occurring in late winter and early spring. Bacterial populations active in ice nucleation were found. Bacterial numbers during pollination were higher in 1986 than in 1987. Conelet abortion at pollination was also higher in 1986 (55%) than in 1987 (11%). A relation may exist between bacterial populations and conelet abortion at pollination.

OSU Link
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2. Colangeli, A.M., J.N. Owens and S.J. Morris. 1989. Factors affecting cone and seed production in Douglas fir. BC Ministry of Forests FRDA-Report 057. 19 p.

Keywords: seed orchard management
tree/stand protection
reproduction

Abstract: Reduced seed yield in 1986 on 4 Pseudotsuga menziesii trees in a British Columbia seed orchard was associated with inadequate pollination, low pollen vigour or viability, embryo abortion, and early ovule abortion. A study of bacterial populations suggested that there may be a causal relationship between this factor and conelet abortion.

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3. Copes, D.L. 1992. Effects of long-term pruning, meristem origin, and branch order on the rooting of Douglas-fir stem cuttings. Canadian-Journal-of-Forest-Research 22(12): 1888-1894.

Keywords: seed orchard management
reproduction

Abstract: The rooting percentages of cuttings taken from 14 Douglas-fir (Pseudotsuga menziesii) clones were examined annually from 1974 to 1988. The trees were 10 and 13 yr old in 1974 and were pruned to 2.0 m in 1978 and 1979 and then recut annually to 0.5, 1.0, or 1.5 m, starting in 1983. The pruned trees showed no evidence of reduced rooting percentage even after 15 yr; average rooting increased from 47% in 1974 to 74% in 1986. Rooting percentage was significantly influenced by tree height. Cuttings collected from 0.5 m tall ramets exhibited better rooting than cuttings from 1.0 or 2.0 m tall ramets, and cuttings from 1.0 m tall ramets rooted better than cuttings from 2.0 m tall ramets. Rooting of cuttings collected from 0.5 m high subinterval zones within trees showed a negative linear relation between rooting percentage and collection height. Cuttings collected from the 0-0.5 m zone rooted 25% better than cuttings from the 1.5-2.0 m zone of the 2-m tall trees. A test of rooting of larger, more orthotropic cuttings gathered from the upper flat surface of pruned ramets indicated that the cuttings from the top rooted significantly less than the smaller, more plagiotropic cuttings from the contiguous side areas (24 vs. 33%, respectively). Meristems of secondary origin showed significantly greater rooting than meristems of primary origin. Comparison of rooting of second-order and first-order meristems of secondary origin indicated that second-order twigs averaged 26% better rooting than the first-order branch tips when the cuttings were collected in January and placed in the rooting beds in February.

4. Copes, D.L. and M. Bordelon. 1994. Effects of tree spacing and height reduction on cone production in two Douglas-fir seed orchards. Western-Journal-of-Applied-Forestry 9(1): 5-7.

Keywords: seed orchard management
planting operations
reproduction

Abstract: Two treatments involving tree spacings (12 and 24 ft) within rows spaced 24 ft apart and height control (topped or not topped at 20 ft) were evaluated in 17- and 22-yr-old coast Douglas fir (Pseudotsuga menziesii var. menziesii) seed orchards in Oregon. Treatment differences for cone production were not significant because of the large tree-to-tree variation in cone production and, at one orchard, the confounding of location with treatment. Cone production in 1990 averaged slightly more than 2 bushels per tree (range 0 to 11.7 bushels). Average production per 96 linear ft of orchard row was 14.8 bushels.

5. Crook, R.W. and W.E. Friedman. 1992. Effects of pollen tube number and archegonium number on reproduction in Douglas-fir: significance for seed orchard management. Canadian-Journal-of-Forest-Research 22(10): 1483-1488.

Keywords: genetic tree improvement
seed orchard management
reproduction
tree/stand health

Abstract: Analyses of the relations between pollen tube number or archegonium number and the number of fertilization events per ovule (fertilization number) in Douglas fir (Pseudotsuga menziesii) growing at a seed orchard near Centralia, Washington, indicated strong trends toward higher levels of simple polyembryony as both pollen tube number and archegonial number increased on a per seed basis. These relations have a significant bearing on the management of conifer seed orchards. Simple polyembryony has been proposed to be an effective means of increasing competition on a per seed basis in conifers and, potentially, the overall fitness of progeny. In conifers, supplemental mass pollination has the direct effect of increasing the number of pollen tubes per ovule. Clonal variation in average number of archegonia per ovule is also likely to exist among conifers. It is proposed that when used together, supplemental mass pollination and selection of clones with high archegonial averages may enhance the fitness of seed orchard progeny.

OSU Link
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6. Edwards, D.G.W. and Y.A. El-Kassaby. 1988. Effect of flowering phenology, date of cone collection, cone-storage treatment and seed pretreatment on yield and germination of seeds from a Douglas-fir seed orchard. Forest-Ecology-and-Management 25(1): 17-29.

Keywords: seed orchard management
reproduction
tree phenology

Abstract: The effects were studied of reproductive phenology, date of cone harvest, cone storage and seed pretreatment on yield and germination of seeds from a Douglas fir seed orchard in Victoria, BC, Canada. Flowering phenology (early, intermediate or late) had no discernible effect on seed maturation. Higher germination and yields of filled seeds were obtained from cones collected in mid-Aug., approximately 2 wk prior to cone opening, than from cones collected just as they began to open. Seeds extracted immediately following harvest germinated better than those from cones stored for 2 months. Seeds from all treatments were dormant and responded to prechilling by exhibiting increased germination rates. The implications of these findings for cone-crop management are discussed.

OSU Link
Non-OSU Link

7. Edwards, D.G.W. and Y.A. El-Kassaby. 1995. Douglas-fir genotypic response to seed stratification. Seed-Science-and-Technology 23(3): 771-778.

Keywords: seed orchard management
reproduction
genetic relationships

Abstract: Douglas fir (Pseudotsuga menziesii) responses to stratification duration were studied using wind-pollinated seeds from 15 seed-orchard clones, collected from a low elevation Douglas fir seed orchard in Saanichton, British Columbia, Canada. Germinative parameters (germination capacity, peak value, germination value, and germination rate and speed) were evaluated in response to four

stratification periods (0, 3, 5, and 7 weeks). Significant differences among germinative parameters were observed indicating that the five-week stratification period represents the most appropriate treatment in minimizing variation caused by genetic differences. The results indicate that the International Seed Testing Association (ISTA) rules, which focus only on germination capacity, do not provide an adequate expression of seedlot dormancy, and since the rules are aimed at bulked seedlots, genetic differences, which can be large in heterogeneous forest tree seeds, are hidden. The results also demonstrate that extended stratification not only reduces the time in which seedlings become established, but also reduces seedling-emergence variation among parental lines.

OSU Link
Non-OSU Link

8. El Kassaby, Y.A. 1995. Evaluation of the tree-improvement delivery system: factors affecting genetic potential. Tree Physiology 15:545-550.

Keywords: genetic tree improvement
nursery operations
seed orchard management
genetic relationships
reproduction

Abstract: Possible causes of the genetic erosion that occurs during the fragmented phases of the tree-improvement delivery system (a term used for the domestication process in forest trees) are reviewed. The impacts of intentional and unintentional directional selection during phenotypic selection, seed production (with its associated reproductive-phenology asynchrony, fecundity differential and varying propensity to inbreeding), seed processing and storage, and seedling production are evaluated. Allozyme analysis data were used to compare heterozygosity of first-generation seed orchards of western red cedar (Thuja plicata), Sitka spruce (Picea sitchensis) and Douglas fir (Pseudotsuga menziesii) with that of their corresponding natural populations. In general, genetic diversity and heterozygosity parameters of seed orchards are higher or similar to those observed in their natural-population counterparts. However, parental contribution to the resultant seed orchard seed crops is consistently asymmetrical, and this is a major cause of genetic erosion. In most cases, less than 20% of an orchard's clones contribute 80% of the cone crop, thus reducing the effective population size. Because seed germination of coniferous tree species is under strong maternal genetic control, the combined effects of differences in reproductive output and germination, as well as of management practices (e.g., simulated long-term storage of seed showed that loss of viability during storage is genotype specific), cause unintentional directional selection during seedling production. This review confirms the need for genetic monitoring of each phase of the tree-improvement delivery system, so that practical solutions can be developed to alleviate genetic erosion.

OSU Link
Non-OSU Link

9. El Kassaby, Y.A., S. Barnes, C. Cook and D.A. MacLeod. 1993. Supplemental mass pollination success rate in a mature Douglas-fir seed orchard. Canadian-Journal-of-Forest-Research 23(6): 1096-1099.

Keywords: genetic tree improvement

seed orchard management
reproduction

Abstract: Supplemental mass pollination (SMP) success rate in a mature Douglas fir (Pseudotsuga menziesii) seed orchard in British Columbia was studied with the aid of a unique electrophoretically detectable allozyme marker. Four SMP methods were tested during periods of maximum pollen release in 1990: operational applications of pollen (pollen applied once to a branch at average receptivity), and branch applications that were carried out during one, two, or three visits (a first pollen application at maximum receptivity and subsequent applications 2 and 4 days later) were conducted. No significant increase in seed-yield traits (total number of seeds per cone, number of filled seeds per cone and seed efficiency) was observed between wind-pollinated and SMP-treated cones. However, multiple branch visits showed significant increases in SMP success rate (18%) when compared with the operational visit (8%) or the one branch visit (9%) results. No significant increase in SMP success rate was obtained when the number of branch visits was increased from two (17.8%) to three (17.9%). It was concluded that operational SMP has the potential to improve the genetic value of the treated Douglas fir crops even under high pollen load. The degree of improvement is dependent directly on SMP fertilization success and indirectly on the genetic value differential between the supplemented and the orchard's ambient pollen, the frequency of application, and the quality (i.e. viability) of the pollen applied.

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10. El Kassaby, Y.A. and R. Davidson. 1990. Impact of crop management practices on the seed crop genetic quality in a Douglas-fir seed orchard. Silvae-Genetica 39(5-6): 230-237.

Keywords: genetic tree improvement
seed orchard management
genetic relationships

Abstract: The impact of 2 crop management practices, supplemental-mass-pollination (SMP) and overhead cooling, on levels of pollen contamination and outcrossing was assessed in a 13-year-old seedling Douglas fir (Pseudotsuga menziesii) seed orchard with the aid of 6 allozyme loci. A 2 x 2 factorial arrangement of SMP/no SMP and cooling/no cooling was applied to 4 genetically similar blocks of trees. The 4 treatment combinations used were spatially and temporally isolated by buffer blocks and 9-day reproductive bud phenology delay, respectively. The study led to the following conclusions: (1) no contamination was observed when cooling and/or SMP was used, (2) no inbreeding was observed when cooling and SMP were used concurrently and (3) SMP was effective in reducing consanguineous mating, but not to the level achieved by cooling and SMP combined. In addition, the results obtained from the control block (i.e. no cooling and no SMP) indicated that (1) isolation zones are effective in reducing contamination, and (2) randomization of trees within seed orchard blocks is associated with a high outcrossing rate.

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Non-OSU Link

11. El Kassaby, Y.A., D.G.W. Edwards and C. Cook. 1990a. Impact of crop management practices on seed yield in a Douglas-fir seed orchard. Silvae-Genetica 39(5-6): 226-230.

Keywords: seed orchard management
tree/stand protection
reproduction
tree/stand health

Abstract: The impact of two crop-management practices, supplemental mass pollination (SMP) and overhead cooling, on seed yield in a 13-yr-old Douglas fir (Pseudotsuga menziesii) seed orchard was studied in Saanichton, British Columbia. A 2x2 factorial trial of SMP/no SMP and cooling/no cooling was applied. There were no significant differences in potential seed yield per cone, average number of successful fertilizations, and average number of filled seeds per cone between cooling or SMP treatments or combinations. Results indicated that within-orchard pollen cloud was not a factor limiting seed yield. Average number of seeds infested by the Douglas fir seed wasp (Megastigmus spermotrophus) larvae was significantly ($P<0.05$) less when cooling was applied, indicating that the treatment was effective in disrupting the synchrony between the presence of ovipositing females and developing cones.

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Non-OSU Link

12. El Kassaby, Y.A., D.G.W. Edwards and D.W. Taylor. 1990b. Effect of water-spray cooling treatment in a Douglas-fir seed orchard on seed germination. New-Forests 4(2): 137-146.

Keywords: seed orchard management
reproduction
tree phenology

Abstract: As part of an assessment of seed orchard crop management practices, results are given of an experiment undertaken to test the effect of cooling treatment on germination in a 13-year-old full-sib Douglas fir (Pseudotsuga menziesii) seedling seed orchard atSaanichton, British Columbia, Canada. Overhead cooling by sprinklers during February-March, used in order to delay flowering, produced non-significant effects on germination capacity, germination rate, germination value, and abnormal germination of seeds. The percentage of variation accounted for by cooling treatment ranged from 0.0 to 1.0%. In contrast, variation among trees within each treatment (i.e. cooled or not cooled) ranged from 28 to 46%. These effects were significant, indicating that each tree has an individual germination pattern. The temporal delay of reproductive phenology caused by temperature manipulation as a result of the cooling treatment was judged to be within the species' biological limits.

OSU Link
Non-OSU Link

13. El Kassaby, Y.A., A.M.K. Fashler and O. Sziklai. 1984. Reproductive phenology and its impact on genetically improved seed production in a Douglas-fir seed orchard. Silvae-Genetica 33(4/5): 120-125.

Keywords: seed orchard management
tree phenology
reproduction

Abstract: Reproductive phenology of buds was monitored for 2 yr in a Douglas fir seed orchard to determine the validity of the theory of panmictic equilibrium. There was a significant variation within clones and families in dates of seed-cone and pollen-cone bud burst, suggesting a major deviation from panmictic equilibrium. This would reduce the size of the breeding population and reduce seed yield. This effect could be reduced, and seed production maximized, either by the use of an irrigation mist system to delay bud development, or by the intensive application of booster pollination.

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Non-OSU Link

14. El Kassaby, Y.A., J. Parkinson and W.J.B. Devitt. 1986. The effect of crown segment on the mating system in a Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) seed orchard. Silvae-Genetica 35(4): 149-155.

Keywords: genetic tree improvement
seed orchard management
genetic relationships
reproduction

Abstract: The mating system in a mixed clonal/seedling Douglas fir seed orchard was studied by analysing 6 polymorphic allozyme loci. Trees were subjected to cooling treatment to retard bud development and compact the pollination period. The outcrossing rates of upper and lower crown levels and northern and southern crown aspects were estimated and compared for clonal and seedling material separately using single and multilocus methods. Single locus estimates of outcrossing rate ranged from 0.645 to 0.999 and were significantly heterogeneous. No significant differences between the multilocus estimates were observed between crown levels or aspects for either the clonal or seedling material. For all comparisons, the unweighted or weighted single locus means were lower than those obtained by the multilocus method, indicating the presence of other types of consanguineous mating in addition to selfing. In general, higher outcrossing rates were observed in the clonal trees than in those derived from seedlings. The implications of these results for seed orchard management are discussed.

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15. El Kassaby, Y.A. and K. Ritland. 1986. The relation of outcrossing and contamination to reproductive phenology and supplemental mass pollination in a Douglas-fir seed orchard. Silvae-Genetica 35(5/6): 240-244.

Keywords: genetic tree improvement
seed orchard management
tree phenology
genetic relationships
economics
reproduction

Abstract: A study was made using allozyme markers of outcrossing and contamination rates in relation to reproductive phenology and supplemental mass pollination in a Douglas fir seed orchard in British Columbia, Canada. Supplemental mass pollination was applied only to the intermediate reproductive phenology class, which showed a high outcrossing rate and no contamination. Both early and late reproductive phenology classes showed significant contamination, but the outcrossing rate for the former was significantly higher than for the latter. These results show that interpretation of seed crop genetic quality based on outcrossing alone could be misleading. The rate and source of contamination, reproductive phenology and crop size should also be considered. The practicability and economics of supplemental mass pollination in avoiding both selfing and contamination are discussed. It was concluded that waterspray cooling and/or supplemental mass pollination of early and late reproductive phenology classes in moderate or good cone-crop years would be an effective management practice. The option of aborting small cone crops in mature orchards is also discussed.

OSU Link
Non-OSU Link

16. Fashler, A.M.K. and Y.A. El-Kassaby. 1987. The effect of water spray cooling treatment on reproductive phenology in a Douglas-fir seed orchard. Silvae-Genetica 36(5-6): 245-249.

Keywords: genetic tree improvement
seed orchard management
tree/stand protection
genetic relationships
reproduction
tree/stand health

Abstract: The effectiveness of reproductive bud cooling on genetic efficiency in a Douglas fir seed orchard in British Columbia, Canada, was tested by comparing the reproductive bud phenology in 3 cooled and 3 uncooled years. The cooling system was found to affect 2 major elements affecting seed orchard genetic efficiency, namely pollen contamination levels and panmictic equilibrium, as well as insect infestation, frost damage, seed yield and management effectiveness. Based on these results, a permanent irrigation/cooling system is recommended for Douglas fir seed orchards.

OSU Link
Non-OSU Link

17. Johnson, R. 1998. Breeding design considerations for coastal Douglas-fir. Pacific-Northwest-Research-Station, USDA-Forest-Service General-Technical-Report PNW-GTR-411. iii + 34 p.

Keywords: genetic tree improvement
seed orchard management
genetic relationships

Abstract: The basic principles of designing forest tree breeding programmes are reviewed for Douglas fir (Pseudotsuga menziesii) in the Pacific Northwest (USA). Breeding populations are discussed given current and future breeding zone sizes and seed orchard designs. Seed orchard composition is discussed for potential genetic gain and maintaining genetic diversity in the forest. Mating and field testing designs

are described and compared. Recommendations of the Breeding Zone Evaluation and Restructuring Cooperatives Working Group of the Northwest Tree Improvement Cooperative are presented.

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18. Miller, G.E. 1983a. Evaluation of the effectiveness of cold-water misting of trees in seed orchards for control of Douglas-fir cone gall midge (Diptera: Cecidomyiidae). Journal-of-Economic-Entomology 76(4): 916-919.

Keywords: seed orchard management
tree/stand protection
tree/stand health
tree phenology

Abstract: The effectiveness of misting trees with cold water in delaying reproductive bud burst of Douglas fir (Pseudotsuga menziesii) and consequently controlling Contarinia oregonensis Foote was evaluated in tests in seed orchards in British Columbia in 1978-80. The misting treatment reduced the amount of damage to the same degree as was achieved with sprays of dimethoate when a 10-day delay in seed-cone bud burst coincided with the earliest 'flowering' trees being the most heavily attacked. Gall midge damage was not reduced to an acceptable level with less than a 10-day delay or when later-flowering trees were the most heavily attacked. It was not possible to determine the likely effectiveness of cold-water misting before bud burst in a given year, because the period of bud-burst delay varied with weather and because synchrony between presence of adult midges and susceptible host-tree stage was not consistent.

OSU Link
Non-OSU Link

19. Miller, G.E. 1983b. When is controlling cone and seed insects in Douglas-fir seed orchards justified? Forestry-Chronicle 59(6): 304-307.

Keywords: seed orchard management
tree/stand protection
economics
reproduction

Abstract: Two seed orchards in British Columbia were sprayed with dimethoate in 1981, and the costs of estimating crop size and insect infestation and of dimethoate application were recorded. The cost/tree was $2.31 or $3.68 (including sprayer rental). Benefit/cost ratios were calculated and plotted against number of cones/tree and varying increases in yield (3-24 filled seeds/cone) due to protection. The number of cones a tree must bear and the increased yield/cone required to cover the cost of one dimethoate application are given in graphs for seed values of $150-1000/kg.

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Non-OSU Link

20. Miller, G.E. 1986. Damage prediction for Contarinia oregonensis Foote (Diptera: Cecidomyiidae) in Douglas-fir seed orchards. Canadian-Entomologist 118(12): 1297-1306.

Keywords: seed orchard management
tree/stand protection
tree/stand health
reproduction

Abstract: Damage to Douglas fir (Pseudotsuga menziesii) in British Columbia at cone harvest by Contarinia oregonensis was positively correlated with the number of egg-infested scales per conelet in the spring. Reducing the average number of galled seeds per cone by 1.5 increased the average number of filled seeds per cone by 1.0 in insecticide trials. Optimum sample sizes for estimating average densities of egg-infested scales were calculated to be 1 conelet/tree and 150 trees/orchard. The mean crowding variable was linearly related to average density, so a sequential sampling technique relative to a critical density was developed for determining the need for control measures.

OSU Link
Non-OSU Link

21. Owens, J.N. 1987. Development of Douglas-fir apices under natural and cone-inducing conditions. Forest-Ecology-and-Management 19(1-4): 85-97.

Keywords: seed orchard management
tree physiology

Abstract: The anatomy, mitotic frequenty (MF), size and total insoluble carbohydrate histochemistry were studied in axillary apices from 9- and 10-year-old Douglas-fir (Psedotsuga menziessi (Mirb.) Franco) trees after cone induction treatments of rootpruning (RP) and (or) stem injections of a gibberellin A4 and A7 mixture (GA). Axillary buds were initiated at the time of RP but RP had no effect on axillary bud initiation. Axillary apices from control and GA-treated trees were similar and followed the normal sequence of bud-scale initiation, differentiation and leaf initiation described previously and no cone buds differentiated. Early development of axillary apices from RP and RP + GA treated trees was normal but development became retarded near the time of vegetative bud flush. Retarded apices were small with low MF and developed many features characteristic of latent apices. The ultrastructure of cells at the base of retarded apices sowed dense cytoplasm and some unusual features. Apical retardation continued until mid-July when normal development resumed and apices differentiated into cone or vegetative buds or became latent. The trees in which the greatest retardation of apical development occurred during lateral shoot elongation produced the most cone buds. These results are discussed in relation to hypotheses proposed to explain how cultural and GA treatments affect cone induction in the Pinaceae.

OSU Link
Non-OSU Link

22. Owens, J.N., J.E. Webber, S.D. Ross and R.P. Pharis. 1985. Interaction between gibberellin A4/7 and root-pruning on the reproductive and vegetative processes in Douglas-fir. III. Effects on anatomy of shoot elongation and terminal bud development. Canadian-Journal-of-Forest-Research 15(2): 354-364.

Keywords: seed orchard management
tree physiology
tree phenology
growth

Abstract: The relative importance of cell division and cell elongation to shoot elongation and the anatomical changes in vegetative terminal apices were assessed for 9- and 10-yr-old seedlings in a seed orchard in British Columbia after two effective cone-induction treatments, gibberellin A4/7 (GA4/7) and root-pruning (RP). Root-pruning was done in mid-April 1981 at the start of vegetative bud swelling and GA treatments were begun at vegetative bud flushing in mid-May and continued until early July. Shoot elongation before flushing resulted primarily from cell divisions and was not affected by the RP treatment. Shoot elongation after flushing resulted primarily from cell expansion which was reduced by RP treatments. Root-pruning significantly slowed mitotic activity, apical growth, and development of vegetative terminal buds from mid-June to mid-July. Apical growth then resumed during leaf initiation and the final number of leaf primordia initiated was not affected. This resulted in a delay of 2-4 wk in the transition from bud-scale to leaf initiation. Retarded terminal vegetative apices anatomically resembled latent axillary apices but were never completely inhibited. GA + RP had the same effect as RP. GA4/7 alone had no effect on shoot or apical development. These results show that RP and GA + RP significantly retard shoot elongation and terminal bud development but still allow normal development of vegetative terminal buds. Retardation of bud development by a few weeks shifts the critical morphogenetic phase of transition from bud scale to leaf initiation to a later time when endogenous and environmental conditions may differ from the normal.

OSU Link
Non-OSU Link

23. Owens, J.N., J.E. Webber, S.D. Ross and R.P. Pharis. 1986. Interaction between gibberellin A4/7 and root-pruning on the reproductive and vegetative processes in Douglas-fir. IV. Effects on lateral bud development. Canadian-Journal-of-Forest-Research 16(2): 211-221.

Keywords: seed orchard management
tree phenology
tree physiology

Abstract: The anatomy, mitotic frequency, size and total insoluble carbohydrate histochemistry were studied in axillary apices from 9- and 10-yr-old trees [in a seed orchard in British Columbia] after cone induction by root-pruning (RP) and/or stem injections of a gibberellin A4 + A7 (GA4/7) mixture. Axillary buds were initiated at the time of root-pruning, but RP treatment had no effect on time or number of axillary buds initiated. Axillary apices from control and GA treated trees were similar and followed the normal sequence of bud-scale initiation, differentiation and leaf initiation and no cone buds differentiated. Early development of axillary apices from RP and RP+GA treatments was normal, but development became retarded near the time of vegetative bud flush. Retarded apices were small with low mitotic frequency and developed many features characteristic of latent apices. Retardation of axillary apices continued until mid-July when normal development resumed and apices became latent or differentiated into reproductive or vegetative buds. Trees which had the greatest retardation of apical development during lateral shoot elongation produced the most cone buds. Results are discussed in relation to 4 hypotheses on effects of cultural and gibberellin treatments on cone induction in the Pinaceae.

OSU Link
Non-OSU Link

24. Ross, S.D. and R.C. Bower. 1989. Cost-effective promotion of flowering in a Douglas-fir seed orchard by girdling and pulsed stem injection of gibberellin A4/7. Silvae-Genetica 38(5-6): 189-195.

Keywords: seed orchard management
reproduction
economics

Abstract: In a seed orchard in British Columbia, Canada, Douglas fir (Pseudotsuga menziesii) grafts of 5-14 cm diam. received different combinations of partial saw-cut stem girdles and ethanolic solutions of GA4/7 injected into shallow holes drilled around the main stem. Grafts averaged 79 seed-cone buds and 4500 pollen-cone buds each without treatment. Girdling alone increased production per tree of seed- and pollen-cone buds to 325 and 9300 respectively. GA4/7 alone was nearly as effective as girdling alone, the response being marginally greater at the high than low dosage (3.82 vs. 1.27 mg/cmsuperscript 2 of stem cross sectional area), but independent of whether the total dose was applied all at once or over two or three injections at 2-wk intervals. Together, girdling and GA4/7 had an additive effect on flowering, increasing production per tree of seed- and pollen-cone buds to 585 and 18 250. The combined treatment was particularly effective on smaller trees that flowered poorly or not at all without treatment, while also enhancing production significantly on larger trees. The combined treatment was safe and highly cost effective. It cost $63.75 per year to maintain each tree in the orchard, so that without any treatment the cost per seed-cone bud initiated was $0.91. Girdling (at $2.07 per tree) reduced this cost to $0.20, and girdling + GA4/7 (at $7.87 per tree) to only $0.13.

OSU Link
Non-OSU Link

25. Ross, S.D. and R.C. Bower. 1991. Promotion of seed production in Douglas-fir grafts by girdling + gibberellin A4/7 stem injection, and effect of retreatment. New-Forests 5(1): 23-34.

Keywords: seed orchard management
reproduction
economics
tree/stand health

Abstract: In a Douglas fir (Pseudotsuga menziesii) seed orchard in British Columbia, Canada, in 1985, 12- to 17-year-old Douglas fir grafts received no treatment, stem girdles only (G), or girdles plus stem injection of gibberellin A4/7 (G+GA) at vegetative bud burst. In 1987 they were retreated with G+GA or left untreated. Trees were untreated in 1986 and cone production in 1987 was very sparse. G+GA treatment in 1987 increased 1988 production of seed cones from 465 to 1600 per tree, with a comparable increase in frequency of grafts producing a heavy crop of pollen cones. However, induction treatments applied in 1985 adversely affected seed- and pollen-cone production in 1988, independent of treatment in 1987. Cone size, total and filled seed per cone, and seed germination were little affected by treatment in either year. Treatment with G+GA in 1987 only maximized production of filled seeds (48 100/tree), although G+GA in both 1985 and 1987 (31 200/tree) was still effective compared with no treatment in either year (14 700/tree). Application time (about 4.8 minutes per tree for G+GA) and costs

are discussed in terms of seed yield (for biennial treatment, about an extra $0.17 per additional 1000 filled seeds). Physiological costs to the tree are noted: the G+GA treatment adversely affected tree condition more severely than previously (or since) experienced, probably as a consequence of prolonged late-summer droughts during each of the treatment years. Additional irrigation and fertilizer treatments are suggested to alleviate such stresses.

OSU Link
Non-OSU Link

26. Ross, S.D. and R.C. Currell. 1989. Effect of top pruning, branch thinning and gibberellin A4/7 treatment on the production and distribution of conebuds in Douglas-fir. Silvae-Genetica 38(5-6): 177-185.

Keywords: seed orchard management
reproduction

Abstract: Three levels each of topping and pruning (in Feb.), with and without stem injections of GA4/7 (during June and July), were replicated in two blocks of a 7-yr-old Douglas fir (Pseudotsuga menziesii) seedling seed orchard in British Columbia, Canada. Flowering was assessed the following year and height increment over two years, when the study was accidentally terminated by management activities. In one orchard block, topping trees from six whorls of branches to five or three whorls depressed female and male flowering disproportionately relative to contributions of the removed crown regions in untopped trees. Trees in the other block were less vigorous and fecund. Here the light topping also depressed female and male flowering but only in proportion to its severity. Heavy topping increased production of seed cones relative to untopped trees and had no effect on male flowering. Pruning of interwhorl and/or smaller whorl branches depressed female flowering in approximate proportion to the branches' contribution in unthinned trees, but had a disproportionate effect on pollen-cone production. Results are discussed in relation to the hypothesis that flowering response to topping and pruning is a function of the vegetative vigour response of shoots following release from apical control. Treatment with GA4/7 increased the production of seed- and pollen-cone buds by 161% and 91% respectively, although seed-cone abortion was also 35% higher in GA4/7-treated trees. A modified stem injection method for the operational GA4/7 treatment of Douglas fir seed orchards is discussed.

OSU Link
Non-OSU Link

27. Ross, S.D., J.E. Webber, R.P. Pharis and J.N. Owens. 1985. Interaction between gibberellin A4/7 and root-pruning on the reproductive and vegetative process in Douglas-fir. I. Effects on flowering. Canadian-Journal-of-Forest-Research 15(2): 341-347.

Keywords: seed orchard management
reproduction

Abstract: In two seed orchard trials in Washington State and British Columbia, profuse female flowering was induced in young, but ontogenetically mature grafts of inherently poor-flowering clones (1979) and in 9- and 10-yr-old seedling-origin trees of both good- and poor-flowering families (1981) by the cultural treatment of root-pruning in conjunction with stem injections of the gibberellin A4 and A7 (GA4/7)

mixture. Promotion of male flowering, however, was confined to the more sexually mature grafts. As an individual treatment in the 1981 study, root-pruning was more effective than GA4/7, particularly for the poor-flowering families which did not respond well to GA4/7 alone. The two treatments combined had a highly synergistic effect on both male and female flowering, the synergism being relatively greater for the poor-flowering than for the good-flowering families. Although GA4/7 was not tested alone on grafted propagules, its use with root-pruning enhanced an already significant increase in seed- and pollen-cone buds from root-pruning alone by 540 and 92%, respectively. Both these and subsequent trials have shown combined root-pruning and GA4/7 to be a most effective cone-bud enhancement treatment for use in young Douglas-fir breeding and seed production orchards.

OSU Link
Non-OSU Link

28. Sandquist, R.E., D.L. Overhulser and J.D. Stein. 1993. Aerial applications of esfenvalerate to suppress Contarinia oregonensis (Diptera: Cecidomyiidae) and Megastigmus spermotrophus (Hymenoptera: Torymidae) in Douglas-fir seed orchards. Journal-of-Economic-Entomology 86(2): 470-474.

Keywords: seed orchard management
tree/stand protection
stand conditions

Abstract: Aerial application of esfenvalerate significantly reduced populations of Contarinia oregonensis and Megastigmus spermotrophus in mature seed orchards of Pseudotsuga menziesii in Oregon. Populations of Oligonychus ununguis increased significantly in treated areas. The results demonstrated that aerial applications can be made under conditions in the Pacific Northwest and can reduce insect damage levels with between 10 to 20-times less insecticide than when high-volume orchard sprayers are used.

OSU Link
Non-OSU Link

29. Schowalter, T.D. 1984. Dispersal of cone and seed insects to an isolated Douglas-fir tree in western Oregon. Canadian-Entomologist 116(10): 1437-1438.

Keywords: seed orchard management
tree/stand protection
tree/stand health

Abstract: An isolated 10-year-old Douglas fir tree (Pseudotsuga menziesii) in Oregon began to produce seed cones in 1983, and the 43 mature cones it produced were removed and dissected. Contarinia oregonensis and Megastigmus spermotrophus were present in 30% of the cones, and undeveloped seeds accounted for 93% of 3059 seeds examined. Of the potentially viable seed (7%), C. oregonensis fused 56% to galled scales, and M. spermotrophus consumed 21%. Ernobius punctulatus and Leptoglossus occidentalis caused seed losses of 8 and 3%, respectively, of the potentially viable seed. These results indicate that C. oregonensis and M. spermotrophus are capable of dispersing to new resources over distances of at least 85 m. They are discussed in relation to the establishment of buffer zones around seed orchards.

OSU Link
Non-OSU Link

30. Schowalter, T.D. 1988. Tree breeding and insects: effect of insects on the genetic diversity of Douglas-fir. Northwest-Environmental-Journal 4(2): 346-347.

Keywords: seed orchard management
nursery operations
tree/stand protection
tree/stand health
reproduction
genetic relationships

Abstract: Two studies on the effects of insects on Douglas fir [Pseudotsuga menziesii] seed and seedling production in Oregon are summarized. In the first study, seed losses due to Douglas fir cone gall midge [Cecidomyiidae] and Douglas fir seed chalcid [Megastigmus spermotrophus] were studied. It is suggested that resistance to these pests may be a heritable trait and that tree position within a stand can modify genetically-controlled susceptibility to insect attack. The second study indicated that genetically-controlled susceptibility of seedlings to attack by lygus bug [Lygus sp.] could be modified by their proximity to alternative food plants.

OSU Link
Non-OSU Link

31. Schowalter, T.D. and M.I. Harverty. 1989. Influence of host genotype on Douglas-fir seed losses to Contarinia oregonensis (Diptera: Cecidomyiidae) and Megastigmus spermotrophus (Hymenoptera: Torymidae) in Western Oregon. Environmental-Entomology 18(1): 94-97.

Keywords: genetic tree improvement
seed orchard management
tree/stand protection
genetic relationships
tree/stand health

Abstract: Seed losses due to the cecidomyiid Contarinia oregonensis and the chalcid Megastigmus spermotrophus were measured in a Douglas-fir (Pseudotsuga menziesii) clonal seed orchard and in a Douglas-fir progeny plantation in western Oregon. Seed losses due to both insects differed significantly among clones and among the progeny of selected parental crosses. Seed loss differed more than 3 times between least-infested and most-infested clones or progeny. Seed losses in the progeny plantation indicated that resistance to these 2 insects is a heritable trait, with greater resistance showing a tendency to dominate over lesser resistance. Insect responses to host genotype may be modified by factors associated with the position of the tree within the stand. Implications of these results for tree improvement programmes and seed orchard management are discussed.

OSU Link
Non-OSU Link

32. Schowalter, T.D., M.I. Haverty, S.A. Dombrosky and J. Sexton. 1986. Response of Douglas-fir cone gall midge and Douglas-fir seed chalcid to host plant genotype. In Proceedings of the 2nd Conference of the Cone and Seed Insects Working Party, Station de Zoologie Forestiere, Olivet, France, September 3-5, 1986. Ed. A. Roques. pp. 217-223.

Keywords: genetic tree improvement
seed orchard management
tree/stand protection
genetic relationships
tree/stand health

Abstract: Seed losses due to 2 species of insects were measured from cones of 51 parental crosses (or families, distinct combinations of 6X11 parents) in a 12-year-old progeny plantation of Douglas fir (Pseudotsuga menziesii) in western Oregon. In 1983 and 1984, seed losses due to Contarinia oregonensis were significantly different among host families. During 1984, 4 of 5 families with the highest midge damage (x=79%) shared a common parent and 4 of 5 families with the lowest midge damage (43%) shared a common parent. This indicates that resistance or susceptibility to the cecidomyiid is probably heritable. Losses due to Megastigmus spermotrophus were measured only in 1984 and were also significantly different among host families. Insect responses to host genotype appeared to be influenced by the position of the tree within the plantation, by the size of the cone crop and, in the case of M. spermotrophus, by prior activity of C. oregonensis.

33. Schowalter, T.D., M.I. Haverty and T.W. Koerber. 1985. Cone and seed insects in Douglas-fir, Pseudotsuga menziesii (Mirb.) Franco, seed orchards in the western United States: distribution and relative impact. Canadian-Entomologist 117(10): 1223-1230.

Keywords: seed orchard management
tree/stand protection
tree/stand health

Abstract: Cones of Douglas fir (Pseudotsuga menziesii) were collected from 17 seed orchards in California, Oregon and Washington in the autumn of 1983; they were dissected, and seed losses were ascribed to Contarinia oregonensis, Megastigmus spermotrophus, Barbara colfaxiana and Dioryctria abietivorella. There appeared to be great differences between orchards, but overall C. oregonensis and M. spermotrophus collectively destroyed about 70% of the filled seed. Physiographic province significantly explained variation in damage by all insect species between orchards. In general, damage by all species increased from northern provinces to southern mountainous provinces. Damage by C. oregonensis and B. colfaxiana appeared to be related to land use management factors also.

OSU Link
Non-OSU Link

34. Sexton, J.M. and T.D. Schowalter. 1991. Physical barriers to reduce damage by Lepesoma lecontei (Coleoptera: Curculionidae) to conelets in a Douglas-fir seed orchard in western Oregon. Journal-of-Economic-Entomology 84(1): 212-214.

Keywords: seed orchard management

tree/stand protection
tree/stand health

Abstract: Damage to Douglas fir (Pseudotsuga menziesii) conelets in Oregon by Lepesoma lecontei was significantly reduced by the application of a sticky barrier around the bole of the seed orchard trees. Early conelet injury was reduced from 25% in controls to 6% in sticky barrier treatments. No significant protection was observed in a test of a metal baffle placed around the bole. Significant treatment effects on cone survival could not be detected. Sticky barriers are a low-cost control that is highly pest specific and need be applied only to those trees producing a crop in a particular year.

OSU Link
Non-OSU Link

35. Sorensen, F.C. 1999. Relationship between self-fertility, allocation of growth, and inbreeding depression in three coniferous species. Evolution 53(2): 417-425.

Keywords: genetic tree improvement
seed orchard management
growth
tree/stand health
carbon allocation

Abstract: Mortality and growth of self and outcross families of three wind-pollinated, mixed-mating, long-lived conifers - Douglas fir (Pseudotsuga menziesii), ponderosa pine (Pinus ponderosa), and noble fir (Abies procera), were followed from outplanting to age 26 (25 for noble fir) in spaced plantings at a common test site in the Oregon Coast Range, near Monmouth. Response to inbreeding differed greatly among species over time and in all regards. Only Douglas fir and noble fir are discussed, because ponderosa pine usually was intermediate to the other two in its response to inbreeding. In earlier reports, compared with noble fir, Douglas fir had a higher rate of primary selfing and larger inbreeding depression in seed set. Douglas fir continued to have higher inbreeding depression in nursery and early field survival. The species differed in time courses of inbreeding depression in height and in allocation of growth due to crowding. Between ages 6 and 12, the relative elongation rate (dm/dm per year) of Douglas fir was significantly greater in the selfs than in the outcrosses. The response was not observed in noble fir. At final measurement, inbreeding depression in diameter relative to inbreeding depression in height was greater in Douglas fir than in noble fir. At final measurement inbreeding depression in height was inversely related to inbreeding depression in survival. Cumulative inbreeding depressions from time of fertilization to final measurement were 0.98, 0.94, and 0.83 for Douglas fir, ponderosa pine, and noble fir, respectively, which indicates that selfs will not contribute to the mature, reproductive populations.

OSU Link
Non-OSU Link

36. Sorensen, F.C. and R.K. Campbell. 1985. Effect of seed weight on height growth of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco var. menziesii) seedlings in a nursery. Canadian-Journal-of-Forest-Research 15(6): 1109-1115.

Keywords: seed orchard management
nursery operations
growth
reproduction

Abstract: Seeds of different mean wt. were produced within each of 10 young Douglas fir trees in a second growth stand in Oregon by leaving some developing cones unbagged and by enclosing others in paper bags for 164 days (from shortly before floral bud flush) or for 117 days (from 26 days after floral buds had been at max. receptivity for pollen). Bagging increased numbers of filled seeds per cone and wt. of individual seeds; 117 days in a bag increased seed wt. by an av. 10.7%. Seed from wind pollinated cones (unbagged or bagged after 26 days receptivity to pollen) were sown in an outdoor nursery at Corvallis, Oregon. Bagging did not affect numbers of cotyledons, but 1st-yr epicotyl length and 2nd-yr total ht. increased by 9.1 and 4.0% respectively. Relations between seed wt. and seedling growth are compared with other reports and inconsistencies are discussed. A growth model was used to project seed wt. differences to later ages and practical implications of long-term effects of seed wt. on plant size, of increasing seed size by cultural techniques and of grading seed lots by size were considered.

OSU Link
Non-OSU Link

37. Sorensen, F.C. and R.K. Campbell. 1997. Near neighbor pollination and plant vigor in coastal Douglas-fir. Forest-Genetics 4(3): 149-157.

Keywords: genetic tree improvement
seed orchard management
growth

Abstract: Nineteen seed parents in a young, patchy second-growth stand of Pseudotsuga menziesii were manually pollinated by near (NN; 12 m) and far neighbours (FN; 100-500 m), and by wind (W) in a heavy-flowering year (1971). Progenies were compared in the nursery and for 10 additional years at close spacing (0.75 m) in the field. In a separate test, the effects of conelet bagging were evaluated using plants of 10 of the same seed parents. Progeny from W and NN pollinations were slightly, but non-significantly smaller than progeny from FN pollination. seed parent x pollen type interactions were highly significant. Bagging effects were significant at the seedling stage, but disappeared in field tests, and did not interact with seed parent at any age. Estimated rates of biparental inbreeding, based on these results and previous reports, are 0 to ~20%. Such variation seems compatible with the variation in natural regeneration habits of the species. If biparental inbreeding is considered as resulting from half-sib mating, the associated inbreeding depression in height is estimated as 0 to 2.3%. At the close spacing used in this study, depression in biomass appeared to be 4-5 times as great as depression in height at age 12.

OSU Link

38. Stein, J.D. and G.P. Markin. 1986. Evaluation of four chemical insecticides registered for control of the Douglas-fir cone gall midge, Contarinia oregonensis (Diptera: Cecidomyiidae), and the Douglas-fir seed chalcid, Megastigmus spermotrophus (Hymenoptera: Torymidae), in Douglas-fir seed orchards. Canadian-Entomologist 118(11): 1185-1191.

Keywords: seed orchard management
tree/stand protection
stand conditions
tree/stand health

Abstract: The control of Contarinia oregonensis and Megastigmus spermotrophus on Douglas fir (Pseudotsuga menziesii) in Washington and Oregon in 1982 and 1983 depended on the levels of infestation and which of 4 insecticides was used. There was no significant reduction in infestation of either pest when acephate was applied. Oxydemeton-methyl (by spray or injection) and dimethoate (in sprays) significantly reduced damage by C. oregonensis. These three compounds and azinphos-methyl were ineffective against M. spermotrophus for infestations affecting <10% of extractable seed. Oxydemeton-methyl injections, azinphos-methyl and dimethoate significantly reduced the incidence of the chalcid when infestation was high (61%). There was no statistically significant difference for pairwise comparisons between compounds that significantly reduced infestation with either pest.

OSU Link
Non-OSU Link

39. Stein, J.D., R.E. Sandquist, T.W. Koerber and C.L. Frank. 1993. Response of Douglas-fir cone and seed insects to implants of systemic insecticides in a northern California forest and a southern Oregon seed orchard. Journal-of-Economic-Entomology 86(2): 465-469.

Keywords: seed orchard management
tree/stand protection
tree/stand health
reproduction
stand conditions

Abstract: The systemic insecticides acephate, dimethoate and carbofuran were implanted into Pseudotsuga menziesii at Oakridge, Oregon and Willow Creek, California, to evaluate their effectiveness in reducing seed and cone insect damage. The acephate-implant treatment significantly reduced seed damage by Barbara colfaxiana and Contarinia oregonensis, and significantly increased the percentage of filled seed by 300% at the California site. Neither dimethoate nor carbofuran significantly affected any of the seed or cone insects encountered. Acephate was not effective against Megastigmus spermotrophus or Leptoglossus occidentalis. The association observed between C. oregonesis damage and undeveloped seeds suggested that management strategies that include effective control measures should also include methods to monitor and reduce seed abortion.

OSU Link
Non-OSU Link

40. Stoehr, M.U., J.E. Webber, C.C.A. Hollefreund and R.A. Painter. 2004. Potential pollen contamination effects on progeny from an off-site Douglas-fir seed orchard: 9-year field results. Canadian-Journal-of-Forest-Research 34(4): 981-984.

Keywords: genetic tree improvement
seed orchard management

reproduction
tree/stand health
growth

Abstract: To evaluate the potential effects of seed orchard pollen contamination from surrounding background sources, we made control pollinations with outside orchard pollen and inside orchard pollen on trees of a Douglas-fir (Pseudotsuga menziesii) coastal-interior transition zone seed orchard. This zone encompasses the coast mountains from the Washington border to Alaska, USA. The resulting progeny were tested on a transition zone and a coastal site. After nine growing seasons, survival was above 90% on both sites for both pollen sources, and the tree height differences due to pollen source were statistically non-significant. Wildstand operational seedlots, used as controls, were 17% shorter than the contaminated seedlings. Orchard management implications of these results are discussed.

OSU Link
Non-OSU Link

41. Stoehr, M.U., J.E. Webber and R.A. Painter. 1994. Pollen contamination effects on progeny from an off-site Douglas-fir seed orchard. Canadian-Journal-of-Forest-Research 24(10): 2113-2117.

Keywords: genetic tree improvement
seed orchard management
growth
genetic relationships
reproduction

Abstract: The effects of background pollen contamination were evaluated for first-year height growth pattern of seedlings originating from a Douglas fir (Pseudotsuga menziesii) coastal-interior transition zone seed orchard located on southern Vancouver Island, British Columbia. Pollen collected from five stands surrounding the orchard (background pollen) and pollen from five half-sib families of the seed orchard were applied to six individual trees in the orchard. The resulting 60 seed lots were raised outdoors in a coastal-climate nursery with five seed lots collected from wild stands of the transition zone. Heights were measured at 10-day intervals during the growing season. Final heights, maximum height growth rate and growth cessation were subjected to analysis of variance. Growth rate and cessation were derived from data fitted to the logistic growth curve using nonlinear regression analysis. Seedlings sired by the background pollen had significantly greater final heights and growth rates. There were no differences in orchard seedlings in growth cessation probably because all seedlings were exposed to a blackout treatment to force bud set in mid-August. The average final height of wild-stand seedlings from the transition zone was 15% and 21% lower than that of pure orchard seedlings and seedlings sired by the background pollen lots, respectively. Standard deviations for measured traits were similar between orchard seedlings sired by background pollen and orchard pollen. If pollen contamination is not prevented, the faster growing seedlings sired by the background pollen may be preferentially selected during culling in the nursery and outplanted on sites to which they are maladapted.

OSU Link
Non-OSU Link

42. Summers, D. and G.E. Miller. 1986. Experience with systemic insecticides for control of cone and seed insects in Douglas-fir seed orchards in coastal British Columbia, Canada. *In* Proceedings of the 2nd Conference of the Cone and Seed Insects Working Party, Station de Zoologie Forestiere, Olivet, France, September 3-5, 1986. *Ed.* A. Roques. pp. 267-283.

Keywords: seed orchard management
tree/stand protection
tree/stand health
reproduction
stand conditions

Abstract: Three systemic insecticides were screened experimentally, and 2 of them used operationally, against cone and seed insects (especially Contarinia oregonensis, Megastigmus spermotrophus and Barbara colfaxiana), in seed orchards of Douglas fir [Pseudotsuga menziesii] on Vancouver I., British Columbia. Dimethoate, as a foliar spray, controlled the pests and increased the number of filled seeds per cone, making it the recommended choice. Oxydemeton-methyl, as a foliar spray, was as effective as dimethoate in controlling the insects but appeared less effective in increasing the number of filled seeds. Injections of oxydemeton-methyl were less effective than foliar sprays in controlling insect damage. Acephate as a foliar spray was inconsistent in the level of pest control achieved and as an injection gave poor results; its use was also associated with the development of serious outbreaks of Adelges cooleyi [Gilletteella cooleyi].

Non-OSU Link

43. Wang, T., S.N. Aitken, J.H. Woods, K. Polsson and S. Magnussen. 2004. Effects of inbreeding on coastal Douglas fir growth and yield in operational plantations: a model-based approach. Theoretical-and-Applied-Genetics 108(6): 1162-1171.

Keywords: genetic tree improvement
seed orchard management
planting operations
yield

Abstract: In advanced generation seed orchards, tradeoffs exist between genetic gain obtained by selecting the best related individuals for seed orchard populations, and potential losses due to subsequent inbreeding between these individuals. Although inbreeding depression for growth rate is strong in most forest tree species at the individual tree level, the effect of a small proportion of inbreds in seed lots on final stand yield may be less important. The effects of inbreeding on wood production of mature stands cannot be assessed empirically in the short term, thus such effects were simulated for coastal Douglas fir [Pseudotsuga menziesii var. menziesii (Mirb.) Franco] using an individual-tree growth and yield model TASS (Tree and Stand Simulator). The simulations were based on seed set, nursery culling rates, and 10-year-old field test performance for trees resulting from crosses between unrelated individuals and for inbred trees produced through mating between half-sibs, full-sibs, parents and offspring and self-pollination. Results indicate that inclusion of a small proportion of related clones in seed orchards will have relatively low impacts on stand yields due to low probability of related individuals mating, lower probability of producing acceptable seedlings from related matings than from unrelated matings, and a greater probability of competition-induced mortality for slower growing inbred individuals than for outcrossed trees. Thus, competition reduces the losses expected due to inbreeding

depression at harvest, particularly on better sites with higher planting densities and longer rotations. Slightly higher breeding values for related clones than unrelated clones would offset or exceed the effects of inbreeding resulting from related matings. Concerns regarding the maintenance of genetic diversity are more likely to limit inclusion of related clones in orchards than inbreeding depression for final stand yield.

OSU Link
Non-OSU Link

44. Webber, J.E. 1995. Pollen management for intensive seed orchard production. Tree-Physiology 15(7/8): 507-514.

Keywords: seed orchard management
reproduction

Abstract: Artificially increasing pollen supply - supplemental mass pollination (SMP) - to conifer seed orchards has the potential to increase seed yields and improve the genetic worth of seed crops that would otherwise suffer from the detrimental effects of pollen contamination and unbalanced paternal contribution. However, success rates, measured as the proportion of seed fertilized by SMP, have been low. This review examines the concepts underlying SMP and presents data for two SMP field trials [? in British Columbia] with Douglas fir (Pseudotsuga menziesii) and white/Engelmann spruce (Picea glauca, Picea engelmannii). The trial results are discussed with respect to pollen fertility, pollination technique, and competing pollen cloud density. A summary is also given of methods for ensuring the successful handling of pollen ex situ.

OSU Link
Non-OSU Link

45. Webber, J.E. and M. Bonnet-Masimbert. 1993. The response of dehydrated Douglas fir (Pseudotsuga menziesii) pollen to three in vitro viability assays and their relationship to actual fertility. Annales-des-Sciences-Forestieres 50(1): 1-22.

Keywords: seed orchard management
reproduction

Abstract: In vitro viability response of Douglas fir (Pseudotsuga menziesii) pollen stored for various periods (1 to several years) was related to actual seed set. Media effects on germination, leaching time for conductivity and pollen hydration effects for all assays were also studied, and it was found that media type had a significant effect on germination response which, in the time of the test (48 h), appeared to be related to osmotic rather than metabolic effects. Hydrating stored dehydrated pollen for 16 h at 100% RH and 25 degrees C prior to the analysis had a significant effect on improving the response for conductivity and germination, but had no significant effect on respiration. Hydration effects were also apparent on the correlation coefficient (r) using simple linear regression. For unhydrated and hydrated pollen, the r values for assay response and percentage filled seed per cone (%FSPC) were 0.70 and 0.85 for respiration (RESP), -0.36 and -0.86 for percentage leachate conductivity (%COND), and 0.07 and 0.83 for percentage germination (CLASS 1 + 2), respectively. Using non-linear regression models, the coefficient of determination (rsuperscript 2) values for assay response of

unhydrated and hydrated pollen against %FSPC were 0.76 and 0.83 for RESP, and 0.24 and 0.82 for %COND, and 0.61 and 0.84 for CLASS 1 + 2 germination, respectively. The regression equations developed for RESP, %COND and germination can be applied to Douglas fir pollen lots when used for controlled crossing pollinations, but may not result in expected seed set values when the pollen lot is also expected to compete with outcross pollen.

OSU Link
Non-OSU Link

46. Webber, J.E., S.D. Ross, R.P. Pharis and J.N. Owens. 1985. Interaction between gibberellin A4/7 and root-pruning on the reproductive and vegetative process in Douglas-fir. II. Effects on shoot elongation and its relationship to flowering. Canadian-Journal-of-Forest-Research 15(2): 348-353.

Keywords: seed orchard management
reproduction
growth

Abstract: [See FA 45, 3761 and previous paper] Shoot elongation and female flowering response were assessed for gibberellin A4/7 (GA4/7) and root-pruning (RP) treatments applied in 1981 to 9- and 10-yr-old seedlings of families with good- and poor-flowering histories in a seed orchard in British Columbia. In families with a poor-flowering history, stem injections of GA4/7 significantly enhanced elongation of third-whorl terminal shoots but produced no flowering response. In families with a good-flowering history, GA4/7 treatment had no effect on shoot elongation but resulted in a significant increase in seed-cone buds. In contrast, root-pruning significantly retarded shoot growth in families with both good- and poor-flowering histories and was also the single most effective treatment for enhancing flowering. Combined, GA4/7 and RP had a synergistic effect on flowering, and GA4/7 partially overcame the inhibition of shoot growth caused by RP alone. These results are consistent with a hypothesis that exogenous and endogenous gibberellins are used preferentially for vegetative growth processes, with increased flowering occurring only after a threshold concentration of effector gibberellins is reached.

OSU Link
Non-OSU Link

47. Wheeler, N.C. 1987. Effect of paclobutrazol on Douglas fir and loblolly pine. Journal-of-Horticultural-Science 62(1): 101-106.

Keywords: seed orchard management
nursery operations
growth

Abstract: Paclobutrazol (1.0 and 10.0 mg/10 cc pot) significantly reduced the growth of Pseudotsuga menziesii and Pinus taeda seedlings when applied as a soil drench to newly germinated, container-grown trees. Shoot growth was generally inhibited more than root growth. Older trees (3- to 9-year-old) were not affected appreciably by a soil drench or stem injection. Dose response varied significantly among half-sib families for nearly all growth traits. It is suggested that the utility of paclobutrazol as a growth regulating agent in conifer seed orchards appears to be limited, although it may find use in container-grown conifer nurseries.

OSU Link
Non-OSU Link

48. Wheeler, N.C., C.J. Masters, S.C. Cade, S.D. Ross, J.W. Keeley and L.Y. Hsin. 1985. Girdling: an effective and practical treatment for enhancing seed yields in Douglas-fir seed orchards. Canadian-Journal-of-Forest-Research 15(3): 505-510.

Keywords: seed orchard management
reproduction
tree/stand health

Abstract: The results are described of 3 girdling experiments carried out over a period of 12 yr (1972-83) in operational Douglas-fir seed orchards in Washington and Oregon. Saw-cut girdles were superior to band girdles for stimulating a cone crop because they were easier to perform, healed faster, and resulted in lower abortion rates in the stimulated crop. Both annual and biennial saw-cut girdle regimes resulted in improved cone yields relative to untreated controls in 4 successive years. Over that same period of time, cumulative response to annual girdling was greater than to biennial girdling, but in certain response years biennial girdling was best. Girdling had no significant effect on numbers of filled seed per cone, filled seed weight, and germination of existing or stimulated crops. There was some indication that repeated girdling increased abortion rates in existing crops but decreased the rate of abortion in the stimulated crop. The long-term effect of repeated girdling on vegetative health and vigour was minor although wounding by girdling increased the incidence of attack by the sequoia pitch moth (Synathedon sequoiae) and other pests. Fertilizing with calcium nitrate without girdling did not significantly increase cone and pollen production; with girdling it gave significant increases. It is suggested that flower promotion treatments such as girdling probably improve the genetic quality of orchard seed by creating near-random mating conditions and by pre-empting unwanted pollen sources.

OSU Link
Non-OSU Link

49. Woods, J.H. 1989. Stem girdling to increase seed and pollen production of coast Douglas-fir. B.C. Ministry-of-Forests Research-Note 103. iii + 13 p.

Keywords: seed orchard management
reproduction
tree/stand health

Abstract: In studies on Vancouver Island, British Columbia, grafted ramets and seedlings of Douglas fir (Pseudotsuga menziesii) were used to determine the effects of various girdling methods, including complete removal of a band of bark and phloem, opposing partial bands, pruning-saw cuts, aluminium girdling inserts and a single knife cut. Data were collected for 4 yr after treatment on production of seed and pollen cones, tree vigour, girdle wound health and seed characteristics. All treatments appeared to be equally effective in promoting male and female flowering in comparison with ungirdled trees. Treatments did not differ in cone abortion, percentages of filled seeds or seed germination, but there were differences in tree vigour, seed weight and wound healing. A simple knife-cut into the xylem resulted in the least vigour loss and fastest healing. Recommendations are given for girdling procedures using this technique.

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