Tree/Stand Health

1. 2001. Common insects and diseases of interior Douglas-fir. British Columbia Ministry of Forests SIL471. 8 p.

Keywords: tree/stand protection
tree/stand health

Abstract: This field guide provides information on the different pests and diseases of the interior Douglas fir (Pseudotsuga menziesii) in British Columbia which include: defoliating insects (Douglas fir tussock moth, spruce budworm and rusty tussock moth); dwarf mistletoe; foliar diseases (e.g., caused by the Cooley spruce adelgid); bark beetles; root diseases (Armillaria root disease, blackstain root disease, laminated root rot and blackstain root disease); wood decay (caused by bracket or conk fungi); and various abiotic problems (sunscald, drought or frost). A guideline to control infestations of these given pests is also included.

OSU Link
Non-OSU Link

2. Adams, T., T. Anekonda and C. Lomas. 1999. Annual Report 1998-99, Pacific Northwest Tree Improvement Research Cooperative. 33 p.

Keywords: genetic tree improvement
tree/stand protection
tree/stand health
growth
tree physiology

Abstract: Summaries are given of research projects on improvement of Douglas fir [Pseudotsuga menziesii] in the Pacific Northwest: seedling drought physiology; genetics of dark respiration and its relationship with drought hardiness; response of saplings to drought, as measured by growth ring variables; use of microsatellite marker loci to identify pollen contamination in seed orchards; and evaluation of miniaturized seed orchard designs.

OSU Link
Non-OSU Link

3. Aitken, S.N. and W.T. Adams. 1996. Genetics of fall and winter cold hardiness of coastal Douglas-fir in Oregon. Canadian-Journal-of-Forest-Research 26(10): 1828-1837.

Keywords: genetic tree improvement
tree/stand protection
tree/stand health
tree physiology
genetic relationships

Abstract: Genetic variation in autumn cold hardiness was studied in two western Oregon breeding populations of coastal Douglas fir (Pseudotsuga menziesii var. menziesii), one on the west slope of the Cascade Mountains and the other in the Coastal Range. On six sampling dates (September, October and November 1992 and January, September and October 1993), shoot cuttings from 40 open-pollinated families in each of two progeny test sites for each breeding zone were subject to artificial freezing at two test temperatures. Damage in each shoot was recorded as visible injury to needle, stem and bud tissue separately. Considerable family variation was found for cold injury scores in all tissues in early to mid autumn, but differences were often smaller or nonsignificant in late autumn and midwinter. Individual heritability estimates for needle cold injury were low (<0.40) and generally decreased in late autumn and midwinter. Family rankings for autumn cold hardiness, however, are expected to be relatively consistent over sites and years, although needles appear to display more family-by-site interaction than stems or buds. Genetic correlations between tissues in cold injury varied considerably and were sometimes weak, indicating that the evaluation of a single tissue is probably not adequate for assessing overall cold hardiness of genotypes. Autumn and winter cold hardiness seem to be largely under separate genetic control since genetic correlations between hardiness at these two stages were weak. This study confirms earlier results in Washington breeding populations and shows that coastal Douglas fir families can be effectively ranked for autumn cold hardiness by conducting artificial freeze tests on cut shoots in mid-autumn (October) and scoring damage to stems and at least one other tissue.

OSU Link
Non-OSU Link

4. Aitken, S.N. and W.T. Adams. 1997. Spring cold hardiness under strong genetic control in Oregon populations of Pseudotsuga menziesii var. menziesii. Canadian-Journal-of-Forest-Research 27(11): 1773-1780.

Keywords: genetic tree improvement
tree/stand protection
tree/stand health
tree phenology
tree physiology
genetic relationships

Abstract: Genetic variation in spring cold hardiness of shoots prior to bud break was studied in two Oregon breeding populations of Pseudotsuga menziesii var. menziesii, one on the west slope of the Cascade Mountains and the other in the Coast Range. In March and April 1993, and April 1994, shoot cuttings from 40 open-pollinated families in each of two progeny test sites in each breeding zone were subjected to artificial freezing. Visible cold damage to needle, stem, and bud tissues was recorded. Date of bud burst (all sites), and injury resulting from a 1992 natural frost event (one site), were also recorded. Spring cold injury varied widely among families. Individual heritabilities for spring cold injury scores averaged 0.76 in the Coastal zone and 0.42 in the Cascade zone. Genetic correlations among tissues, sites, sampling dates, and years, and between April cold injury and date of bud burst were high, in most cases over 0.80. Correlations were also strong between natural frost damage in 1992 and artificial cold injury scores in 1993. Artificial freeze testing stem tissues of cut shoots sampled in April from a single test site should effectively rank families in this region for spring cold hardiness.

OSU Link
Non-OSU Link

5. Aitken, S.N., W.T. Adams, N. Schermann and L.H. Fuchigami. 1996. Family variation for fall cold hardiness in two Washington populations of coastal Douglas-fir (Pseudotsuga menziesii var. menziesii (Mirb.) Franco). Forest-Ecology-and-Management 80(1/3): 187-195.

Keywords: genetic tree improvement
tree/stand protection
tree/stand health
tree physiology
tree phenology
genetic relationships

Abstract: In order to assess the genetics of autumn (fall) cold hardiness in coastal Douglas fir (Pseudotsuga menziesii var. menziesii), shoot cuttings were collected in October from saplings (9-year-old trees) of open-pollinated families in two progeny tests in each of two breeding zones in Washington, one in the Coast range (80 families) and one on the west slope of the Cascade Mountains (89 families). Samples from over 5500 trees were subjected to artificial freezing and visually evaluated for needle, stem and bud tissue injury. The extent to which cold injury is genetically related to tree height and shoot phenology (timing of bud burst and bud set) was also evaluated. Significant family variation was found for all cold hardiness traits; however, individual heritability estimates were relatively low (ranging from 0.09 to 0.22). Significant family-by-test site interaction was detected for needle injury in the Cascade breeding zone, but not in the coastal zone. Genetic correlations (rA) among needle, stem and bud tissues for cold damage were weak (0.16<less or =>rA<less or =>0.58) indicating that genes controlling autumn cold hardening are somewhat different for different tissues. Timing of bud burst and bud set were only weakly correlated with cold injury (rA<less or =>0.49). Thus, bud phenology is a poor predictor of autumn cold hardiness in this species. There was no consistent relationship between tree height and cold injury in the coastal zone. In the Cascade zone, taller trees appeared to be more susceptible to cold injury, but the association was weak (mean rA=0.38, range 0.20-0.72).

OSU Link
Non-OSU Link

6. Alvarez, I.F. and R.G. Linderman. 1983. Effects of ethylene and fungicide dips during cold storage on root regeneration and survival of western conifers and their mycorrhizal fungi. Canadian-Journal-of-Forest-Research 13(5): 962-971.

Keywords: nursery operations
tree/stand health
mycorrhizal response

Abstract: Survival and growth of Pseudotsuga menziesii, Pinus ponderosa and Abies concolor seedlings, and survival of mycorrhizal fungi on their roots were assessed after cold storage with or without 5 p.p.m. ethylene in combination with 4 root treatments: washed, dipped in Truban [etridiazole] or Benlate sol. or not treated. Ethylene treatment resulted in increased survival, apical bud burst, and new root formation in the greenhouse if roots had not been washed or dipped in fungicide. None of the gas storage or root treatments greatly affected seedling survival in the field. Root washing decreased seedling vigour, especially in fir. None of the root treatments or gas storage conditions affected root fungal populations; bacterial and actinomycete populations appeared to be affected and the response varied according to host species. Pisolithus tinctorius, which formed mycorrhizae with 10-20% of the

short roots of the seedlings, did not survive cold storage. Thelephora spp. and an ectendomycorrhizal fungus both survived cold storage and rapidly colonized roots newly formed on seedlings planted after cold storage.

OSU Link
Non-OSU Link

7. Alvarez, I.F. and J.M. Trappe. 1983a. Dusting roots of Abies concolor and other conifers with Pisolithus tinctorius spores at outplanting time proves ineffective. Canadian-Journal-of-Forest-Research 13(5): 1021-1023.

Keywords: planting operations
site preparation
mechanical preparation
growth
tree/stand health
mycorrhizal response

Abstract: Dusting roots of Abies concolor, Abies magnifica var. shastensis, Pseudotsuga menziesii and Pinus ponderosa with Pisolithus tinctorius (Pt) spores when planted out produced no Pt mycorrhizae at the end of the first growing season. In the 3rd yr occasional Pt mycorrhizae had formed on A. concolor. Inoculations reduced seedling survival in some cases. High rates of spore application may have desiccated roots of the true firs and spore amounts applied need careful attention. Soil scarification and ripping significantly promoted growth of A. concolor seedlings compared with scarification alone.

OSU Link
Non-OSU Link

8. Amaranthus, M.P. and D.A. Perry. 1987. Effect of soil transfer on ectomycorrhiza formation and the survival and growth of conifer seedlings on old, nonreforested clear-cuts. Canadian-Journal-of-Forest-Research 17(8): 944-950.

Keywords: planting operations
tree/stand health
growth
mycorrhizal response

Abstract: Small amounts (150 ml) of soil from established conifer plantations and mature forest were transferred to planting holes on 3 sites in the Klamath Mts., S. Oregon and N. California. The sites had been clear felled and burned 8-27 yr earlier and unsuccessfully reforested. At Cedar Camp, a high alt. (1720 m) southerly slope with sandy soil, transfer of soil from a Douglas fir plantation increased first-yr survival of Douglas fir seedlings by 50%, mycorrhizal formation and b.a. growth. Soil from mature forest did not enhance survival and growth. Soil transfer was less effective on 2 sites at lower alt. with clayey soils. Douglas fir seedlings at Crazy Peak showed similar, but less well defined, patterns to those at Cedar Camp. All Pinus lambertiana seedlings at Wood Creek survived well and were generally unaffected by soil transfer. Results suggest that adequate mycorrhizal formation is critical to seedling growth and

survival on cold, droughty sites. Transfer of soil from a suitable source may offset the decline in native mycorrhizal fungi if reforestation is delayed.

OSU Link
Non-OSU Link

9. Amaranthus, M.P. and D.A. Perry. 1989a. Interaction effects of vegetation type and Pacific madrone soil inocula on survival, growth and mycorrhiza formation of Douglas-fir. Canadian-Journal-of-Forest-Research 19(5): 550-556.

Keywords: planting operations
growth
tree/stand health
mycorrhizal response

Abstract: One-yr-old non-mycorrhizal Douglas fir (Pseudotsuga menziesii) seedlings were planted in 1985 in cleared blocks within 3 adjacent vegetation types in SW Oregon, viz., whiteleaf manzanita (Arctostaphylos viscida), annual grass meadow, and an open stand of Oregon white oak (Quercus garryana). Within subplots in each block, either pasteurized or unpasteurized soil from a nearby Pacific madrone (Arbutus menziesii) stand was transferred to the planting holes of the seedlings; control seedlings received no madrone soil. Second-year survival averaged 92, 43 and 12% for seedlings planted on the manzanita, meadow and oak sites, respectively. Growth differences generally paralleled survival differences. Added madrone soil, whether pasteurized or unpasteurized, did not influence survival. Unpasteurized madrone soil substantially increased the growth of seedlings on the manzanita site, but not in the meadow or oak stand. Pasteurized madrone soil did not affect growth in any of the vegetation types. Unpasteurized madrone soil nearly tripled the number of mycorrhizal root tips forming on seedlings and resulted in formation of a new mycorrhiza type on the manzanita site, although it had little or no effect on the meadow or oak sites. These results suggest that manzanita and madrone impose a biological pattern on soils that stimulates Douglas fir growth and survival, and support results of other studies indicating that root symbionts and rhizosphere organisms mediate interactions among plant species.

OSU Link
Non-OSU Link

10. Amaranthus, M.P. and D.A. Perry. 1989b. Rapid root tip and mycorrhiza formation and increased survival of Douglas-fir seedlings after soil transfer. New-Forests 3(3): 259-264.

Keywords: planting operations
mycorrhizal response
root development
tree/stand health

Abstract: In order to re-inoculate soil with mycorrhizal fungi, small amounts (about 150 ml) of soil from an established Douglas fir (Pseudotsuga menziesii) plantation were added to planting holes when Douglas fir seedlings were planted on an old, unrevegetated clearcut in
the Klamath Mountains of Oregon. Seedlings were lifted throughout the growing season to determine

the influence of soil transfer on the rate of root tip initiation and mycorrhiza formation. Six weeks after planting, seedlings receiving plantation soil had formed 62% more root tips than controls; however, no statistically significant differences were apparent 15 weeks after planting. By that time, a small percentage of root tips were visibly mycorrhizal; seedlings receiving transferred soil had the most colonization (13.6 vs. 3.5 per seedling, p <less or =>0.05). Of seedlings receiving transfer soil, 36.6% survived the first growing season, compared to 11.3% of control seedlings. At this high altitude, soils often remain frozen well into spring, leaving only a brief period between the time when soils become warm enough for root growth and the onset of summer drought. Under these conditions, the rapid root growth and mycorrhiza formation stimulated by plantation soil increases the ability of seedlings to survive the first growing season.

OSU Link
Non-OSU Link

11. Anekonda, T.S., M.C. Lomas, W.T. Adams, K.L. Kavanagh and S.N. Aitken. 2002. Genetic variation in drought hardiness of coastal Douglas-fir seedlings from British Columbia. Canadian-Journal-of-Forest-Research 32(10): 1701-1716.

Keywords: genetic tree improvement
tree/stand protection
growth
tree/stand health
genetic relationships
tree physiology

Abstract: Genetic variation in drought hardiness traits and their genetic correlations with growth potential and recovery traits were investigated in 39 full-sib families of coastal Douglas-fir (Pseudotsuga menziesii var. menziesii) from southwestern British Columbia, Canada. Seedlings of these families were grown in raised nursery beds and subjected to three moisture regimes each in the second (well-watered or control, mild, and moderate drought) and third (control, severe drought, and recovery from second-year moderate drought) seasons. Traits assessed included drought hardiness (foliage damage, cavitation of xylem tracheids, xylem hydraulic conductivity, and height and diameter growth increment) in the drought treatments, growth potential (total height and diameter) in the control treatment, and height and diameter growth increments in the recovery treatment. Xylem cavitation in the growth ring produced in a particular year was nearly three times greater under the moderate drought and four times greater under the severe drought than in the control treatment. Xylem hydraulic conductivity of seedlings in the severe drought treatment was 40% lower than conductivity of seedlings under the control treatment. Mean foliage damage in seedlings subjected to severe drought (third season) was much greater (33%) than in seedlings subjected to mild or moderate drought (second season). Families differed significantly in most drought hardiness traits, with individual tree heritabilities averaging 0.19. Thus, much potential exists for identifying drought-hardy families at the seedling stage and using this information for deployment or breeding purposes. In addition, most hardiness traits were strongly intercorrelated (genetic correlations often exceeded |0.80|) indicating that these traits are controlled largely by the same set of genes and that selection for hardiness based on one trait will increase hardiness as reflected in the other traits as well. Genetic correlations were only moderate (0.49) between hardiness traits measured in different years, perhaps due to the large difference in severity of the drought applied in the two seasons. Although injury to seedlings, as reflected in foliage damage and xylem cavitation, was relatively low under the moderate drought of the second season, it did result in

reduced growth increment the following (recovery) year. Growth potential under favourable moisture regimes was nearly uncorrelated with drought hardiness, suggesting that drought hardiness could be improved in this southwestern British Columbia breeding population without negatively impacting growth potential in favourable moisture conditions.

OSU Link
Non-OSU Link

12. Antonelli, A.L. and R.L. Campbell. 1991. Cooley spruce gall aphid. College of Agriculture and Home Economics, Washington State University. Extension Bulletin EB0966: 2 p.

Keywords: tree/stand protection
tree/stand health

Abstract: Notes are provided on the biology, injuriousness and chemical control (carbaryl and endosulfan are suggested) of Adelges cooleyi [Gilletteella cooleyi] on certain coniferous trees [including Picea sitchensis, P. engelmannii, P. pungens and Pseudotsuga menziesii] inWashington State.

OSU Link
Non-OSU Link

13. Arnott, J.T. and D. Beddows. 1982. Influence of Styroblock container size on field performance of Douglas-fir, western hemlock, and Sitka spruce. Tree Planters' Notes 33(3): 31-34.

Keywords: nursery operations
growth
tree/stand health

Abstract: Pseudotsuga menziesii, Tsuga heterophylla and Picea sitchensis seeds were sown in April 1971 in BC/CFS Styroblocks sizes 2 and 8 with volumes of 40 and 125 cmsuperscript 3 respectively. The seedlings in the larger containers were kept in a heated greenhouse for 2-3 months to stimulate growth to fill the containers, before joining those in the smaller containers in an outdoor shadehouse nursery. Seedlings were planted out in British Columbia in March 1972. A second trial was started in April 1972 and seedlings planted out in April 1973. Survival and ht. growth were recorded for 5 growing seasons. The larger containers produced larger seedlings at planting. There were n.s.d. in survival of seedlings grown in the different sized containers for all 3 species. The seedlings grown in the larger containers were significantly taller after the first growing season in the field, a difference which persisted for the 5 seasons. Growing seedlings in the larger containers was more expensive and the seedlings took longer to plant than those grown in the smaller containers.

OSU Link
Non-OSU Link

14. Arnott, J.T. and F.T. Pendl. 1994. Field performance of several tree species and stock types planted in montane forests of coastal British Columbia. Canadian-Forest-Service, Pacific and Yukon Region Information Report BC-X-347. viii + 45 p.

Keywords: nursery operations
planting operations
growth
tree/stand health
wood quality

Abstract: Planting trials were established at sites within the Mountain Hemlock and montane Coastal Western Hemlock biogeoclimatic zones. Six test areas were chosen within each zone. Amabilis fir (Abies amabilis), noble fir (A. procera), yellow cedar (Chamaecyparis nootkatensis) and mountain hemlock (Tsuga mertensiana) were the species selected for planting in the Mountain Hemlock zone. In addition to Abies amabilis and A. procera, western white pine (Pinus monticola), western redcedar (Thuja plicata), Douglas fir (Pseudotsuga menziesii) and western hemlock (Tsuga heterophylla) were planted in the Coastal Western Hemlock zone. Plug (PSB 211), plug transplant and bareroot stock types were used for the eight species across both zones. Seedlings were planted during the autumn (September/October) and spring (May) in each of two successive years: 1978-79 and 1979-80. Survival, growth and tree form 13 years after planting were used as indicators of the reliability (a combination of tree survival and form) and productivity of the planting treatment combinations. Noble fir and amabilis fir were the most reliable species in the Mountain Hemlock zone; i.e. these species have average survival rates higher than 80% and few form defects. Yellow cedar crowns were badly broken by snow, which reduced the reliability of this species in the early years of plantation establishment. The growth, survival and form of mountain hemlock ranked between that of the true firs and yellow cedar. Noble fir was by far the most productive species in the Mountain Hemlock zone. Within the Coastal Western Hemlock zone no single species demonstrated a superior combination of productivity or reliability. Douglas fir, western hemlock and western redcedar were good species in the lower elevations of the zone, whereas noble fir and amabilis fir were better species at the upper elevational limits of the zone. Western white pines should be avoided until rust-resistant seed sources are available. Little variation was found among the three planting stock options and even less between the two planting seasons. Plug transplant stock was more reliable than bareroot or plug stock; productivity ranked from greatest to least in the following order within both zones: plug transplant, bareroot and plug stock. This ranking among stock types may well change as different stock types are developed. However, the relative size and design differences among stock types, no matter when they become available, will always have an effect on the ultimate reliability and productivity of planted trees. Autumn planting gave significantly lower survival in the Coastal Western Hemlock zone only.

OSU Link
Non-OSU Link

15. Axelrood, P.E., W.K. Chapman, K.A. Seifert, D.B. Trotter and G. Shrimpton. 1998. Cylindrocarpon and Fusarium root colonization of Douglas-fir seedlings from British Columbia reforestation sites. Canadian Journal of Forest Research 28:1198-1206.

Keywords: planting operations
tree/stand protection
tree/stand health

Abstract: Poor performance of Douglas fir (Pseudotsuga menziesii) plantations established in 1987 has occurred in southwestern British Columbia. Affected sites were planted with 1-yr-old container stock that exhibited some root dieback in the nursery. A study was initiated in 1991 to assess Cylindrocarpon

and Fusarium root infection in planted and naturally regenerating (natural) Douglas fir seedlings from 7 affected plantations. Percentages of seedlings harbouring Cylindrocarpon spp. and percentage root colonization were significantly greater for planted seedlings than natural seedlings. A significant linear trend in Cylindrocarpon root colonization was observed for planted seedlings with colonization levels being highest for roots closest to the remnants of the root plug and decreasing at distances greater than 10 cm from that region. This trend in Cylindrocarpon colonization was not observed for natural seedlings. Cylindrocarpon destructans var. destructans [Nectria radicola var., radicola] and C. cylindroides var. cylindroides were the only species isolated from planted and natural conifer seedlings. For most sites, percentage of seedlings harbouring Fusarium spp. and percentage Fusarium root colonization were less than for Cylindrocarpon. Recovery of Fusarium spp. from seedlings and root colonization levels were not significantly different for planted and natural seedlings from all sites.

OSU Link
Non-OSU Link

16. Axelrood, P.E., M. Neumann, D. Trotter, R. Radley, G. Shrimpton and J. Dennis. 1995. Seedborne Fusarium on Douglas-fir: pathogenicity and seed stratification method to decrease Fusarium contamination. New-Forests 9(1): 35-51.

Keywords: nursery operations
tree/stand protection
tree/stand health
growth

Abstract: Twelve Douglas-fir (Pseudotsuga menziesii) seedlots from coastal British Columbia were assayed for seedborne Fusarium; all of the seedlots were contaminated. The percentage of non-stratified seeds from individual seedlots harbouring Fusarium ranged from 0.3 to 95.4. Sixty-seven percent of the seedlots had Fusarium on less than 2% of the seeds. Post-stratification seedborne Fusarium levels were significantly less for running water imbibition compared with standing water imbibition. However, seedling growth at a container nursery was not consistently different for stratified seed imbibed initially in standing or running water. Fusarium disease symptoms were not observed in the nursery environment. The species of Fusarium isolated from seed were F. acuminatum [Gibberella acuminata], F. avenaceum [G. avenacea], F. lateritium [G. baccata], F. moniliforme [G. fujikuroi], F. oxysporum, F. poae and F. sambucinum [G. pulicaris]. Twelve Fusarium isolates, comprising 6 species, were assessed for pathogenicity. Disease symptoms were observed after 4 weeks incubation and Fusarium isolates ranged in virulence from low to high. Fusarium oxysporum isolates were the most pathogenic.

OSU Link
Non-OSU Link

17. Axelrood, P.E. and R. Radley. 1991. Biological control of Fusarium on Douglas-fir seedlings. Bulletin-SROP 14(8): 85-87.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: A bacterial culture collection was established from the rhizosphere and rhizoplane of Douglas fir (Pseudotsuga menziesii) seedlings collected from nursery and forest locations in British Columbia, Canada. Of the 2000 strains screened, 350 inhibited growth of at least 1 conifer seedling root pathogen (Fusarium, Cylindrocarpon or Pythium) in in vitro antibiosis assays. A total of 96 strains were screened for Fusarium disease control in biological control assays. One strain that inhibited all 3 pathogens in vitro was able to significantly reduce the incidence of disease caused by Fusarium on P. menziesii seedlings. Another strain that tested negative in in vitro antibiosis assays also reduced the disease incidence by a similar amount. This paper was presented at the Second international workshop on plant growth-promoting rhizobacteria - progress and prospects, held in Interlaken, Switzerland, Oct. 14-19, 1990.

18. Barclay, H.J. and H. Brix. 1984. Effects of urea and ammonium nitrate fertilizer on growth of a young thinned and unthinned Douglas-fir stand. Canadian-Journal-of-Forest-Research 14(6): 952-955.

Keywords: fertilization
thinning
growth
tree physiology
tree/stand health

Abstract: The effects were studied of 2 sources of nitrogen fertilizer applied at rates of 224 and 448 kg/ha N on growth of thinned and unthinned plots established in 1970 in a 24-yr-old stand on southern Vancouver Is., British Columbia. Ammonium nitrate yielded higher growth of diam. and vol. than urea over a 9-yr period, particularly with thinning. Ht. growth was not affected by nitrogen source. The efficiency of nitrogen fertilizing in terms of stem vol. response per kilogram of nitrogen applied was greatest with ammonium nitrate in thinned plots. Tree mortality increased substantially with fertilizing for both sources, and decreased markedly with thinning.

OSU Link
Non-OSU Link

19. Barclay, H.J. and H. Brix. 1985a. Effects of high levels of fertilization with urea on growth of thinned and unthinned Douglas-fir stands. Canadian-Journal-of-Forest-Research 15(4): 730-733.

Keywords: fertilization
thinning
growth
tree physiology
tree/stand health

Abstract: Diameter height and volume growth were documented for 9 yr after thinning and fertilizing in a 24-yr-old stand on a poor site on southern Vancouver Is. The treatments involved 3 thinning treatments (0, 1/3, and 2/3 b.a. removed) and 6 fertilizer treatments (0-1344 kg/ha N) with urea. Increments for both diameter and gross volume increased with the rate of fertilizer application and responses were still apparent 9 yr after treatment. For unthinned plots, the 9-yr volume growth responses were 30, 50, and 80% with fertilizer rates of 224, 448, and 896 kg/ha N, respectively. The efficiency of fertilizer use, measured as stem volume response per unit of nitrogen applied, decreased

with rate of fertilizer application, but this result may change over a longer response period. There was a positive interaction between fertilizing and thinning such that high amounts of both mutually enhanced growth. Mortality increased with fertilizing, but only noticeably in unthinned plots.

OSU Link
Non-OSU Link

20. Barclay, H.J. and C.R. Layton. 1990. Growth and mortality in managed Douglas fir: relation to a competition index. Forest-Ecology-and-Management 36(2-4): 187-204.

Keywords: fertilization
thinning
growth
tree/stand health

Abstract: Twelve-year increments of diameter at breast height (DBH), height, and volume in thinned and fertilized 45-year-old Douglas fir (Pseudotsuga menziesii) stands on Vancouver Island, Canada, were related (by regression) to degree of thinning, amount of fertilizer (3x3 factorial), initial DBH, and a competitive stress index (CSI). The ability of the CSI to predict growth after treatment was examined. Causes of tree death, and CSI data, are presented, and the relationship between them discussed. The CSI was found to be only moderately good at predicting Douglas fir growth and mortality: initial DBH provided a better predictor. Most mortality in unthinned plots resulted from suppression, and correlated reasonably well with CSI; mortality in thinned plots was not correlated with CSI, and resulted principally from snow damage. Tree height variability generally became less over the 12 years following treatment, which is more consistent with two-sided than one-sided competition predictions, a result which is contrasted to that of many other species.

OSU Link
Non-OSU Link

21. Belz, D. and T.E. Nishimura. 1989. Effects of imazapyr, 2,4-D and metsulfuron methyl on conifer tolerance. Proceedings-of-the-Western-Society-of-Weed-Science (Vol. 42): 98-104.

Keywords: site preparation
chemical preparation
release treatments
chemical release
tree/stand health

Abstract: Imazapyr at 0.25-1.0 lb/acre alone or 0.5 lb/acre in combination with 2,4-D 2 lb/acre or metsulfuron 0.3 lb/acre was evaluated for effect on growth and injury to Pseudotsuga menziesii, Pinus ponderosa, Tsuga heterophylla and Abies amabilis seedlings in thePacific Northwest region. Applications were made at 4 times: 3 month pre-planting in Dec., as buds began to swell in Mar., during the spring flush of growth in May, and after bud set in Aug. The effect of different application rates was of less significance than their timings. Application during active growth gave unacceptable injury levels; pre-planting caused least injury, but autumn treatment was acceptable for tolerant species. Species tolerance was in the order Pinus ponderosa > Pseudotsuga menziesii > T. heterophylla > A. amabilis.

OSU Link
Non-OSU Link

22. Bettinger, P., K.A. Bettinger and K. Boston. 1998. Correlation among spatial and non-spatial variables describing a cut-to-length thinning site in the Pacific Northwest, USA. Forest-Ecology-and-Management 104(1/3): 139-149.

Keywords: thinning
commercial thinning
tree/stand health

Abstract: Variables describing the pre- and post-logging conditions of a thinning site in 47-yr-old naturally regenerated stand of second-growth Douglas fir (Pseudotsuga menziesii) and western hemlock (Tsuga heterophylla) in western Oregon, were examined for correlation, and subsequently used to develop models to estimate residual stand damage levels. A cut-to-length harvesting system was utilized to perform the thinning operation, which used a single-grip harvester and a forwarder, and marked logging trails. Several of the variables were measured in an intensive field survey; other variables were developed using geographic information system (GIS) processes. An analysis of correlations among the site variables showed several obvious, and a few interesting, results that describe the operation. Most of the variables provided negative, or inconclusive, assistance in describing the variation in stand damage levels. Only one variable, the number of original trees/hectare, was significantly correlated with residual stand damage levels, and was represented in the models that were developed to estimate residual stand damage levels. The resulting models are of limited practical value, however, since they explain little of the variability in damage levels. Most of the variation in residual stand damage levels may well be explained by random chance, operator error, other unmeasured operational variables associated with this harvesting system, or interactions among variables. The main conclusion from the study is that although both spatial and non-spatial data were utilized in describing the logging operation and in developing models to estimate stand damage levels, the importance of using spatial data was inconclusive.

OSU Link
Non-OSU Link

23. Bettinger, P. and L.D. Kellogg. 1993. Residual stand damage from cut-to-length thinning of second-growth timber in the Cascade Range of western Oregon. Forest-Products-Journal 43(11/12): 59-64.

Keywords: thinning
commercial thinning
tree/stand health

Abstract: Residual stand damage was measured on 25% of an area that had been thinned with a cut-to-length logging system. Total damage (scar area) per acre was less than in any similar study in the Pacific Northwest, although 39.8% of the residual trees sustained some damage. Only 0.8% of the trees, however, sustained significant damage. Western hemlock (Tsuga heterophylla) was more susceptible to damage than Douglas fir (Pseudotsuga menziesii). Most of the damage occurred within 15 feet of a trail centreline and originated within 3 feet of the groundline. Early summer logging may have resulted in

more damaged trees than might occur during other seasons. Future volume loss due to decay is likely to be minimal because a low percentage of scars were considered vulnerable to wood-decaying fungi.

OSU Link
Non-OSU Link

24. Binkley, D. 1984. Importance of size-density relationships in mixed stands of Douglas-fir and red alder. Forest-Ecology-and-Management 9(2): 81-85.

Keywords: thinning
growth
tree/stand health

Abstract: Pairs of Douglas-fir, and Douglas-fir and red alder (Alnus rubra) stands were examined at four locations (in Oregon, Washington and British Columbia) for patterns in average tree size as a function of stand density. On fertile sites, the mixed stands experienced higher mortality than the pure conifer stands. On infertile sites, the pure conifer stands were well below the maximum tree size and density relationship compared to fertile sites or mixed stands, suggesting under-utilized site resources were available for nitrogen-fixing alder.

OSU Link
Non-OSU Link

25. Birchler, T.M., R. Rose and D.L. Haase. 2001. Fall fertilization with N and K: effects on Douglas-fir seedling quality and performance. Western-Journal-of-Applied-Forestry 16(2): 71-79.

Keywords: nursery operations
nursery fertilization
growth
tree physiology
tree morphology
tree/stand health

Abstract: Coastal Douglas fir (Pseudotsuga menziesii) 1+1 seedlings from coastal Oregon, USA, were applied with two fertilizers (NH4NO3+K2SO4 and (NH4)2SO4+KCl) at four rates (0, 80, 160, 320 kg N and K/ha) split over three application dates (September 19, October 13, November 1, 1996). Fertilizer type did not affect total Kjeldahl nitrogen (TKN) levels on any of the sampling dates. By January 10, TKN concentrations had increased 16, 30 and 34%, and chloride concentrations had increased 57, 77 and 112% relative to the seedlings without fertilizer, for 80, 160 and 320 kg N+K/ha treatments, respectively. Nitrate levels increased briefly after the first application of NH4NO3+K2SO4. Potassium levels remained relatively unchanged. Levels of most other nutrients, as well as foliar dry weight, increased between September 16 and January 10, but these increases were generally unrelated to the fertilizer treatments. Root growth potential and cold hardiness did not differ among treatments. Seedlings that received 160 or 320 kg N/ha broke bud an average of 3 days earlier than the seedlings without fertilizer. Chlorophyll fluorescence (Fv/Fm) of seedlings with fertilizer was consistently higher than that of seedlings without fertilizer on November 13 and December 30. These treatment differences were not reflected in seedling outplanting performance after one growing season.

OSU Link
Non-OSU Link

26. Blake, J.I., R. Linderman and D. Lavender. 1988b. Seedling vigor of Douglas fir and western hemlock in relation to ethylene exposure levels and ethane production during cold storage. *In* Proceedings: 10th North American Forest Biology Workshop, 'Physiology and genetics of reforestation', University of British Columbia, Vancouver, British Columbia, July 10-22, 1988. *Eds.* J. Worrall, J. Loo-Dinkins and D.P. Lester. pp. 235-242.

Keywords: nursery operations
tree morphology
tree phenology
tree/stand health

Abstract: The effects were examined of ethylene treatment on Pseudotsuga menziesii and Tsuga heterophylla 2-yr-old bare root seedlings lifted in October or December (in a nursery in Washington) and stored for 2 and 7 days. Seedlings exposed to 0.5 p.p.m. ethylene at +1 degrees C for 7 days exhibited reduced bud and root activity. These effects were apparently reversed at 5.0 p.p.m. In a second experiment, reducing ethylene concentrations with KMnO4 during storage at +1 or +10 degrees C for 30 days did not affect foliage colour, but root and bud activity were generally enhanced. Ethylene concentrations in control bags ranged from 0.80 to 2.24 p.p.m. in October-lifted seedling bags and from 0.10 to 1.3 p.p.m. in December-lifted samples. The quantity of ethane in stored bags of P. menziesii seedlings was closely related to an increase in foliage discoloration. Little or no ethane was measured in T. heterophylla storage bags.

Non-OSU Link

27. Blake, J.I. and R.G. Linderman. 1992. A note on root development, bud activity, and survival of Douglas-fir, and survival of western hemlock and noble-fir seedlings, following exposure to ethylene during cold storage. Canadian-Journal-of-Forest-Research 22(8): 1195-1200.

Keywords: nursery operations
tree morphology
tree phenology
tree/stand health

Abstract: Three cold storage experiments were conducted with bare-root (2+0) Douglas fir (Pseudotsuga menziesii) seedlings from coastal Oregon and eastern Washington Cascade sources. The objectives were to determine the effects of ethylene at ambient and below-ambient (absorbed by KMnO4 pellets) concentrations, and at 0.5 and 5 p.p.m. ethylene, during short-term storage on subsequent root development and bud activity, and to relate these results to survival in the field at sites in Washington and Oregon, after prolonged cold storage. Root numbers and lengths were measured 28 days after a 7-day storage period after lifting seedlings on 27 September and 1 December. In the coastal source, root numbers and lengths in the 5 p.p.m. ethylene treatment were, respectively, 46 and 49% greater in September, and 22 and 13% greater in December, than the controls. No comparable treatment effects were found for the Cascade source. Neither the KMnO4 nor the 0.5 p.p.m. ethylene treatments affected root development in either seed source. For terminal buds in the controls, the number of days to 50% bud break was increased 2-8 days by a 30-day cold storage period compared with a 7-day period. For the

coastal source, no increase in the time to 50% bud break was observed in the 5 p.p.m. ethylene treatment. Seedling survival was evaluated in the field for the same treatments following 4 months cold storage for the Douglas fir sources, coastal western hemlock (Tsuga heterophylla), and noble fir (Abies procera). Survival for the 5 p.p.m. ethylene treatment compared with the control was increased by 55% in the coastal Douglas fir source and by 13% in western hemlock. These results suggest that stimulated root development and bud activity may be partially responsible for the observed survival increase following cold storage at elevated ethylene levels.

OSU Link
Non-OSU Link

28. Bledsoe, C.S. and R.J. Zasoski. 1983. Effects of ammonium and nitrate on growth and nitrogen uptake by mycorrhizal Douglas-fir seedlings. *In* Tree root systems and their mycorrhizas. *Ed.* D. Atkinson. pp. 445-454.

Keywords: nursery operations
nursery fertilization
growth
tree physiology
tree morphology
tree/stand health

Abstract: In a greenhouse pot study, 1-yr-old mycorrhizal (inoculated with Hebeloma crustuliniforme) and non-mycorrhizal Douglas fir seedlings were grown in sandy forest soil amended with 10% of clay minerals (bentonite and/or kaolinite) and ammonium or nitrate fertilizer. Ht. growth, root and shoot DM and accumulation of nitrogen and P were greater in mycorrhizal than non-mycorrhizal seedlings, especially in the nitrate treatment. Ammonium interacted with kaolinite to reduce survival which again was poorer in the absence of mycorrhiza.

OSU Link
Non-OSU Link

29. Bloomberg, W.J. 1988. Modeling control strategies for laminated root rot in managed Douglas-fir stands: model development. Phytopathology 78(4): 403-409.

Keywords: planting operations
site preparation
mechanical preparation
tree/stand protection
tree/stand health

Abstract: A model of laminated root rot caused by Phellinus [Inonotus] weirii was developed to assess potential control strategies in managed Pseudotsuga menziesii stands. The model mimicked key processes in disease initiation and development quantified as functions of time and space. These processes were horizontal and vertical tree root distribution, root contact with inoculum and among root systems, spread of mycelium through root systems, root decay, reduction of diam. growth in infected trees, tree mortality and persistence of inoculum in roots of stumps and killed trees. The

processes were expressed as mathematical functions which were integrated in a computer program to calculate spread of the disease and stand-growth loss and mortality. Data for quantification of functions were obtained by experiments and from the literature. Simulated control practices included infected stump removal, sanitation fellings and mixed planting of Douglas fir and resistant species. Accuracy of the model was tested by comparing calculated disease spread and mortality with the following data: (1) spread and damage in two 60-yr-old, 1-ha stands in Oregon, (2) results from a statistically based model for spread and damage that had performed satisfactorily, and (3) observed spread and damage behaviour in stands of different ages and growth rates. Results from the model compared favourably with all of the above situations.

OSU Link
Non-OSU Link

30. Bloomberg, W.J. and G. Reynolds. 1988. Equipment trials for uprooting root-rot-infected stumps. Western-Journal-of-Applied-Forestry 3(3): 80-82.

Keywords: site preparation
mechanical preparation
tree/stand protection
tree/stand health

Abstract: Residual roots from Douglas fir (Pseudotsuga menziesii) and western hemlock (Tsuga heterophylla) were measured following stump-root extraction one yr after harvesting a 55-yr-old, 314 stems/ha, 47% Douglas fir, 17% maple (Acer macrophyllum), 16% red cedar (Thuja plicata), 6% western hemlock stand with 20% infection by Phellinus weirii in the Cowichan valley, Vancouver Island, Canada. Extraction was by a Caterpillar D8H with brush-clearing blade, a 180-hp backhoe or a 115-hp backhoe. All 3 machines recovered more than 90% of root vol. The small backhoe left significantly greater numbers and lengths of root residues per msuperscript 3 soil, though the vol. of residues was greatest for the Caterpillar. An earlier study suggested that a root density of 32 roots/msuperscript 3 was needed to produce one root contact; as the least efficient treatment by the Caterpillar left 23.2 roots/msuperscript 3 in the ground, it is suggested that this would provide insufficient contacts with a new tree crop to transmit infection.

OSU Link
Non-OSU Link

31. Brand, D.G. 1986a. A competition index for predicting the vigour of planted Douglas-fir in southwestern British Columbia. Canadian-Journal-of-Forest-Research 16(1): 23-29.

Keywords: planting operations
tree/stand health
growth

Abstract: As a method of quantifying brush competition, data from 124 planted Douglas firs, age 1-5 yr, were used to derive a competition index to predict changes in tree vigour measured as a relative production rate. The index, which includes measures of brush proximity, relative ht. and % ground cover, appears to act as a measure of light interception around the tree crown. Tree vigour was found to

be largely a function of the age of the tree from planting and the competition index. Foliage-based measures of growth vigour were related more strongly to the index than measures of b.a. or ht. The index has potential for assessing interspecific competition problems on suitable sites. Caution must be used in extrapolating results outside Douglas fir plantations on moist rich sites in coastal BC.

OSU Link
Non-OSU Link

32. Brandeis, T.J., M. Newton and E.C. Cole. 2001. Underplanted conifer seedling survival and growth in thinned Douglas-fir stands. Canadian-Journal-of-Forest-Research 31(2): 302-312.

Keywords: planting operations
thinning
commercial thinning
site preparation
chemical preparation
release treatments
chemical release
growth
tree/stand health
regeneration

Abstract: In a multilevel study conducted at the Oregon State University's McDonald-Dunn Research Forest, Oregon, USA, to determine limits to underplanted conifer seedling growth, Douglas-fir (Pseudotsuga menziesii), grand fir (Abies grandis), western redcedar (Thuja plicata) and western hemlock (Tsuga heterophylla) seedlings were planted in January 1993 beneath second-growth Douglas-fir stands that had been thinned in 1992 to basal areas ranging from 16 to 31 m2/ha. Understorey vegetation was treated with a broadcast herbicide (glyphosate + imazapyr) application prior to thinning, a directed release herbicide (glyphosate, plus triclopyr for tolerant woody stems) application 2 years later, or no treatment beyond harvest disturbance. Residual overstorey density was negatively correlated with percent survival for all four species. Broadcast herbicide application improved survival of grand fir and western hemlock. Western redcedar, grand fir and western hemlock stem volumes were inversely related to overstorey tree density and this effect increased over time. There was a strong indication that this was also the case for Douglas-fir. Reduction of competing understorey vegetation resulted in larger fourth-year stem volumes in grand fir and western hemlock.

OSU Link
Non-OSU Link

33. Brandeis, T.J., M. Newton and E.C. Cole. 2002. Biotic injuries on conifer seedlings planted in forest understory environments. New Forests 24:1-14.

Keywords: planting operations
site preparation
chemical preparation
release treatments
chemical release

thinning
tree/stand protection
growth
tree/stand health

Abstract: The effects of partial overstorey retention, understorey vegetation management, and protective Vexar(R) tubing on the frequency and severity of biotic injuries in a two-storied stand underplanted with western redcedar (Thuja plicata), Douglas-fir (Pseudotsuga menziesii), grand fir (Abies grandis), and western hemlock (Tsuga heterophylla) were investigated. The most prevalent source of damage was browsing by black-tailed deer (Odocoileus hemionis columbiana); deer browsed over 74% of Douglas-fir and over 36% of western redcedar seedlings one or more times over the four years of this study. Neither the spatial pattern of thinning (even or uneven) nor the density of residual overstorey affected browsing frequency. Spraying subplots may have slightly increased browsing frequency, but the resulting reduction of the adjacent understorey vegetation increased the volume of all seedlings by 13%, whether or not they were browsed. Vexar(R) tubing did not substantially affect seedling survival, browsing damage frequency, or fourth-year volume. Greater levels of overstorey retention reduced frequency of second flushing. Chafing by deer and girdling by rodents and other small mammals began once seedlings surpassed 1 m in height. Essentially all grand fir seedlings exhibited a foliar fungus infection.

OSU Link
Non-OSU Link

34. Brix, H. 1993. Fertilization and thinning effect on a Douglas-fir ecosystem at Shawnigan Lake: a synthesis of project results. B.C. Ministry of Forests FRDA-Report 196. X + 64 p.

Keywords: fertilization
thinning
growth
tree morphology
tree/stand health
carbon allocation
wood quality
tree physiology
photosynthesis
economics

Abstract: Treatments were initiated in 1970-71 in a 24-year-old Douglas fir (Pseudotsuga menziesii) near Shawnigan Lake, Vancouver Island, British Columbia, to determine the effects of 3 intensities of thinning (removing none, one-third and two-thirds of basal area) and 3 levels of urea fertilizer (0, 224 and 448 kg N/ha) on the growth and biology of the trees. Subsidiary experiments were established during 1972-87 to examine the effects of high doses of urea (672-1344 kg N/ha), ammonium nitrate as an N source instead of urea, understorey response to thinning and fertilizer, and responses to P and S fertilizer.

OSU Link
Non-OSU Link

35. Buermeyer, K.R. and C.A. Harrington. 2002. Fate of overstory trees and patterns of regeneration 12 years after clearcutting with reserve trees in Southwest Washington. Western-Journal-of-Applied-Forestry 17(2): 78-85.

Keywords: thinning
regeneration
tree/stand health

Abstract: Changes in management objectives for some forestlands in the Pacific Northwest have spurred interest in the creation of multistoried stands and the use of natural regeneration systems, but data on such systems are lacking. We assessed the status of the overstory trees and the regeneration 12 yr after a clearcut harvest with reserve trees in an even-aged, 145-yr-old Douglas-fir stand on a moderately productive site (site class 3) in southwest Washington. The 15 ha harvest unit was superimposed over two areas differentially thinned 15 and 34 yr before clearcutting. The clearcut harvest retained 18 trees/ha with a mean diameter of 63 cm. The reserved overstory trees had a 93% survival rate after 12 yr; most dead trees had been windthrown. Diameter growth for the reserved trees averaged 3.3 cm and was greatest during the most recent 3 yr period, which also had the highest growing-season precipitation. In a 1 ha mapped area, there were 5,854 seedlings/ha, and more than 99% of the regeneration was Douglas-fir. Most seedlings were less than 2 m tall. Seedling density was somewhat clumped (value of 2.1 for Pielou's index of nonrandomness), but 79% of randomly located 4.04 m2 (mil-acre) plots and 98% of 5x5 m grid cells had at least one conifer seedling. There was no obvious pattern of regeneration based on direction from the reserved trees, but both seedling density and seedling size within the drip lines of reserved tree crowns were less than in the rest of the area. The number of seedlings was similar on the two halves of the plot corresponding to the original thinning blocks, but seedling size and age differed. In the half of the study plot that had been twice lightly thinned, only 14% of the seedlings were >0.5 m tall; however, 41% of the seedlings were >0.5 m in the block that had been thinned more heavily. There was no difference between the thinning blocks in the ages of seedlings <less or =>0.5 m tall (mean age of 5 yr). This example of clearcutting with reserve trees resulted in reasonable survival of the overstory trees and adequate stocking but slow growth rates in the naturally regenerated Douglas-fir. Heavier thinning before harvest was associated with more advance regeneration, more shrub cover, and less windthrow of the reserved trees than in the more lightly thinned block. If an abundance of tree species other than Douglas-fir was desired on this site, interplanting would be required.

OSU Link
Non-OSU Link

36. Busse, M.D., G.O. Fiddler and A.W. Ratcliff. 2004. Ectomycorrhizal formation in herbicide-treated soils of differing clay and organic matter content. Water, Air, and Soil Pollution 152:23-34.

Keywords: release treatments
chemical release
growth
tree morphology
tree/stand health
soil properties
mycorrhizal response

Abstract: Herbicides are commonly used on private timberlands in the western United States for site preparation and control of competing vegetation. How non-target soil biota respond to herbicide applications, however, is not thoroughly understood. We tested the effects of triclorpyr, imazapyr, and sulfometuron methyl on ectomycorrhizal formation in a greenhouse study. Ponderosa pine, Douglas-fir, and white fir seedlings were grown in four forest soils ranging in clay content from 9 to 33% and organic matter content from 3 to 17%, and treated with commercial formulations of each herbicide at 0, 1.0, and 2.0 times the recommended field rate. Many of the possible herbicide-soil combinations resulted in reduced seedling growth. Root development was particularly sensitive to the three herbicides, with an average of 51% fewer root tips compared to the control treatment. The ability of mycorrhizal fungi to infect the remaining root tips, however, was uninhibited. Mycorrhizal formation was high, averaging 91% of all root tips, regardless of herbicide, application rate, soil type, or conifer species. In agreement, soil microbial biomass and respiratory activity were unaffected by the herbicide treatments. The results show that these herbicides do not alter the capability of mycorrhizal fungi to infect roots, even at concentrations detrimental to seedling growth.

OSU Link
Non-OSU Link

37. Campbell, D.L. and J. Evans. 1988. Recent approaches to controlling mountain beavers (Aplodontia rufa) in Pacific Northwest forests. In Proceedings: Thirteenth Vertebrate Pest Conference, Monterey, California. pp. 183-187.

Keywords: tree/stand protection
tree/stand health

Abstract: Investigations by the Denver Wildlife Research Center into ways of managing mountain beaver (Aplodontia rufa) populations are described. Methods were developed for alleviating mountain beaver damage to conifer trees being grown for timber in the Pacific Northwest. Studies initiated in 1986 indicated that aversive conditioning with Big Game Repellent Powder (BGR-P) dusted on culled Douglas fir (Pseudotsuga menziesii) seedlings placed in burrows significantly reduced mountain beaver damage to planted seedlings treated with BGR-P and to untreated seedlings. Trials also showed that strychnine-sword fern (Polystichum munitum) baits prepared with a 4.9% (active) strychnine paste concentrate were very effective and selective for mountain beaver control. Other topics discussed are the results of several probes with toxic baits and phosphine gas, trials with a drug (reserpine) and a wetting agent to induce hypothermia, and destruction of underground nests to prevent reinvasion.

OSU Link
Non-OSU Link

38. Campbell, S.J. and P.B. Hamm. 1989. Susceptibility of Pacific Northwest conifers to Phytophthora root rot. Tree Planters' Notes 40(1): 15-18.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: One-yr-old bare-rooted seedlings of 11 conifer species were inoculated with (a) Phytophthora cactorum, (b) P. cryptogea, (c) P. drechsleri, (d) P. megasperma or (e) P. pseudotsugae. Development of above-ground symptoms and root disease was followed for 10 wk. Isolates of (a), (b) and (e) caused the most overall mortality and isolates of (d) the least. Pinus contorta, P. ponderosa, P. monticola, Larix occidentalis, Libocedrus decurrens, Picea sitchensis and P. engelmannii showed tolerance to the root disease, Abies grandis and Pseudotsuga menziesii showed intermediate susceptibility and A. magnifica and Tsuga mertensiana were quite susceptible. Results are discussed in relation to management of conifer nurseries in the Pacific Northwest.

OSU Link
Non-OSU Link

39. Carroll, G.C. 1988. Facultative fungal egg-parasites as agents of gypsy moth mortality. Northwest-Environmental-Journal 4(2): 345-346.

Keywords: tree/stand protection
tree/stand health

Abstract: Research on entomogenous fungi attacking the forest pest Lymantria dispar in Oregon is summarized. The pathogenicity of 20 fungi was tested against eggs in the laboratory and Beauveria bassiana, Paecilomyces farinosus, Spicaria coccospora and Verticillium lecanii were shown to be consistently pathogenic. Preliminary studies showed that some of these fungi can invade and persist in bark of Douglas fir [Pseudotsuga menziesii] and oak [Quercus spp.], and subsequently infect egg masses on the bark.

OSU Link
Non-OSU Link

40. Carter, R.E. and R.P. Brockley. 1990. Boron deficiencies in British Columbia: diagnosis and treatment evaluation. Forest-Ecology-and-Management 37(1-3): 83-94.

Keywords: fertilization
growth
tree/stand health

Abstract: Two case-studies are presented, outlining methods of diagnosis and treatment evaluation of boron deficiencies in a Douglas fir (Pseudotsuga menziesii) stand in coastal southern British Columbia and a lodgepole pine (Pinus contorta) stand near Burns Lake, in the interior of the province. Site conditions commonly associated with B deficiency are outlined, and relations between dormant-season foliar B concentration and growing-season precipitation and moisture stress are suggested. Diagnostic methods used in the study include examination of deficiency symptoms, and foliar-analysis techniques; evaluation of response for corrective fertilizer treatments is based on changes in frequency and severity of deficiency symptoms and growth responses, measured by graphical-analysis and changes in shoot length between treatments. Boron deficiencies and response to B fertilizers are difficult to confirm. Results of graphical-analysis and examination of frequency and severity of deficiency symptoms were inconclusive, while changes in shoot length identified a measurable response in the Burns Lake fertilizer trial with lodgepole pine. Deficiencies appear to be acute rather than chronic,

and may not occur in untreated control trees for several years after establishment of fertilizer trials. Alternative causes for deficiency symptoms are also common, further complicating diagnosis and evaluation of response to treatment. It is concluded that all future trials should include nitrogen and/or other limiting nutrients with and without B to aid in identification of acute B deficiencies and deficiencies induced by increasing growth.

OSU Link
Non-OSU Link

41. Chanway, C.P. 1997. Inoculation of tree roots with plant growth promoting soil bacteria: an emerging technology for reforestation. Forest-Science 43(1): 99-112.

Keywords: nursery operations
tree/stand protection
growth
tree/stand health
mycorrhizal response

Abstract: Results from studies performed with beneficial asymbiotic tree root associated bacteria are reviewed in this article in relation to the possible uses of such microorganisms for artificial forest regeneration. The review includes sections on plant growth promoting bacteria for pine (Pinus spp.), spruce (Picea spp.), Douglas fir (Pseudotsuga menziesii) and hemlock (Tsuga heterophylla). Seedling root systems are colonized heavily by asymbiotic soil bacteria, many of which have the potential to influence plant growth significantly. A heterogeneous group of these microorganisms is well known for their ability to colonize roots and stimulate growth of agricultural plant species, sometimes doubling seedling biomass accumulation only a few weeks after inoculation, but more usually resulting in less spectacular biomass gains (e.g., 15%-30% greater than uninoculated controls within a growing season). Plant growth promoting soil bacteria may exert such effects through a variety of mechanisms, and include microorganisms that stimulate seedling emergence or infection by symbiotic fungi and bacteria. Other plant beneficial soil bacteria possess biological control activity or are capable of transforming plants genetically. Inoculation of tree seedlings with such bacterial before outplanting would be an inexpensive, environmentally benign, and easily applied nursery treatment, but comparatively little work has been performed with these microorganisms in forestry. Recent results with various tree species, however, indicate that seedling performance can be significantly enhanced through bacterial inoculation of root systems: pine and spruce biomass increased 32%-49% 1 yr after inoculation and outplanting at a reforestation site. In addition, infection by desired species of ectomycorrhizal fungi can also be enhanced by inoculation with certain strains of root colonizing bacteria.

OSU Link
Non-OSU Link

42. Chastagner, G.A., R.S. Byther, J.D. MacDonald and E. Michaels. 1984. Impact of Swiss needle cast on postharvest hydration and needle retention of Douglas-fir Christmas trees. Plant-Disease 68(3): 192-195.

Keywords: tree/stand protection
tree/stand health
tree physiology

Abstract: Healthy Douglas-fir (Pseudotsuga menziesii) Christmas trees were compared with those infected by Phaeocryptopus gaeumannii for needle loss and dehydration after cutting. The presence of infected needles increased the rate of dehydration (as measured by changes in xylem water potential) of cut trees placed in water or left dry. Fungicide applications 1 yr before harvest significantly improved retention of 1-yr-old needles on trees displayed either wet or dry, whereas applications during the year of harvest made no difference in retention of either current-season or 1-yr-old needles.

OSU Link
Non-OSU Link

43. Childs, S.W. and L.E. Flint. 1987. Effect of shadecards, shelterwoods, and clearcuts on temperature and moisture environments. Forest-Ecology-and-Management 18(3): 205-217.

Keywords: planting operations
tree/stand health
soil properties
tree physiology
tree phenology

Abstract: A comparison was made of two common techniques used to improve seedling survival on hot, dry reforestation sites. Adjacent shelterwood and clearcut sites in SW Oregon, USA, planted with 2+0 Douglas fir, were located and instrumented to compare temp.and moisture. In addition, cardboard shadecards were placed beside half of the seedlings studied. Seasonal measurements or observations of soil moisture, soil temp., solar radiation, air temp., stomatal diffusion resistance, seedling phenology and survival provided the basis for comparisons. Shelterwoods and shadecards improved seedling survival in relation to the clearcut. Both treatments affected soil temp. but the nature of the effects was different. The shelterwood canopy reduced solar radiation incident at the soil surface and caused cooler soil temp. throughout the soil profile. Shadecards reduced soil temp. only to a depth of 20 mm. Both treatments reduced the duration of periods of high soil temp. Shelterwood treatment delayed seasonal water loss and reduced seedling water stress as measured by stomatal resistance. Shadecards did not significantly affect seedling stomatal resistance. Differences in seedling survival caused by shadecards and shelterwoods are apparently due to different influences on the seedling microclimate. Shelterwood causes a large reduction in soil temp. aswell as decreased seedling water stress. Shadecards modify the soil temp. less extensively and so have less effect on seedling survival.

OSU Link
Non-OSU Link

44. Christiansen, E.C. and S.G. Pickford. 1991. Natural abatement of fire hazard in Douglas-fir blowdown and thinning fuelbeds. Northwest-Science 65(4): 141-148.

Keywords: thinning
precommercial thinning
tree/stand health

Abstract: The changes over time in fuelbed loading and depth in precommercially thinned and windthrown low altitude stands of Douglas fir (Pseudotsuga menziesii) were investigated in the Bull Run

Watershed, Oregon, using standard fuel inventory techniques. Non-linear least squares regressions were fitted to the resulting data. Slash from precommercial thinning lost half of its original loading and depth within 2 yr. No foliage was retained on twigs and branches after 1 yr. Changes in fuels from windthrown trees were similar to those in slash, except that more material was present initially. Fine fuels (<3 inches in diameter) decreased to background levels within 2-4 yr, but large fuels persisted for longer. Sound logs became rotten after about 80 yr. The study confirmed that the fire hazard after precommercial thinning slash and wind throw was abated after 3 yr.

OSU Link
Non-OSU Link

45. 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
Non-OSU Link

46. Cole, E.C. and M. Newton. 1989a. Height growth response in Christmas trees to sulfometuron and other herbicides. Proceedings-of-the-Western-Society-of-Weed-Science (Vol. 42): 129-135.

Keywords: release treatments
chemical release
growth
tree/stand health
stand conditions

Abstract: Abies procera, A. grandis and Pseudotsuga menziesii cv. Menziesii were evaluated for tolerance to sulfometuron (0.05-0.21 kg/ha), atrazine (4.5 kg/ha) and hexazinone (2.2 kg/ha). Herbicides were applied pre-budbreak and sulfometuron was also applied post-budbreak. Weeds were suppressed

equally effectively by all rates and herbicides pre-em. Low rates of sulfometuron were less effective post-em. There was no significant damage to A. procera seedlings, although the highest rate of sulfometuron slowed growth significantly. A. grandis was not affected by any treatment. All treatments caused injury to 1-year-old P. menziesii, primarily needle chlorosis and slight stunting. Growth was best in atrazine-treated plots. For 3-year-old P. menziesii, injury was not significant but high rates of sulfometuron caused cosmetic damage. Best growth was observed with hexazinone and worst with sulfometuron. Post-budbreak applications and high rates of sulfometuron reduced growth more than pre-budbreak application and low rates.

OSU Link
Non-OSU Link

47. Cole, E.C. and M. Newton. 1989b. Seasonal efficacy comparison of two glyphosate formulations. Proceedings-of-the-Western-Society-of-Weed-Science (Vol. 42): 136-142.

Keywords: release treatments
chemical release
tree/stand health
stand conditions

Abstract: Glyphosate formulations with 13% (Roundup) and without (Accord) surfactant were compared at 0.84 and 1.68 kg/ha, applied June-Oct. against Alnus rubra, Rubus spectabilis, R. parviflorus, R. ursinus and Pteridium aquilinum in a Pseudotsuga menziesii cv. menziesii plantation. No differences in efficacy between the two formulations against any species were noted. All species were controlled better by high rates of herbicide. R. spectabilis and R. parviflorus were controlled <less or =>100%, although July applications were least effective. A. rubra was reduced <less or =>80% and early application gave best control. Rates of application had less effect on Pteridium aquilinum control (<less or =>98%), and Oct. applications were least effective. Damage to Pseudotsuga menziesii was worst with June applications and decreased through the year. Oct. treatment caused negligible damage.

OSU Link
Non-OSU Link

48. Cole, E.C., M. Newton and D.E. White. 1986. Response of northwestern hardwoods, shrubs, and Douglas-fir to Arsenal and Escort. Proceedings-of-the-Western-Society-of-Weed-Science (Vol.39): 93-101.

Keywords: release treatments
chemical release
tree/stand health
stand conditions

Abstract: Arsenal (imazapyr) and DPX-T6376 (metsulfuron) were evaluated for scrub control in Pseudotsuga menziesii plantations at 3 sites in Oregon in 1984-85. Arsenal produced the most complete and consistent control of Acer macrophyllum when applied in late summer, but early summer applications were more effective against the sclerophyll brush species Arbutus menziesii, Ceanothus velutinus var. laevigatus, Arctostaphylos columbiana and A. viscida. High rates of Arsenal gave good

control of Alnus rubra and Rubus spectabilis, but did not control R. laciniatus or R. procerus. On all the controlled species, growth of new foliage was decreased or prevented. DPX-T6376 reduced the crown vol. of A. macrophyllum and killed the sclerophyll brush species, all Rubus spp. but not A. rubra. Both chemicals produced severe injury to P. menziesii.

OSU Link
Non-OSU Link

49. Cole, E.C., M. Newton and D.E. White. 1988. Efficacy of imazapyr and metsulfuron methyl for site preparation and conifer release in the Oregon Coast Range. Forest-Research-Laboratory,-Oregon-State-University Research-Note 81. 7 p.

Keywords: release treatments
chemical release
tree/stand health
stand conditions

Abstract: Imazapyr (Arsenal) and metsulfuron methyl (Escort) were tested at 3 rates for controlling shrubs in young Douglas fir (Pseudotsuga menziesii) plantations on 3 sites in the Oregon Coast Range. Imazapyr was highly effective on red alder (Alnus rubra) and bigleaf maple (Acer macrophyllum), but was less effective on salmonberry (Rubus spectabilis) and other blackberry (Rubus) species. Metsulfuron-methyl was ineffective on red alder and bigleaf maple, but gave excellent control of salmonberry, Himalaya blackberry (R. procerus) and evergreen blackberry (R. laciniatus). Both chemicals caused severe injury to Douglas fir seedlings, especially when applied during the growing season. It is concluded that these herbicides are promising for site preparation, but have limited use for release of Douglas fir.

OSU Link
Non-OSU Link

50. Coleman, M., J. Dunlap, D. Dutton and C. Bledsoe. 1987. Nursery and field evaluation of compost-grown conifer seedlings. Tree-Planters' Notes 38(2): 22-27.

Keywords: nursery operations
nursery fertilization
growth
tree physiology
tree/stand health

Abstract: Seedlings of Douglas fir (Pseudotsuga menziesii), noble fir (Abies procera) and ponderosa pine (Pinus ponderosa) were raised in beds that had been treated with 0, 2, 4 or 6 inches of compost (fir/hemlock sawdust and municipal sewage sludge, 3:1) at a nursery in Carson, Washington. In autumn 1983, the 2+0 stock was lifted, stored until spring 1984 and then planted out on Mt. St. Helens, Washington (Douglas fir), near Estacada, Oregon (noble fir) or E. of the Cascade crest near Leavenworth, Washington (ponderosa pine). Data are given on the ht., biomass and concn. of N, P, Zn, Cu, Pb, Ni and Cd after 1 yr in the nursery beds and on the ht. and survival for 2 yr after planting. The

responses of the seedlings to the compost, the immobilization of nutrients and the accumulation of heavy metals are discussed.

OSU Link
Non-OSU Link

51. Colinas, C., D. Perry, R. Molina and M. Amaranthus. 1994b. Survival and growth of Pseudotsuga menziesii seedlings inoculated with biocide-treated soils at planting in a degraded clearcut. Canadian-Journal-of-Forest-Research 24(8): 1741-1749.

Keywords: planting operations
fertilization
growth
tree/stand health
tree morphology

Abstract: To determine the factors of transfer soils responsible for increased seedling survival and growth, planting holes, at a site in SW Oregon, were inoculated with forest, plantation, and clear-cut soils subjected to one of 8 treatments: (i) treated with fertilizer to test for effects of nutrients; treated with biocides to test for effects of (ii) grazers (microarthropods or nematodes), (iii) protozoa, (iv) fungi, or (v) bacteria; (vi) pasteurized; (vii) Tyndallized; or (viii) untreated. Douglas fir (Pseudotsuga menziesii) seedlings were planted in June 1990 and seedling growth and survival was assessed in December 1990. Survival was increased by inoculation with untreated plantation soils, but not if they were fertilized or treated with dimethoate + carbofuran (grazercide), fumagillin (protozoacide), or oxytetracycline + penicillin (bactericide). Addition of untreated forest soil did not increase survival. For all soils, survival was increased by captan (fungicide), pasteurization and Tyndallization. Untreated plantation and forest soil transfers increased dry weights whereas neither did when treated with dimethoate + carbofuran. Dry weights of seedlings given clear-cut soil were increased by fertilization, pasteurization and Tyndallization of the soil; the latter two treatments also increased the number of short roots. It is hypothesized that stimulation of seedling growth by soil transfers was related to an increased rate of nutrient mineralization due to microbivorous soil animals contained within the transfer soils. Soil transfers may have enhanced seedling survival by at least two mechanisms: (i) by providing a safe site for beneficial rhizosphere organisms to proliferate, free from competing organisms that have proliferated in the clear-cut soil; and (ii) through volatile organic compounds, especially ethylene, that stimulated seedling root growth.

OSU Link
Non-OSU Link

52. Copes, D.L. 1983. Failure of grafted Douglas-fir planted at Monterey, Calif. Tree-Planters' Notes 34(3): 9-10.

Keywords: genetic tree improvement
tree grafting
growth
tree/stand health
tree phenology

Abstract: Trees were grafted onto established rootstocks (grown from rooted cuttings from Oregon or seedlings from California) in Oregon in April 1979, and in Dec. 109 of these were transplanted to a site on the Monterey Peninsula, California. Grafts were examined in July 1981. More than 30% of the transplanted grafts had died of early incompatibility and the cumulative 1980 and 1981 leader growth of the survivors averaged 12 cm. Identical grafts in Oregon showed 2-10% death due to incompatibility and av. leader growth of 1-2 m. It is suggested that the atypical unreliable budflush and reduced leader elongation in Monterey was due to winter temperatures that were not cool enough to satisfy bud dormancy requirements. It had been hoped to establish seed orchards out of range of pollen contamination from local Douglas fir stands.

OSU Link
Non-OSU Link

53. Copes, D.L. 1989. Bark scoring problem grafts in five Douglas-fir seed orchards: a case history. Pacific-Northwest-Research-Station,-USDA-Forest-Service. Research-Note PNW-RN-487. 12 p.

Keywords: genetic tree improvement
tree grafting
tree/stand health
tree physiology

Abstract: Grafted seed orchards of Douglas fir (Pseudotsuga menziesii) often suffer tree losses caused by delayed graft incompatibility. Bark scoring (to improve translocation across the graft union) was performed in April, June and August 1983 and 1985 on 379 trees, 5-16 yr old, in 5 seed orchards in western Oregon. Cuts were made with a small chainsaw every 3.1 to 4.3 cm across the defective union. Effects of scoring were assessed in 1984 and 1986. Many trees showed improved vigour after treatment and annual mortality was only 1.6% when all defective grafts were treated. The greatest improvement in average compatibility occurred in trees treated in April, when the youngest grafts responded most favourably. Inherent and induced incompatibility was found, with brownline round the entire or part of the circumference of the union, respectively. Wound tissue in induced incompatible grafts was usually free of brownline, but brownline appeared in all wound tissue of inherently incompatible grafts. These latter grafts will require bark scoring every 2-3 yr to maintain a live cambium at the union.

OSU Link
Non-OSU Link

54. Copes, D.L. 1999. Breeding graft-compatible Douglas-fir rootstocks (Pseudotsuga menziesii (MIRB.) FRANCO). Silvae-Genetica 48(3/4): 188-193.

Keywords: genetic tree improvement
tree grafting
tree/stand protection
growth
tree phenology
tree/stand health
genetic relationships

Abstract: A study encompassing 24 years was conducted to determine if a breeding programme could produce highly graft-compatible rootstocks for P. menziesii. A total of 27 trees of apparent high graft compatibility were selected and crossed to produce 226 control-pollinated families. Seedlings were grown, field planted and grafted with test scions. Graft unions from field tests were evaluated anatomically for internal symptoms of incompatibility. Average compatibility of progeny from the 226 crosses was 90.6%, compared with 65% in native populations. Breeding values were calculated for each parent by the best linear prediction (BLP) procedure. Average compatibility resulting from crossing among the top 10 parents was estimated by breeding values as 95.4%. Field-test results of progeny from 34 crosses among the 10 most compatible parents showed 96% compatibility. In addition to field-tests for graft compatibility, nursery tests of seedlings from 124 crosses were evaluated for second-year vegetative bud flush and seedling height. It was possible, while maintaining adequately high levels of graft compatibility, to breed both for resistance to spring frost damage and for increased seedling height.

OSU Link
Non-OSU Link

55. Copes, D.L. and N.L. Mandel. 2000. Effects of IBA and NAA treatments on rooting Douglas-fir stem cuttings. New-Forests 20(3): 249-257.

Keywords: nursery operations
tree morphology
tree/stand health

Abstract: The effectiveness of 6 indole-3-butyric acid (IBA) and four 1-napthaleneacetic acid (NAA) concentrations, 4 combinations of IBA and NAA concentrations, and control were tested for their ability to enhance rooting frequency of Douglas-fir [Pseudotsuga menziesii] cuttings. Two IBA and one NAA treatments were also compared to the control for quality of root system. Between 1984 and 1998, six independent studies were conducted in mist or fog environments with the 14 clones. Auxin concentrations tested ranged from 0 to 123 mM IBA and 0 to 10 mM NAA. Auxin, clone and auxin by clone effects were significant in every study, although individual clone analyses showed only two clones to differ significantly for auxin. All auxin treatments except the 10 mM NAA treatment induced significantly greater rooting percentage than the control, but no single auxin, auxin concentration or combination of auxins was clearly superior in every study. The 10 mM NAA concentration was the only concentration tested that reduced rooting percentage to less than the control. Both NAA and IBA appeared to have broad ranges of root-enhancing activity. However, within the effective range of IBA evaluated, 24.6 or 49.3 mM produced the greatest rooting percentage in 4 of 5 studies testing IBA. NAA solutions with concentrations between 2.5 and 7.5 mM NAA generally resulted in similar rooting success. Rooting responses to increased IBA and NAA were both nonlinear; rooting decreased with both too little and too much auxin. Combinations of IBA and NAA in the same solution did not increase rooting percentage above what was achieved with one auxin. For root system quality, auxin treated cuttings in one study, had significantly better root systems than control, but there was no difference in the other study in which root quality was estimated.

OSU Link
Non-OSU Link

56. 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
Non-OSU Link

57. Crouch, G.L. and M.A. Radwan. 1981. Effects of nitrogen and phosphorus fertilizers on deer browsing and growth of young Douglas-fir. Pacific-Northwest-Forest-and-Range-Experiment-Station,-USDA-Forest-Service. Research-Note PNW-RN-368. 15 p.

Keywords: fertilization
tree/stand health
growth
tree physiology

Abstract: N and P fertilizers were applied in March 1968 singly or in combination at a rate equivalent to 200 lb/acre of N or P to young trees (2-5 ft tall) in Oregon and Washington. Trees were examined and measured for up to 4 yr. In the first year after treatment trees given the N-only fertilizer in Washington were more heavily browsed by black tailed deer (Odocoileus hemionus columbianus), but this effect disappeared in the second year. Height growth was increased by N-only treatment in taller trees in Oregon after 1 and 2 yr, but the effect had disappeared after 4 yr. Total N content was significantly increased by the N and N + P treatments in the first year, but this effect also disappeared after 2 yr. The amounts of moisture, ash, Ca and P, and diam. growth were not affected by any treatments.

OSU Link
Non-OSU Link

58. Cruickshank, M.G., D.J. Morrison and Z.K. Punja. 1997. Incidence of Armillaria species in precommercial thinning stumps and spread of Armillaria ostoyae to adjacent Douglas-fir trees. Canadian-Journal-of-Forest-Research 27(4): 481-490.

Keywords: thinning
precommercial thinning
tree/stand health

Abstract: The frequency of Armillaria species in precommercial thinning stumps and the interaction at root contacts between Douglas fir (Pseudotsuga menziesii) crop trees and stumps colonized by A. ostoyae were investigated at sites in four biogeoclimatic zones along a transect from the coast through the southern interior of British Columbia. The frequency of stumps colonized by A. ostoyae and A. sinapina varied among lower, mid, and upper slope transects. On coastal sites, A. sinapina dominated fresh hygrotopes and A. ostoyae dominated slightly dry hygrotopes, and the frequency of both fungi was low on moist hygrotopes. On interior sites, A. ostoyae was found over all hygrotopes, but with lower frequency on the driest sites. The distribution of the two Armillaria species on sites is apparently determined by anoxia associated with periodic soil saturation, by drying of the soil, and by host response limiting spread of pathogenic species. At root contacts between colonized stump roots and crop tree roots, transfer and infection by A. ostoyae occurred more frequently in moist biogeoclimatic zones than dry ones. Lesion size on crop tree roots was related to inoculum volume at some sites and to stump root diameter at others. The percentage of lesions on roots at which crop trees formed callus was associated with tree bole volume. The results indicate that there will be crop tree mortality following precommercial thinning, especially where inoculum levels are high in the Interior Cedar-Hemlock and Interior Douglas fir biogeoclimatic zones.

OSU Link
Non-OSU Link

59. Curtis, R.O. 1987. Levels-of-growing-stock cooperative study in Douglas-fir: Report No. 9 - some comparisons of DFSIM estimates with growth in the levels-of-growing stock study. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Paper PNW-RP-376. 34 p.

Keywords: thinning
commercial thinning
growth
tree/stand health
computer modeling

Abstract: Initial stand statistics for the 9 levels-of-growing-stock (LOGS) study installations in Oregon and Washington, USA, and Vancouver Island, British Columbia, Canada, were projected by the Douglas fir (Pseudotsuga menziesii) stand simulation program (DFSIM) over the available periods of observation. Thinnings were simulated by use of observed top height trends, actual residual basal areas, and actual ratios of cut tree diameters to stand diameter before cutting (d/D). Estimates were compared with observed gross and net volumes and basal area growth, net change in quadratic mean diameter, and change in number of trees. Although the LOGS installations included regimes quite different from those in most of the data used to construct DFSIM, overall agreement was reasonably good. Results indicated some density-related bias in the thinned stands and a need for revision in the method used to control the maximum density in the DFSIM program and in the associated mortality estimates.

OSU Link
Non-OSU Link

60. Curtis, R.O. and D.D. Marshall. 2002. Levels-of-growing-stock cooperative study in Douglas-fir: report no. 14 - Stampede Creek: 30-year results. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Paper PNW-RP-543. xi + 77 p.

Keywords: thinning
commercial thinning
growth
yield
tree morphology
tree/stand health

Abstract: Results of the Stampede Creek installation of the levels-of-growing-stock (LOGS) study in Douglas-fir (Pseudotsuga menziesii) are summarized. To age 63 (planned completion of 60 feet of height growth), volume growth on the site III natural stand has been strongly related to level of growing stock, but basal area growth-growing stock relations were considerably weaker. Marked differences in tree size distributions have resulted from thinning. Periodic annual volume increments at age 63 are two to three times greater than mean annual increment; this stand is still far from culmination. Results for this southwest Oregon installation are generally similar to those reported from other LOGS installations, although development has been slower than on the site II installations that make up the majority of the series.

OSU Link
Non-OSU Link

61. DeYoe, D.R., H.R. Holbo and K. Waddell. 1986. Seedling protection from heat stress between lifting and planting. Western-Journal-of-Applied-Forestry 1(4): 124-126.

Keywords: nursery operations
planting operations
tree/stand protection
tree/stand health

Abstract: Seven protective treatments were evaluated for preventing overheating of 2+0 Douglas fir seedlings in Kraft paper bags. Trials were conducted in May 1982 at Corvallis, Oregon on 3 clear days with max. air temp. of 78 degrees F and a hazy day with max. temp. 66 degrees . Seedlings were returned to cold storage (35 degrees) overnight. Seedling temp. differed significantly between treatments. Unprotected seedlings (paper bag only) in full sun reached 89 degrees after 7 h. Green canvas caused increased heating rates and higher temp. (104 degrees after 7 h). A white sheet and a crinkled foil wrap performed no better than a paper bag alone. Canvas painted off-white reduced max. temp. to 80 degrees . Heavy shading (2% of full sun) and Mylar with white surface towards the sun were the most effective materials for preventing overheating (max. temp. 59-60 degrees). Mylar with the silver surface facing the sun was less effective (max. temp. 71 degrees).

OSU Link
Non-OSU Link

62. Dimock, E.J., II and E.B. Collard. 1981. Postplanting sprays of dalapon and atrazine to aid conifer establishment. Pacific-Northwest-Forest-and-Range-Experiment-Station,-USDA-Forest-Service Research-Paper PNW-RP-280. iii + 16 p.

Keywords: release treatments
chemical release
growth
tree/stand health
stand conditions

Abstract: A mixture of dalapon and atrazine at 8 and 4 lb/acre, respectively, or dalapon or atrazine alone were applied to control perennial grasses and forbs competing with newly planted seedlings of ponderosa pine and Douglas fir. In 4 studies in Oregon in 1975, herbicides were spot sprayed around individual seedlings. In 2 studies in Washington and Oregon in 1976, herbicides were broadcast sprayed. The mixture consistently controlled grass and forbs better than either herbicide alone, reducing grass and forb cover respectively by 80-82% and 48-58% in the first year. Control persisted for 2-4 yr. Varying results are reported as to the effects of the different treatments on height growth and survival.

OSU Link
Non-OSU Link

63. Donald, D.G.M. and D.G. Simpson. 1985. Shallow conditioning and late fertilizer application effects on the quality of conifer nursery stock in British Columbia. B.C.-Ministry-of-Forests Research-Note 99. viii + 36 p.

Keywords: nursery operations
nursery fertilization
tree/stand protection
tree morphology
tree/stand health
growth

Abstract: Eight trials on 2+0 stock of Picea engelmannii, P. glauca, P. sitchensis, Pinus contorta and Pseudotsuga menziesii (var. glauca and var. menziesii) in 4 nurseries were conducted to compare the effects of shallow conditioning (undercutting and wrenching at 10 cm deep) with those of the standard conditioning regime (undercutting and wrenching at 20 cm) on nursery performance, storage and field performance. The application of a complete NPK fertilizer 50 days before lifting was also evaluated. Shallow conditioning and late fertilizer application improved the root growth capacity at lifting, but could not replace cold exposure for hardening Pseudotsuga menziesii. Shallow conditioning had little effect on survival after planting and reduced initial ht. increment of all species. Application of fertilizer just before lifting improved the early growth of the trees without adversely affecting survival. Planting seedlings some 5 cm deeper than they stood in the nursery improved establishment.

OSU Link
Non-OSU Link

64. Driessche, R.v.-d. 1983. Growth, survival, and physiology of Douglas-fir seedlings following root wrenching and fertilization. Canadian-Journal-of-Forest-Research 13(2): 270-278.

Keywords: nursery operations
nursery fertilization
tree/stand health
tree morphology
tree physiology
growth

Abstract: Seedlings at different nurseries on Vancouver Island were subjected to wrenching treatments during their 2nd year of growth using a fixed blade at 20-25 cm below the bed surface. In the first experiment, wrenching reduced water potential of trees on unirrigated loam soil by an av. of 300 kPa during Aug. and Sept. Wrenched trees lifted in Oct. and stored at 2 degrees C until May, showed 25% higher survival than unwrenched trees 1 yr after planting. Trees lifted in Dec. had uniformly high survival (98%) and showed no effect of wrenching. Wrenched trees from irrigated plots had lower shoot length relative growth rates (RGR) than unwrenched trees during the year after planting. In the second experiment, wrenching treatments were applied to seedlings, growing in a loamy sand, for different periods between 15 May and 11 Sept. as follows: (a) no wrenching, (b) early summer, (c) midsummer, (d) late summer and (e) all summer. Three fertilizer treatments (none, and 2 amounts of NPK) were applied to each wrenching treatment, and seedlings were lifted for storage at 2 degrees C in Oct. and Dec. Stored trees and freshly lifted trees were planted at 700 m alt. on 3 March. Wrenching increased root dry wt., particularly when additional fertilizer was applied, but had no measurable effect on cold hardiness or root growth capacity. Nevertheless, late summer wrenching increased survival 5 and 7% above control 1 and 2 yr after planting. Wrenching had little subsequent effect on new shoot growth of planted trees during the 2 yr after planting. However, late-summer wrenched trees showed significantly more new shoot growth than all-summer wrenched trees. More fertilizer reduced cold hardiness and survival of cold-stored trees, but increased root growth capcity. Cold hardiness (measured by electrical impedance) was correlated with survival of cold-stored trees after planting (rsuperscript 2 = 0.82). Root growth capacity, averaged over all fertilizer treatments was closely correlated with survival of stored and freshly lifted trees (rsuperscript 2 = 0.93). Foliar nutrient concn. were reduced by wrenching, but fertilizing increased nutrient reserves within the seedling.

OSU Link
Non-OSU Link

65. Driessche, R.v.-d. 1984b. Seedling spacing in the nursery in relation to growth, yield, and performance of stock. Forestry-Chronicle 60(6): 345-355.

Keywords: nursery operations
growth
tree morphology
carbon allocation
tree physiology
tree/stand health

Abstract: In 3 experiments at nurseries in coastal British Columbia Picea sitchensis, P. glauca, Pinus contorta var. latifolia, Thuja plicata and coastal and interior varieties of Pseudotsuga menziesii were sown in May 1979, 1980 or 1982 and grown at spacings ranging from 0.5 to 12 cm. A 1-cm increase in spacing increased seedling dry wt. by 0.5-1.5 g and root collar diam. by 0.2-0.25 mm up to a spacing of about 8-10 cm. Above this, response was less. Ht. of 2-yr-old seedlings was increased slightly or even decreased by wider spacing. Height : diameter ratios decreased sharply and shoot : root dry wt. decreased or remained unchanged with wider spacing. The number of needle primordia in 2-0 P. menziesii buds increased up to a spacing of 2 cm, and the number of 1st and 2nd order branches were also increased by wider spacing. Increases in root growth capacity were associated with wider spacing in T. plicata and Picea sitchensis. In a test of 3 types of precision seeders, none produced anything like accurate seed placement. Irregularity was increased by 10-20% non-viable seed and winter mortality. Increased spacing of 2-5 cm between seedlings was justified by the yield of acceptable seedlings only when the culling standard was increased to a root collar diam. of about 6 mm. Three yr after planting out the survival of P. glauca was increased 11% by wider spacing. After 2 yr P. sitchensis survival was increased 13% by wider spacing. Both species grown at wider spacing maintained a ht. and diam. advantage over those from close spacing.

OSU Link
Non-OSU Link

66. Driessche, R.v.-d. 1988a. Nursery growth of conifer seedlings using fertilizers of different solubilities and application time, and their forest growth. Canadian-Journal-of-Forest-Research 18(2): 172-180.

Keywords: nursery operations
nursery fertilization
growth
carbon allocation
tree physiology
tree/stand health

Abstract: Beginning in May 1982, seedlings of Douglas fir and white spruce were grown for 2 yr in a bare-root nursery in southern British Columbia. Seedlings were treated with four types of commercial fertilizers (slow-release Osmocote, ammonium phosphate, ammonium sulphate and Hi-Sol, a soluble fertilizer with 20-20-20 NPK) at 2 different frequencies during both years to give total N applications of 0, 210 or 350 kg/ha. In addition, Douglas fir seedlings that had been grown for 2 yr without fertilizer were treated with the same amounts of fertilizer as a late season treatment during 1 Sep.-20 Oct. 1983. Ammonium fertilizers produced larger seedlings than Osmocote and Hi-Sol. Dry wt. increased with application rate, but frequency of application had only a small effect. Fertilizer increased the proportion of stem dry matter and decreased the proportion of needle and root dry matter. Dry wt. of 2+0 white spruce seedlings was correlated with soil pH, extractable NO3 and available P measured in Sep. of the first growing season. Douglas fir seedlings were planted out in Mar. 1984. Late-season fertilized seedlings had greater N and P tissue concn. than seedlings fertilized during the growing season. Survival and growth rate after planting were also both greater in late-season fertilized seedlings. Results suggested that fertilizer composition was more important than fertilizer solubility for nursery growth.

OSU Link
Non-OSU Link

67. Driessche, R.v.-d. 1988b. Response of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) to some different fertilizers applied at planting. New-Forests 2(2): 89-110.

Keywords: nursery operations
nursery fertilization
fertilization
growth
tree/stand health
tree physiology

Abstract: Four fertilizer experiments to assess type of fertilizer, dosage and timing, were conducted on eastern Vancouver Island, BC, Canada. Two-yr-old, bare root planting stock was used except in experiment 3, where container stock was compared with bare root stock. Little growth response was obtained after one year, but height growth responses of 12 to 31% were measured after 3 to 6 yr with fertilizers supplying 8.4 to 16.8 g N per tree. Growth responses were little affected by type of fertilizer and were primarily due to N, with release rate having no marked effect. The exception to this was triple superphosphate which did not increase growth but did increase survival. Survival was reduced by ammonium sulphate and to a lesser extent by Agriform (NPK). Container seedlings responded more to fertilization at planting than bare root seedlings. Seedling N, P and K concn. and contents declined following planting for 6 months and only started to recover after July. Application of fertilizer caused a small increase in seedling nutrient concn. regardless of date, but this had no detectable effect on dry weight measured 6 wk later.

OSU Link
Non-OSU Link

68. Driessche, R.v.-d. 1991a. Influence of container nursery regimes on drought resistance of seedlings following planting. I. Survival and growth. Canadian-Journal-of-Forest-Research 21(5): 555-565.

Keywords: nursery operations
tree/stand protection
growth
tree morphology
carbon allocation
tree/stand health

Abstract: In a 2 year study, Douglas fir (Pseudotsuga menziesii), lodgepole pine (Pinus contorta) and white spruce (Picea glauca) seedlings, grown in Styroblock containers in a container nursery from February to July 1988, were exposed to three temperatures and three levels of drought stress applied factorially during 18 July to 29 September 1988. Mean temperatures of 13, 16 and 20 degrees C were imposed in growth chambers, in a cooled plastic house, and in an ambient plastic house, respectively. Control, medium and severe levels of drought stress were imposed in a series of eight cycles, resulting in mean xylem pressure potentials of -0.32, -0.50 and -0.99 MPa, respectively. Seedlings were kept in the ambient plastic house until January 1989, when they were lifted and cold-stored until transplanting to covered 0.5-m deep sand beds, which provided hygric, mesic, and xeric conditions for testing all species and treatments. At the end of nursery growth, an increase in nursery temperature increased height and height : diameter ratio in all species and shoot:root dry weight ratio in Douglas fir and lodgepole pine. Increase in temperature also increased the number of seedlings with large well-formed buds in white

spruce, but reduced the number in Douglas fir. Drought stress reduced height and dry weight in all species and bud length in lodgepole pine. After 9 weeks in sand beds, low nursery temperature increased survival (19% for lodgepole pine and white spruce grown in the xeric bed), except for Douglas fir grown in the xeric bed. Nursery drought stress also increased survival (16% for Douglas fir and lodgepole pine in the xeric bed), but had little effect on white spruce. Low temperature and drought stress treatments that increased survival also reduced height and dry weight of lodgepole pine and white spruce after one growing season in sand beds. Survival showed significant negative correlations with height, dry weight and height:diameter and shoot : root weight ratios. Low nursery temperature continued to affect growth 16 weeks after planting, increasing relative growth rate and allometric ratio (K) of Douglas fir and reducing K of white spruce.

OSU Link
Non-OSU Link

69. Driessche, R.v.-d. 1991b. Influence of container nursery regimes on drought resistance of seedlings following planting. II. Stomatal conductance, specific leaf area, and root growth capacity. Canadian-Journal-of-Forest-Research 21(5): 566-572.

Keywords: nursery operations
tree/stand protection
tree physiology
tree/stand health

Abstract: Seedlings of Douglas fir (Pseudotsuga menziesii), lodgepole pine (Pinus contorta) and white spruce (Picea glauca) were grown in a container nursery from February to July 1988 and then exposed to three temperatures and three levels of drought stress applied factorially during mid-July to October 1988. Seedlings were retained in a shelter house until January 1989, when they were cold-stored until early May. Measurements of stomatal conductance (gs), transpiration (E), and specific leaf area (SLA) were made at the end of the treatment period in September 1988 and again after growth the following year at the end of June. Root growth capacity (RGC) was tested in early May 1989. Results were considered in conjunction with performance of other samples of the same plants that had been planted in sand beds in April 1989, where irrigation was regulated to provide three levels of moisture stress. Low temperature (13 degrees C) generally reduced gs and E, which were adjusted for xylem pressure potential, and SLA, in all species by the time nursery treatment was completed at the end of September. No effect of nursery temperature treatment on gs or E could be detected when new needles were measured in June and July (after 9 to 12 weeks of growth), but SLA of lodgepole pine increased with nursery temperature treatment, andSLA of white spruce decreased with treatment. RGC was higher for the 13 degrees C treatment than for the 16 and 20 degrees C treatments. Survival of outplanted seedlings was mainly inversely related to nursery temperature. Low nursery temperature reduced gs, E, andSLA and increased RGC. SLA of planted lodgepole pine increased with level of nursery drought treatment, and severe nursery drought increased gs under stress, when measured in June. No other effects of drought were detected, although drought treatment was effective in increasing survival of planted seedlings. It is suggested that other mechanisms, such as osmotic adjustment, were responsible for the results observed.

OSU Link
Non-OSU Link

70. Driessche, R.v.-d. 1992b. Changes in drought resistance and rootgrowth capacity of container seedlings in response to nursery drought, nitrogen, and potassium treatments. Canadian-Journal-of-Forest-Research 22(5):740-749.

Keywords: nursery operations
nursery fertilization
tree/stand protection
tree/stand health
growth
carbon allocation
tree physiology

Abstract: Douglas fir (Pseudotsuga menziesii), lodgepole pine (Pinus contorta), and white spruce (Picea glauca) seedlings, each represented by two seed lots, were grown in Styroblock containers in a greenhouse and plastic shelter house from February 1989 to January 1990. The seedlings were exposed to two N treatments (20 and 200 mg/litre) and three K treatments (5, 25 and 100 mg/litre) arranged factorially within three drought treatments. After winter storage, seedlings from a complete set of treatments were planted into hygric, mesic and xeric sand beds during 12-14 March. Increasing nursery drought stress increased survival of Douglas fir and lodgepole pine after planting, and high N treatment level increased survival of lodgepole pine and white spruce. Under xeric conditions, combined nursery drought and high N treatments increased survival of lodgepole pine by 33%, indicating the importance of nursery cultural regime for stock quality. Increase in nursery drought stress did not decrease seedling size by much; increase in N increased seedling size one season after planting. A positive relation between shoot : root ratio and survival in lodgepole pine and white spruce indicated that increase in N increased both shoot growth and drought resistance over the N range investigated. Only Douglas fir showed an interaction between drought and N treatment and a small response in both survival and dry weight to K application. Root growth capacity, measured at the time of planting, showed an approximate doubling in all species due to high N treatment, and was also increased in white spruce by drought stress. Survival and root growth capacity were poorly correlated, but dry-weight growth in sand beds was well correlated with root growth capacity. Shoot dry weight and percentage N in shoots measured after nursery growth were correlated with root growth capacity. Manipulation of root growth capacity by changing nursery treatment was possible without altering resistance to drought stress after planting.

OSU Link
Non-OSU Link

71. Dunsworth, B.G. 1985. Three-yr survival and height growth of 2+0 bareroot Douglas-fir seedlings treated with a Symbex root dip. Tree-Planters' Notes 36(1): 24-25.

Keywords: nursery operations
nursery fertilization
growth
tree/stand health

Abstract: Seedling roots were dipped in a sol. of Symbex [a stimulant containing fertilizer and microorganisms?] diluted 40:1 with water, or water before planting out in May 1980 on Vancouver

Island, British Columbia. Although the ht. growth of Symbex-treated trees was significantly greater in 1981, there were n.s.d. in total ht., ht. growth or survival after 3 growing seasons.

OSU Link
Non-OSU Link

72. Dunsworth, B.G. 1988. Douglas-fir fall root phenology: a bioassay approach to defining planting windows. In Proceedings: 10th North American Forest Biology Workshop, 'Physiology and genetics of reforestation', University of British Columbia, Vancouver, British Columbia, July 10-22, 1988. Eds. J. Worrall, J. Loo-Dinkins and D.P. Lester. pp. 295-307.

Keywords: planting operations
growth
tree/stand health
tree phenology

Abstract: Natural seedling root phenology during the autumn and spring was observed in Douglas fir [Pseudotsuga menziesii] and western hemlock [Tsuga heterophylla] over several seasons on Vancouver Island, British Columbia. These observations were used to determine the soil climate conditions under which peak activity occurred. Mitotic indexing and total root tip counts were used to quantify root activity. Peak activity for both spring and autumn in both species could be reasonably bracketed by soil climate conditions of -1 bar soil tension and 4 degrees C. The hypothetical planting window defined by these soil climate conditions was then tested with a series of timing of planting studies for Douglas fir (autumn) and western hemlock (spring) containerized stock. The results indicated that although quality of planting stock and the season following planting are influential, a 10 to 15% survival and growth advantage can be gained by planting within the hypothetical window.

Non-OSU Link

73. Duryea, M.L. and S.K. Omi. 1987. Top pruning Douglas-fir seedlings: morphology, physiology, and field performance. Canadian-Journal-of-Forest-Research 17(11): 1371-1378.

Keywords: nursery operations
nursery pruning
tree phenology
tree/stand health
growth
yield

Abstract: Seedlings from 9 seed sources at 6 nurseries in Washington, Oregon and California were treated with various pruning treatments including tall and short ht. (25 and 15 cm, respectively), early and late timing (6 wk after bud burst or 6 wk after bud set, respectively), pruning twice or no pruning. Seedlings were evaluated for phenology and quality, and graded in the nursery. For each seed source, seedlings were planted at field sites in their own zone and on one common site. Seedlings pruned tall and early began growing again within 5 wk and set buds 2 wk later than unpruned seedlings. Shippable yield of seedlings pruned tall and early and of unpruned seedlings were n.s.d, although more pruned seedlings had multiple leaders. Pruned seedlings were smaller than unpruned seedlings at the time of

planting. Survival and growth were the same for pruned and unpruned seedlings in the 1st year after planting. Pruned seedlings grew more than unpruned seedlings in the 2nd year, but were still shorter after 2 yr. Field growth was greater in seedlings pruned tall or early than in seedlings pruned short or late. It is concluded that pruning should be continued as a cultural practice if it benefits nurseries, but that late short pruning should be avoided.

OSU Link
Non-OSU Link

74. Edgren, J.W. 1981. Field performance of undercut coastal and Rocky Mountain Douglar-fir 2+0 seedlings. Tree-Planters' Notes 32(3): 33-36.

Keywords: nursery operations
tree/stand health
growth

Abstract: Seedlings from 1 seed source each of Pseudotsuga menziesii var. menziesii (coastal) and P. menziesii var. glauca (Rocky Mountain) were grown in a nursery in Washington and half were undercut at 15 cm below the surface at 1-yr-old. Seedlings were lifted in March the next yr (1968) and planted out at 2 sites in Oregon. Survival of undercut coastal firs 3 yr after planting was significantly better than controls. Survival of Rocky Mountain fir was not significantly affected by undercutting. Ht. growth of control seedlings of both varieties was significantly greater in their 1st season than that of undercut seedlings, but the differences disappeared the following year.

OSU Link
Non-OSU Link

75. El Kassaby, Y.A. 2000. Representation of Douglas-fir and western hemlock families in seedling crops as affected by seed biology and nursery crop management practices. Forest Genetics 7(4): 305-315.

Keywords: genetic tree improvement
nursery operations
genetic relationships
tree/stand health
reproduction

Abstract: The impact of container-nursery management practices on the genetic representation of seedling crops of Douglas fir (Pseudotsuga menziesii) and western hemlock (Tsuga heterophylla) were evaluated. Two experiments, one for each species, were conducted inBritish Columbia, Canada, to determine the cumulative effects of seed-donor variation on germination parameters (percent and speed) and their interaction with container-nursery practices of thinning and culling on the genetic representation of each seed-donor in the resultant seedling crops. The experimental work was conducted on seedlots that were represented with equal contribution of seeds from 15 seed orchard parents (families). In each experiment, a total of 25 920 seeds were sown in four different arrangements to compare the crop development under single-, two-, and three-seeds per cavity (seeds within cavity were selected randomly among the 15 families) and family blocks (seeds within block belonged to one family). This experimental design allowed determination of inter- and intra-family competition. Within

each experiment, a total of 15 015 cavities were used and the identity of every seed within every cavity within each arrangement was maintained throughout the study. Families were compared based on: (1) changes in their rank order from seedling emergence (germination) to post-thinning and post-culling status, and (2) relative performance of each family from seed contribution to seedling production. Changes were observed in both assessments (i.e., rank and relative contribution). Path analysis was used to determine the percent contribution of each factor to seedling production. It was determined that seedling germination, germinant thinning, and seedling culling all affected seedling production, indicating the presence of several consecutive unintentional bottlenecks in the process. Family sowing with culling standards that recognize the growth differences among families in the nursery and single seed sowing after understanding the inter-/intra-family competition are recommended for seedling production to maintain seedling-crop family representation.

OSU Link

76. 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.

OSU Link
Non-OSU Link

77. El Kassaby, Y.A. and A.J. Thomson. 1996. Parental rank changes associated with seed biology and nursery practices in Douglas-fir. Forest Science 42:228-235.

Keywords: genetic tree improvement
nursery operations
reproduction
genetic relationships
tree/stand health

Abstract: The impact of container-nursery management practices on the genetic composition of seedling crops was evaluated in an experimental study in a seed orchard in British Columbia. The study

was designed to determine the cumulative effects of: (1) differences in parental reproductive output in bulk seedlots; (2) parental variation in germination parameters (percentage and speed); and (3) the interaction of these parameters with container-nursery practices of thinning and culling, and their effect on the genetic representation of parents in the resultant seedling crops. Results from the experimental study were compared with predictions of a stochastic simulation designed to estimate the consequences of differential parental seed contribution, and seed germination percentage and germination speed on indicators of crop performance. The experimental study was conducted on a Douglas-fir (Pseudotsuga menziesii) bulk seedlot that was representative of the differential seed contributions from 19 seed orchard parents. The nursery study included a total of 42 000 seeds. Seeds were sown at three seeds per cavity. Within the 14 000 cavities used, the identity of every seed was maintained throughout the study. Comparisons of parents were made based on: (1) changes in their rank order from sowing to postthinning and postculling status; and (2) relative performance from seed contribution to seedling production. Changes were observed in both assessments. Path analysis was used to determine the percentage contribution of each factor to seedling production. It was determined that germination, thinning, and culling contributed 66, 20, and 14%, respectively, to seedling production, indicating the presence of three consecutive bottlenecks in the process. Single seed or individual family sowing in the nursery was recommended for seedling production to maintain genetic diversity.

OSU Link
Non-OSU Link

78. Entry, J.A., K. Cromack, Jr., R.G. Kelsey and N.E. Martin. 1991. Response of Douglas-fir to infection by Armillaria ostoyae after thinning or thinning plus fertilization. Phytopathology 81(6): 682-689.

Keywords: thinning
fertilization
tree/stand protection
growth
tree morphology
carbon allocation
tree/stand health
tree physiology

Abstract: Second-growth stands of Douglas-fir (Pseudotsuga menziesii) were thinned to a 5- x 5-m spacing (TT); additional plots were thinned and fertilized once with 360 kg of N (as urea)/ha (TF). An unthinned, unfertilized stand (UT) served as a control. Ten years after treatment, trees were inoculated with 2 isolates of A. ostoyae. Trees receiving the TF and TT treatments produced greater diameter growth, leaf area, and wood production/msuperscript 2 leaf area per year than did those under the UT treatment. Rates of infection by A. ostoyae were highest in trees that received the TF and lowest in trees that received the TT treatment. Concn of sugar, starch and cellulose in root bark tissue were highest in trees receiving the TF treatment and lowest in trees receiving TT treatment. Concn of lignin, phenolics and protein-precipitable tannins were highest in root bark from TT trees and lowest in root bark from TF trees. Biochemical parameters of root bark tissue were regressed with incidence of infection; coefficients of determination (rsuperscript 2) ranged from 0.07 (starch) to 0.57 (phenolic compounds). Ratios of the energetic costs of phenolic and of lignin degradation to the energy available from sugars (Epd:Eas and Eld:Eas) were correlated with incidence of infection (rsuperscript 2 = 0.77 and 0.70, respectively). It is concluded that thinning combined with fertilization may predispose P. menziesii trees

to infection by A. ostoyae by lowering concn of defensive compounds in root bark and increasing the energy available to the fungus to degrade them.

OSU Link
Non-OSU Link

79. Erickson, R.D. 1995. Douglas-fir tussock moth. *In* Forest Pest Leaflet 09. Pacific-Forestry-Centre,-Canadian-Forest-Service.

Keywords: tree/stand protection
tree/stand health

Abstract: The recognition, biology, host plants, injuriousness, distribution and control of the lymantriid Orgyia pseudotsugata, especially on Douglas fir (Pseudotsuga menziesii), in British Columbia are discussed. Natural controls, such as parasitoids, predators and a nuclear polyhedrosis virus, normally control endemic populations, and a list is provided of 3 species of parasitic Diptera and 17 Hymenoptera that have been reared from the lymantriid in British Columbia.

OSU Link
Non-OSU Link

80. 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 isrecommended for Douglas fir seed orchards.

OSU Link
Non-OSU Link

81. Feller, M.C. 1990. Herbicide application followed by prescribed fire to convert a brushfield into a conifer plantation in south coastal B.C.: a combination of the initial effects of two treatments. B.C. Ministry of Forests FRDA Report 146. 40 p.

Keywords: site preparation
chemical preparation

prescribed fire
growth
tree/stand health
soil properties
stand conditions

Abstract: A field study was carried out in Pseudotsuga menziesii stands in British Columbia, Canada, to investigate the effects on vegetation of glyphosate applications in September 1987 or July 1988, followed by burning in October 1988. Results did only show slight differences between treatments.

OSU Link
Non-OSU Link

82. Ferris, R.L. and H.A. Woensdregt. 1983. Western false hemlock looper in British Columbia. In Pest-Leaflet. Pacific-Forest-Research-Centre, Canada.

Keywords: tree/stand protection
tree/stand health

Abstract: The infestation history, hosts, distribution, appearance, life history, damage and control of Nepytia freemani are described.

OSU Link
Non-OSU Link

83. Figueroa, P.F. 1993. Efficacy and cost of ground-applied herbicide methods for red alder control. Down to Earth 48(1): 6-10.

Keywords: release treatments
chemical release
stand conditions
growth
tree/stand health

Abstract: The effects on red alder [Alnus rubra] mortality, diam. at breast height and height, and any phytotoxic effects to Douglas fir [Pseudotsuga menziesii] of Garlon 4 (triclopyr) at 4 lb/gallon and Chopper EC (imazapyr) at 2 lb, applied by stream line, thin line and low vol. treatments, and of Garlon 3A (triclopyr) at 3 lb, Roundup (glyphosate) at 3 lb and Arsenal (imazapyr) at 4 lb applied by cut stump treatment were evaluated in streamside buffer zones in two 6-year-old P. menziesii plantations in SW Washington. All treatments resulted in good control of A. rubra, but the most cost-effective control was achieved by the stream line application of Garlon 4, followed by low vol. basal or thin line treatments of Garlon 4 and cut stump treatment with 50% Garlon 3, 45% Roundup and 10% Arsenal. Negligible P. menziesii damage was caused by cut stump treatments, but damage occurred with basal-bark treatments although Garlon 4 generally caused less injury than Chopper EC.

OSU Link

84. Figueroa, P.F., R.C. Heald and S.R. Radosevich. 1990. Sensitivity of actively growing Douglas-fir to selected herbicide formulations. Proceedings-of-the-Western-Society-of-Weed-Science 43: 45-52.

Keywords: release treatments
chemical release
growth
tree/stand health

Abstract: The results of field studies at 2 sites in Washington and California indicated that aerial spraying of 2,4-D at 4 lb/acre, triclopyr ester at 4 lb/acre or 2,4-D + triclopyr ester at 1.2 lb/acre + 0.5 lb/acre to control red alder [Alnus rubra] led to a significant reduction in Douglas fir [Pseudotsuga menziesii] growth and survival if applied during periods of active conifer growth. Herbicides applied singly at high rates caused significantly more mortality than the herbicides in combination. At both sites, trees had not fully recovered 5 and 6 years after treatment; damaged trees were at least 1 year behind untreated trees in growth.

OSU Link
Non-OSU Link

85. Filip, G.M. and L.M. Ganio. 2004. Early thinning in mixed-species plantations of Douglas-fir, hemlock, and true fir affected by Armillaria root disease in Westcentral Oregon and Washington: 20 year results. Western-Journal-of-Applied-Forestry 19(1): 25-33.

Keywords: thinning
precommercial thinning
tree/stand protection
growth
tree/stand health

Abstract: Four 10- to 20-year-old plantations were treated to determine the effects of precommercial thinning on tree growth and mortality caused by Armillaria root disease in the Cascade Range of western Oregon and Washington, USA. One plantation was Douglas-fir (Pseudotsuga menziesii) and noble fir (Abies procera), one Douglas-fir and western hemlock (Tsuga heterophylla), one Douglas-fir alone, and one Shasta red fir (Abies magnifica var. shastensis) and mountain hemlock (Tsuga mertensiana). After 20 years, differences in crop tree mortality between thinned and unthinned plots were not significant (P=0.9768). Quadratic mean diameter growth of crop trees, however, was significantly (P=0.0053) greater in thinned than in unthinned plots. Crop tree basal area/ac growth was significantly (P=0.0008) greater in thinned plots. There were no significant (P=0.6647) differences in basal area/ac growth of all trees between thinned and unthinned plots. Apparently, from a root-disease perspective, precommercial thinning does not affect incidence of crop-tree mortality after 20 years, but individual and per acre tree growth of crop trees increase significantly.

OSU Link
Non-OSU Link

86. Filip, G.M. and D.J. Goheen. 1995. Precommercial thinning in Pseudotsuga, Tsuga, and Abies stands affected by armillaria root disease: 10-year results. Canadian-Journal-of-Forest-Research 25(5): 817-823.

Keywords: thinning
precommercial thinning
tree/stand protection
growth
tree/stand health

Abstract: Four 10- to 20-year-old stands were pre-commercially thinned to determine the effects of thinning on tree growth and mortality caused by armillaria root disease (Armillaria ostoyae) in the Cascade Range of western Oregon and Washington, USA: one stand of Douglas fir (Pseudotsuga menziesii var. menziesii) and noble fir (Abies procera), one of Douglas fir and western hemlock (Tsuga heterophylla), one of Douglas fir alone, and one of Shasta red fir (Abies magnifica var. shastensis) and mountain hemlock (Tsuga mertensiana). After 10 years, differences in crop-tree mortality between thinned and unthinned plots were not significant in any of the four stands. Tree radial growth was significantly increased by thinning in 6 of 15 plots. Crop-tree basal area (per hectare) growth was significantly greater in thinned plots. Basal area (per hectare) growth of all trees was significantly greater in unthinned plots. Apparently, from a root-disease perspective, pre-commercial thinning does not affect the incidence of crop-tree mortality after 10 years, but tree growth increases significantly.

OSU Link
Non-OSU Link

87. Fischer, V.F. and V.F. Carrithers. 1992. Tolerance of one and two year old douglas-fir seedlings to triclopyr applications. In Proceedings-of-the-Western-Society-of-Weed-Science, 10-12-March-1992.

Keywords: release treatments
chemical release
tree/stand health

Abstract: In field trials conducted near Marquam, Oregon, during 1988-90, the tolerance was evaluated of douglas-fir [Pseudotsuga menziesii] seedlings to triclopyr ester and triclopyr amine (both applied at 0.5-1.5 lb/acre) during the 1st 2 years after transplanting. Triclopyr amine did not cause significant damage to 1- or 2-year-old plants. Triclopyr ester in a water carrier resulted in injury to terminal buds of 1-year-old plants when applied at 1.5 lb, and in a diesel carrier resulted in damage to lateral and terminal buds when applied at concn of <more or =>1.0 lb. Two-year-old plants were more tolerant than 1-year-old plants to both triclopyr formulations, with triclopyr ester at 1.5 lb in a water carrier resulting in only slight needle injury. However, in a diesel carrier, triclopyr ester at 1.5 lb still resulted in terminal and lateral bud damage.

OSU Link
Non-OSU Link

88. Folk, R.S., S.C. Grossnickle, P. Axelrood and D. Trotter. 1999. Seed lot, nursery, and bud dormancy effects on root electrolyte leakage of Douglas-fir (Pseudotsuga menziesii) seedlings. Canadian-Journal-of-Forest-Research 29(8): 1269-1281.

Keywords: nursery operations
tree physiology

tree/stand health
photosynthesis
growth
tree phenology

Abstract: The effects of seed lot, nursery culture, and seedling bud dormancy status on root electrolyte leakage (REL) of Douglas-fir (Pseudotsuga menziesii) seedlings were assessed to determine if these factors should be considered when interpreting REL for seedling quality. The relationships of REL to survival, net photosynthesis (Pn), stomatal conductance (gwv) mid-day shoot water potential (Psi mid), root growth capacity (RGC), and relative height growth were determined for each factor in experiments in 1994-95 in nurseries inBritish Columbia. Nursery culture had no effect on the relationship between REL and all other measured attributes. Seed lot affected the relationship between REL and Pn, Psi mid, and survival. However, critical REL (i.e., lowest value associated with detectable root damage) and PS80 REL (i.e., level associated with an 80% probability for survival) were similar between seed lots. Bud dormancy status affected the relationship between REL and survival, RGC, and relative height growth. Control levels of REL, critical REL, and PS80 REL decreased as the number of days required for 50% terminal bud break declined. Thus, terminal bud dormancy status must be known before REL can be used to assess seedling quality. If the bud dormancy status of Douglas-fir populations is known, then critical and PS80 REL levels may be useful as indices of root damage.

OSU Link
Non-OSU Link

89. Fraser, R.G., J.D. Beale and R.J. Nevill. 1995. Reduction of Phellinus weirii inoculum in Douglas-fir stumps by the fumigant Telone II-B. Canadian-Journal-of-Forest-Research 25(1): 63-68.

Keywords: tree/stand protection
tree/stand health

Abstract: Two dosages of Telone II-B (1,3-dichloropropene) at 3.4 and 6.7 mL/kg of stump and root biomass were tested to determine the efficacy in reducing Phellinus weirii inoculum in infected Douglas fir (Pseudotsuga menziesii), stumps. After 21 months, both doses of Telone II-B proved equally effective and significantly reduced residual P. weirii mycelium in infected roots. Fumigation reduced residual endotrophic P. weirii in the large-diameter root classes nearest the stump, but survival of the fungus was less affected with increasing distance from the stump and in the smaller root diameter classes. Treated stumps also had significantly fewer roots with ectotrophic mycelium than untreated stumps. Four weeks after application, soil samples taken near treated stumps revealed no evidence of the fumigant. These findings suggest that application of Telone II-B could be used as an effective control measure for P. weirii.

OSU Link
Non-OSU Link

90. Gardner, E.R. 1990. Fertilization and thinning effects on a Douglas-fir ecosystem at Shawnigan Lake: 15-year growth response. Canadian-Forest-Service, Pacific and Yukon Region Information-Report BC-X-319. ix + 42 p.

Keywords: fertilization
thinning
growth
yield
tree morphology
tree/stand health

Abstract: Responses after 15 yr to 3 rates of nitrogen (urea), applied at 0, 224 or 448 kg N/ha to a 24-yr-old Douglas fir (Pseudotsuga menziesii) stand in the very dry maritime region of British Columbia, were analysed on the basis of per hectare, individual tree, crop tree and tree size class. Thinned and unthinned plots were measured.

OSU Link
Non-OSU Link

91. Gourley, M., M. Vomocil and M. Newton. 1990. Forest weeding reduces the effect of deer-browsing on Douglas fir. Forest-Ecology-and-Management 36(2-4): 177-185.

Keywords: release treatments
chemical release
tree/stand protection
growth
tree/stand health

Abstract: In January and February 1981, three-year-old bare-root Douglas fir (Pseudotsuga menziesii) transplants were established in four clear-felled locations in the Oregon Coast Range where browsing by black tail deer (Odocoileus hemionus columbiana) was expected. Protection was provided against browsing by 5 physical (rigid protection tube 7.5x75 cm; protective netting, paper budcaps; leather guard 20x5 cm; and 'Remae' budcaps) and one chemical ('Deer Away') treatment, each of which was tested with and without complete wood control with glyphosate. After five years, none of the protective treatments provided any growth advantages; some even caused growth losses. In contrast, weed control, with or without additional protective measures, consistently improved growth. By the 5th year, weeded trees averaged twice the biomass of unweeded trees, regardless of browsing. Average tree size was largest in the treatment with no weed competition and with no barriers to prevent browsing. Advantages of weeding were greatest on the poorest site. Weed control, in conjunction with the large size of transplants, appeared to prevent most loss due to damage from moderate deer-browsing.

OSU Link
Non-OSU Link

92. Green, R.N. and R.E. Carter. 1993. Boron and magnesium fertilization of a coastal Douglas-fir plantation. Western-Journal-of-Applied-Forestry 8(2): 48-53.

Keywords: fertilization
growth
tree/stand health
tree physiology

Abstract: A study was made of the role of boron and magnesium nutrition in the occurrence of severe growth distortion symptoms in Douglas-fir (Pseudotsuga menziesii) in the Skwawka River valley of south coastal British Columbia. Four fertilizer treatments, including boron (2.25 kg/ha B), magnesium (42 kg/ha Mg), boron plus magnesium, and a control, were applied in conjunction with planting on a site believed to be deficient in these nutrients. After 5 growing seasons, only treatments containing boron (B and B + Mg) showed improved height growth compared to controls. The incidence of leader dieback, swollen leading shoots, and foliage distortion was significantly related to treatment, with virtually no occurrence in plots treated with boron. Seedling uptake of applied boron was high, with foliar concentrations of 45 p.p.m. found after the second growing season. Foliar B levels declined to 13-15 p.p.m. after 5 growing seasons. No significant increase in foliar magnesium levels was detected for either of the magnesium treatments. The reduction in the incidence of leader dieback, and shoot and foliar symptoms, in seedlings treated with B indicate that these symptoms were the result of boron deficiencies. This is the first study to verify boron deficiency in coastal Douglas fir through fertilizer trials.

OSU Link
Non-OSU Link

93. Greene, S.E. and W.H. Emmingham. 1986. Early lessons from commercial thinning in a 30-year-old Sitka spruce-western hemlock forest. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Note PNW-RN-448. 14 p.

Keywords: thinning
commercial thinning
growth
tree/stand health
tree morphology

Abstract: Three commercial thinning treatments were applied to a 30-yr-old stand of Picea sitchensis and Tsuga heterophylla with Pseudotsuga menziesii that had been precommercially thinned at 15 yr old on the Oregon coast. Data were collected to determine the effects of thinning on diam. and ht. growth, the amount of damage and subsequent decay in remaining trees and relations between leaf area and volume production.

OSU Link
Non-OSU Link

94. Haase, D.L., J.H. Batdorff and R. Rose. 1993. Effect of root form on 10-year survival and growth of planted Douglas-fir trees. Tree-Planters' Notes 44(2): 53-57.

Keywords: planting operations
growth
tree/stand health

Abstract: Douglas fir seedlings (Pseudotsuga menziesii) were planted with three root-form treatments including C-roots ('correctly' planted controls), L-roots, and J-roots. After 10 years, there were no significant differences in outplanting performance between the three root-form treatments on a good site in western Oregon. The results are in agreement with those of other studies, which suggests that

when no other confounding planting errors are present, deformed root systems play a less dramatic role in subsequent field performance than is generally thought. These results in no way imply that poor planting is acceptable.

OSU Link
Non-OSU Link

95. Haase, D.L. and R. Rose. 1998. Ten years of herbicide testing in PNW forest nurseries. *In* Proceedings of the Annual Meeting of the Western Society of Weed Science, Waikoloa, Hawaii, 10-12 March, 1998. pp. 50-52.

Keywords: nursery operations
tree/stand health

Abstract: Nursery trials were conducted in Oregon in 1987-96 to investigate the level of weed control and phytotoxicity of herbicides applied to Douglas fir (Pseudotsuga menziesii), noble fir (Abies procera), lodgepole pine (Pinus contorta), ponderosa pine (P. ponderosa), western hemlock (Tsuga heterophylla), Pacific yew (Taxus brevifolia), red alder (Alnus rubra) and bitterbrush (Picramnia pentandra) seedlings. Results indicated that lactofen, metolachlor and clethodim gave good weed control and caused little phytotoxicity. Notably, clethodim did not damage T. heterophylla. Oxadiazon caused phytotoxic symptoms at high but not low concentrations. However, clopyralid, isoxaben, pendimethalin, prodiamine and thiazopyr were deemed unsuitable for some or all species in nurseries on the basis of phytotoxic damage recorded in these and other trials.

OSU Link
Non-OSU Link

96. Haase, D.L., J. Trobaugh and R. Rose. 1999. Douglas-fir container stock grown with fertilizer-amended media: some preliminary results. Rocky Mountain Research Station, USDA Forest Service National Proceedings: Forest and Conservation Nursery Associations 1999, 2000, and 2001. RMRS P-24. 31-32 pp.

Keywords: nursery operations
nursery fertilization
growth
tree physiology
tree/stand health

Abstract: This paper presents the initial results of a study conducted in a nursery in Oregon, USA, to quantify the response of container grown Douglas-fir (Pseudotsuga menziesii) seedlings to various fertilizer treatments (Simplot's 13-13-13 and 17-5-11, and Scotts Company's 18-5-12 and 15-9-10) in terms of height, stem diameter and foliar nutrient content.

97. Hacker, A.L. and B.E. Coblentz. 1993. Habitat selection by mountain beavers recolonizing Oregon Coast Range clearcuts. Journal-of-Wildlife-Management 57(4): 847-853.

Keywords: site preparation

mechanical preparation
tree/stand protection
tree/stand health

Abstract: In Oregon, mountain beavers (Aplodontia rufa) are managed as pests in Douglas fir (Pseudotsuga menziesii) stands; they are normally removed from clearcuts prior to reforestation, but recolonization nevertheless poses problems to regenerating stands. Habitat selection by recolonizing mountain beaver was studied on 8 replanted clearcuts, 4 each of 2 different ages (1 yr old and 4-5 yr old), in the Coast Range mountains of Polk and Lincoln counties, Oregon between June 1989 and August 1990. Clearcuts were recolonized throughout, irrespective of distances from edge (Rsuperscript 2 = 0.01). Six habitat variables were selected by stepwise logistic regression to model recolonized versus non-colonized habitat. Mountain beavers selected areas with high amounts of small (<25 cm) and large diameter (>25 cm) woody debris, forage plants, and uprooted stumps; they were likely to recolonize areas that had soft soils and areas in drainages. The logistic function that included these 6 variables had a correct classification rate of 85% based on a jackknife procedure.Forest managers should find these habitat features useful for predicting mountain beaver recolonization and damage. Potentially productive approaches to habitat management and site preparation are suggested, including reduction of habitat suitability and colonist numbers by minimizing dead wood accumulations, and provisioning of alternate food sources to minimize tree damage without reducing recolonization.

OSU Link
Non-OSU Link

98. Hadfield, J.S. 1988. Integrated pest management of a western spruce budworm outbreak in the Pacific Northwest. Northwest-Environmental-Journal 4(2): 301-312.

Keywords: tree/stand protection
tree/stand health
economics

Abstract: The integrated pest management of the tortricid Choristoneura occidentalis on Douglas fir (Pseudotsuga menziesii) and true fir (Abies spp.) in the Northwest USA is described. Details of the population dynamics and impact of this pest are given. The integrated pest management programme involves the following steps: monitoring the pest-food plant system to measure populations and damage; evaluating the effects of the outbreak; developing alternative strategies for managing the outbreak; evaluating the economic and environmental consequences of these strategies; selecting a strategy; and monitoring the implemented strategy.

OSU Link

99. Hadfield, J.S. and P.T. Flanagan. 2000. Dwarf mistletoe pruning may induce Douglas-fir beetle attacks. Western-Journal-of-Applied-Forestry 15(1): 34-36.

Keywords: tree/stand protection
tree/stand health

Abstract: Fresh attacks by Douglas fir beetles (Dendroctonus pseudotsugae) to Douglas fir (Pseudotsuga menziesii) trees growing in a camp site in Wenatchee National Forest, central Washington, USA, were found following pruning to remove dwarf mistletoe (Arceuthobium douglasii) infections. All Douglas fir trees with a diameter at breast height (dbh) of at least 12.7 cm were examined. Beetle attacks were found on 41% of pruned trees and 5% of unpruned trees. Among pruned trees, both the average number of branches pruned and the average dbh were greater in trees attacked by Douglas fir beetles than in unattacked trees.

OSU Link
Non-OSU Link

100. Haglund, W.A., K.W. Russell and R.C. Holland. 1981. Moss control in container-grown conifer seedlings. Tree-Planters' Notes 32(3): 27-29.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: Seedlings grown in styroblock containers were sprayed with 8 surfactants, or combinations of surfactant and the fungicide captan. Phytotoxicity and moss control were recorded 7 and 14 days after treatment and trees were measured after 30-60 days. The least phytotoxic surfactant was X77; this had no significant effect on ht., stem diam. and total wt. of Pseudotsuga menziesii or Tsuga heterophylla seedlings. Almost complete moss control was achieved with 40-80 lb captan and 2.5-10 gal X77 in 100 gal water applied to Abies procera seedlings; treatment with the highest concn. (80 lb captan and 10 gal X77) was only phytotoxic when the seedlings already had foliar injury. In Tsuga heterophylla treatment with captan and X77 at various concn. caused tree injury only at 80-90 degrees F, but not at 60-65 degrees F.

OSU Link
Non-OSU Link

101. Hahn, P.F. and A.J. Smith. 1983. Douglas-fir planting stock performance comparison after the third growing season. Tree-Planters' Notes 34(1): 33-39.

Keywords: nursery operations
planting operations
growth
tree/stand health

Abstract: Three types of containerized (40, 75 or 125 cmsuperscript 3 containers) and bare rooted (2+1, 3+0 and plug-1 stock) seedlings were planted out in Oregon in Feb. 1979 on N. and S. facing slopes, clear felled in 1978. In general, containerized seedlings showed superior survival rates and greater height growth - particularly on the harsh S. slope, and lower reforestation costs. The 75-cmsuperscript 3 containerized seedlings are recommended, except for N. facing and wet coastal areas, where brush competition can be severe shortly after planting. In such areas, taller bare-rooted seedlings performed better.

OSU Link
Non-OSU Link

102. Hamm, P.B., S.J. Cooley and E.M. Hansen. 1984. Response of Phytophthora spp. to metalaxyl in forest tree nurseries in the Pacific Northwest. Plant-Disease 68(8): 671-673.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: In tests on Douglas fir (Pseudotsuga menziesii) at 2 commercial forest tree nurseries in Ore., 1 application of Subdue (metalaxyl) suppressed root rot. Of 3 P. spp. isolated from treated seedlings (P. megasperma, P. drechsleri and P. pseudotsugae), only P. pseudotsugae decreased in isolation frequency because of the fungicide. Survival of P. spp. in infected seedlings remained high after treatment. At 1 nursery, 10 months after the first application, P. spp. were isolated from 92% of the seedlings across fungicide treatments, whereas at the 2nd isolation frequencies from seedlings were 77, 70, 29 and 13%, respectively, after 0, 1, 2 and 3 applications. P. was recovered from previously healthy seedlings 8 wk after they were transplanted into naturally infested, metalaxyl-treated soil.

OSU Link
Non-OSU Link

103. Han, H., L.D. Kellogg, G.M. Filip and T.D. Brown. 2000. Scar closure and future timber value losses from thinning damage in western Oregon. Forest-Products-Journal 50(1): 36-42.

Keywords: thinning
tree/stand health
economics

Abstract: This study investigated bark growth and decay development after thinning damage at two western Oregon sites, and estimated value loss with a tree growth model. All scars that remained open in western hemlock (Tsuga heterophylla) and Sitka spruce (Picea sitchensis) had advanced decay 13 years after initial wounding. Scars less than 4 inches wide closed in 8 years. Douglas-fir (Pseudotsuga menziesii) was more resistant to decay; no rot was observed in scars less than 21 years old. Advanced decay and pitch rings, however, were observed in 29-year-old scars, both open and closed. Because of these defects, future value loss increased with time after wounding and with higher stand damage levels. Fifty years after thinning, about 2% of the total future log value, or $189/ac. (1997$), could be lost in Douglas-fir stands with 20% stand damage and a 2-inch diameter deduction. This loss could be reduced to $58/ac. if stand damage were minimized to 5% with more careful techniques. The increase in thinning costs ($61/ac. for tractor thinning; $79/ac. for cut-to-length; $124/ac. for skyline; with a 5% increase in production time) that is incurred while trying to minimize stand damage could be justified if it reduced future value losses to crop trees.

OSU Link
Non-OSU Link

104. Hansen, E.M., J.K. Stone, B.R. Capitano, P. Rosso, W. Sutton, L. Winton, A. Kanaskie and M.G. McWilliams. 2000. Incidence and impact of Swiss needle cast in forest plantations of Douglas-fir in coastal Oregon. Plant-Disease 84(7): 773-778.

Keywords: tree/stand protection
growth
tree/stand health

Abstract: An epidemic of Swiss needle cast, caused by the ascomycete Phaeocryptopus gaeumannii, is causing defoliation and growth reductions in Douglas-fir forest plantations along the Oregon Coast. The area of symptomatic plantations has been monitored annually since 1996 by aerial survey; in spring 1999, 119,500 ha were affected. Pathogen and symptom development have also been monitored on nine permanent plots in stands of differing disease severity. Infection levels and symptom severity are greatest in low elevation plantations close to the coast. In areas of severe disease, trees retain only current year needles. Defoliation is proportional to the number of stomata occluded by pseudothecia of the fungus, with needles being shed when about 50% of stomata are occupied, regardless of needle age. Fungus sporulation and premature needle abscission are greatest on the upper branches of trees. Annual application of fungicides increases needle retention significantly. Tree height and diameter growth and total tree volume are reduced by disease, and tree volume is significantly correlated with needle retention on our plot trees. The epidemic continues to be most severe in Douglas-fir plantations established on sites where Sitka spruce and western hemlock or red alder predominated in earlier times.

OSU Link
Non-OSU Link

105. Harper, P.A. and A.S. Harestad. 1986. Vole damage to coniferous trees on Texada Island. Forestry-Chronicle 62(5): 429-432.

Keywords: thinning
precommercial thinning
tree/stand protection
tree/stand health
growth

Abstract: Microtus townsendii injured trees by removal of bark and cambium from stems, branches and roots of Douglas fir, western hemlock and, rarely, Pinus monticola on Texada Island, British Columbia. Damage occurred more frequently in precommercially thinned stands <40 yr old than in unspaced stands. Trees with d.b.h. <less or =>19 cm were damaged by voles, but there was no selection by diam. or age class. No trees of ht. >16 m were damaged. For trees <16 m, damage increased as ht. decreased. There were n.s.d. in growth rates of trees damaged by voles when comparing the 2-yr av. before spacing and vole damage with the av. after these events. Stands should continue to be monitored to evaluate long-term effects of vole damage. On the basis of these results, control of voles is not recommended.

OSU Link
Non-OSU Link

106. Harrington, T.B. and J.C. Tappeiner, II. 1997. Growth responses of young Douglas-fir and tanoak 11 years after various levels of hardwood removal and understory suppression in southwestern Oregon, USA. Forest-Ecology-and-Management 96(1/2): 1-11.

Keywords: release treatments
manual release
growth
tree/stand health

Abstract: Douglas fir (Pseudotsuga menziesii) was planted as 2-yr-old bare rooted seedlings on 2 sites in SW Oregon cleared of old-growth Douglas fir and understorey tanoak (Lithocarpus densiflorus) in 1980, and broadcast burned in 1981. Planting was done in 1981 at one site and in 1982 at the second site. Height, diameter, and crown width of the young Douglas fir and sprout-origin tanoak were measured 1-11 years after reducing the density of the tanoak stand (in 1983, at 2 yr old) to 0, 25, 50 and 100% of its initial cover. On some of the experimental plots suppression of understorey vegetation was also carried out. Tanoak cover developed linearly with time, with steepness of the growth trajectory increasing at a diminishing rate with increasing percentage of initial tanoak cover. Fifth-year cover of understorey vegetation declined linearly with increasing percentage of initial tanoak cover. Survival of Douglas fir (96-100%) differed little among initial abundances of tanoak, while growth trajectories for its size became increasingly exponential with decreasing percentage of initial tanoak cover. Eleventh-year heights of Douglas fir were similar for 0, 25 and 50% of initial tanoak cover; however, diameter increased linearly with decreasing percentage of initial tanoak cover, and the slope of the relationship steepened with understorey suppression. The results indicate that young stands exhibiting a wide range of stand compositions and productivities can be established by early manipulations of tanoak and understorey abundance. Complete removal of tanoak plus understorey suppression are necessary to maximize Douglas fir growth, while productive, mixed stands can be achieved by removing 50% or more of tanoak cover.

OSU Link
Non-OSU Link

107. Harrington, T.B., R.G. Wagner, S.R. Radosevich and J.D. Walstad. 1995. Interspecific competition and herbicide injury influence 10-year responses of coastal Douglas-fir and associated vegetation to release treatments. Forest-Ecology-and-Management 76(1/3): 55-67.

Keywords: release treatments
chemical release
manual release
growth
tree/stand health
tree physiology
stand conditions

Abstract: Responses of competing vegetation and planted Douglas fir (Pseudotsuga menziesii var. menziesii) were studied for 10 years after six herbicide and manual release treatments in the Washington and Oregon Coast Ranges. Studies were installed in six 2- or 3-yr-old plantations, with Douglas fir densities of 988 to 1482 plants/ha at time of planting and 721 to 1282/ha 2 to 3 years late. Research objectives were to quantify regional, long-term responses of vegetation (Douglas fir and non-

coniferous species) to various levels of competition, light and soil water availability, and intensity versus importance of factors influencing Douglas fir growth. Three treatments reduced shrub cover relative to the untreated check: triclopyr in year 1, glyphosate in years 1-5, and repeated control (via several herbicide applications) in years 1-10. Reductions in woody cover from glyphosate stimulated increases in herb cover in years 3 and 5, while repeated control reduced herb cover in years 1, 2 and 5. Through year 10, Douglas fir survival (86-99%) varied little among treatments. Visual symptoms of herbicide injury to Douglas fir from triclopyr (45% of trees) and glyphosate (17% of trees) were associated with 0.1-0.2 m reductions in first-year height. After adjusting for tree size, Douglas fir growth in stem basal area 2 years after triclopyr was less than that of the untreated check, suggesting prolonged effects of herbicide injury. Because it sustained low levels of interspecific competition, caused minimal tree injury, and prevented overtopping cover from red alder (Alnus rubra), repeated control was the only treatment in which Douglas fir size (9.8 m height and 21 cm basal diameter in year 10) significantly exceeded (P<less or =>0.02) that of the untreated check (7.8 m height and 12 cm diameter).

OSU Link
Non-OSU Link

108. Harrison, R.B., S.P. Gessel, D. Zabowski, C.L. Henry, D.S. Xue, D.W. Cole and J.E. Compton. 1996. Mechanisms of negative impacts of three forest treatments on nutrient availability. Soil-Science-Society-of-America-Journal 60(6): 1622-1628.

Keywords: fertilization
growth
soil properties
tree/stand health

Abstract: Many forest management treatments are directly aimed at maintaining or enhancing forest productivity. There may also be secondary effects that detract from this goal. Three case studies in Washington state, USA, are discussed in which several mechanisms may have led to adverse secondary impacts. In the first study, pulp and paper (PIT) sludges were mixed into soil and growth of Douglas-fir (Pseudotsuga menziesii), noble fir (Abies procera) and western white pine (Pinus monticola) was monitored. There was a significant negative correlation of height and diameter growth and C:N ratio for Douglas-fir and western white pine. In a second study, effects of 50 years of red alder (Alnus rubra) and Douglas-fir growth on soil chemistry and stand productivity were compared. When the 50-year-old stands were cut and red alder was established by planting into the soil of the former Douglas-fir and red alder forests, a reduction in available P in the soil of the previous red alder stand was observed. In a third study, high rates of low C:N ratio organic matter (300 t/ha) were added in municipal biosolids (~8000 kg N/ha) to Douglas-fir and grand fir (Abies grandis) plantations. Excess organic N in the biosolids apparently mineralized, nitrified, and contributed to soil acidification and accelerated cation leaching. Severe Mg deficiency (0.25 g/kg in biosolids-treated vs. 0.93 g/kg in untreated areas) might be the cause of observed foliar chlorosis and poor growth rates.

OSU Link
Non-OSU Link

109. Harrison, R.B., C.L. Henry and D.S. Xue. 1994b. Magnesium deficiency in Douglas-fir and grand fir growing on a sandy outwash soil amended with sewage sludge. Water, Air, and Soil Pollution 75(1/2): 37-50.

Keywords: fertilization
tree/stand health
tree physiology
soil properties

Abstract: Soil and plant samples were collected from chlorotic plantations of grand fir (Abies grandis) and Douglas fir (Pseudotsuga menziesii) near Seattle, Washington state, USA, in winter 1989. The soils had been amended in 1981 with an average of 300 dry t/ha of municipal sewage sludge. The sludge amendment resulted in an N application rate of approximately 8000 kg/ha. Foliage analysis indicated that a severe Mg deficiency (0.25 g/kg in sludge-treated vs. 0.93 g/kg in untreated areas) might be the cause of chlorosis. No other nutrient showed concentrations in the deficient or toxic ranges. Trace metal levels in foliage were increased significantly for Ni, Cd and Cr at sludge-treated sites, but were not at toxic levels. Soil samples taken to a depth of 1.4 m indicated the potential for soil acidification (up to 0.9 pH unit) in soil surface horizons. In addition, exchangeable Ca, Mg and K may have been depleted in surface horizons. Exchangeable Al and Fe were greater in the surface of sludge-treated sites. These observations, and the loss of much of the nitrogen added during the sludge amendment, indicated that nitrification and cation leaching were the most likely mechanism for acidification and depletion of exchangeable cations. Fertilizing the plantation with MgSO4 or dolomitic limestone was carried out in spring 1990. New foliage collected in June 1990 was non-chlorotic and significantly higher in Mg concentration than unfertilized foliage (1.1. vs. 0.7 g/kg, respectively). The results of this study indicate that it is important to assess the potential for initiating a nutrient deficiency due to secondary effects of sludge application in forest systems.

OSU Link
Non-OSU Link

110. Harrison, R.B., E.C. Turnblom, C.L. Henry, P. Leonard, R. King and R. Gonyea. 2002. Response of three young Douglas-fir plantations to forest fertilization with low rates of municipal biosolids. Journal-of-Sustainable-Forestry 14(2/3): 21-30.

Keywords: fertilization
growth
tree/stand health

Abstract: Growth responses were monitored in three Pseudotsuga menziesii stands (Units 2, 11 and 13) in Washington, USA, following single low applications (17-19 t/ha) of municipal biosolids amendment. At the last measurement, in 1995, there were a total of 162 vs. 137 live trees (per 0.121 ha of 3 plots) in unit 2, 94 vs. 137 in unit 11, and 100 vs. 110 in unit 13 in control vs. biosolids-treated plots, respectively. The response ranged from 0.4 to 2.2 cm for average diameter at breast height, and -0.03 to 0.64 m for average total height. The small negative response could be due to mortality of trees or small errors in height measurements. The response in per ha values ranged from 0.8-5.2 m2/ha for basal area, 9-39 m3/ha for volume, and 3965-16 107 kg/ha for dry weight.

OSU Link
Non-OSU Link

111. Heilman, P. 1983. Effects of surface treatment and interplanting of shrub alder on rowth of Douglas-fir on coal spoils. Journal-of-Environmental-Quality 12(1): 109-113.

Keywords: planting operations
site preparation
mechanical preparation
growth
tree physiology
soil properties
tree/stand health

Abstract: Annual growth of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) planted on topsoiled spoils at a coal mine near Centralia, Wash., was monitored for the first 6 y after planting. Treatments were contour bedding, contour bedding plus interplanted Sitka alder (Alnus sinuata (Reg.) Rydb.), and unbedded control. The bedding significantly increased growth of Douglas-fir in all 5 y of the study. Total height growth after 5 y was 35% greater than control on the bedding only plots, and 43% greater on the bedding plus Sitka alder plots. Height growth of Douglas-fir in the mixed stand was significantly greater during the 2nd and 3rd y of the study, but after 5 yr, no significant difference was evident in total height between the mixed and pure Douglas-fir plots. Concentration of N in Douglas-fir foliage was significantly increased by bedding in the fifth but not in the fourth year. Interplanting with Sitka alder had no significant effect on N in Douglas-fir foliage. The top 0.3 m of soil in the ridged portion of the bedded area contained significantly less moisture over a summer than did the top 0.3 m of the unbedded soil. At deeper depths, however, soil moisture was not significantly affected by bedding. Wind damage caused by a severe storm that occurred after 5 y was very much greater on the unbedded plots (49% wind-thrown vs. 9 to 15% wind-thrown on the bedded plots) despite the smaller size of the trees on unbedded plots.

OSU Link
Non-OSU Link

112. Helgerson, O.T. 1985. Survival and growth of planted Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) and ponderosa pine (Pinus ponderosa Dougl. ex Laws.) on a hot, dry site in southwest Oregon. Tree-Planters' Notes 36(4): 3-6.

Keywords: nursery operations
planting operations
tree/stand health
growth

Abstract: One-yr-old containerized seedlings and 2-yr-old bare rooted seedlings of both species were planted in Feb. 1982 on a W.-facing 35% slope on Tin Pan Peak. The site receives <760 mm of precipitation annually. Weeds were controlled with herbicides applied before and after planting. Survival after 2 yr averaged 94% for all stock types; survival of bare rooted seedlings (98-99%) was significantly better than that of containerized seedlings (88-92%). Relative vol. growth was greater for pine than Douglas fir. After 2 yr, the 2+0 bare rooted pines were significantly larger than the 2+0 Douglas firs, despite a smaller starting size.

OSU Link
Non-OSU Link

113. Helgerson, O.T. 1990a. Effects of alternate types of microsite shade on survival of planted Douglas-fir in southwest Oregon. New-Forests 3(4): 327-332.

Keywords: planting operations
tree/stand protection
tree/stand health
growth

Abstract: Five-yr survival of 2+0 bare root Douglas fir (Pseudotsuga menziesii) seedlings was increased by 3 types of shading: cardboard shadecards placed S. or E. of seedlings; and bottomless styrofoam cups inverted around seedling base, on 2 S.-facing sites. On the drier site, seedlings survived well without shading (89% unshaded, 98% shaded), but on the wetter site, where seedlings were more stressed, shading was more beneficial (62% unshaded, 89% shaded). Shading did not affect growth. Seedlings grew more in 5 yr on the drier than the wetter site, possibly because of better handling and planting practices, less browsing by deer, and better weed control.

OSU Link
Non-OSU Link

114. Helgerson, O.T. 1990b. Response of underplanted Douglas-fir to herbicide injection of sclerophyll hardwoods in southwest Oregon. Western-Journal-of-Applied-Forestry 5(3): 86-89.

Keywords: nursery operations
release treatments
chemical release
stand conditions
tree physiology
tree/stand health
growth

Abstract: Low-value broadleaf sclerophyll forests in SW Oregon, typically composed of tanoak (Lithocarpus densiflorus), Pacific madrone (Arbutus menziesii) and chinkapin (Castanopsis chrysophylla), may be converted to commercially valuable Douglas fir (Pseudotsuga menziesii) by underplanting. Results are given of studies of container-grown plug and nursery-grown bareroot fir seedlings planted out in March 1983 on plots in which all broadleaf stems had been previously (September 1981) injected with triclopyr amine. Although 60% broadleaf cover was killed by injection, 7 years later ground cover was significantly greater on these treated plots because of sprouting. Seedlings planted beneath treated broadleaf trees experienced greater daytime, but less predawn, moisture stress; plugs survived better than bareroots; and survival of seedlings on treated plots was not significantly better until 2 years after planting. Herbicide injection also resulted in increased height, diameter and volume growth rates of Douglas fir seedlings, and is recommended for the establishment of a conifer stand.

OSU Link
Non-OSU Link

115. Helgerson, O.T., D.H. McNabb and S.D. Hobbs. 1991. Survival and growth of Douglas-fir seedlings after prescribed burning of a brushfield in southwest Oregon. Western-Journal-of-Applied-Forestry 6(3): 55-59.

Keywords: site preparation
prescribed fire
tree/stand health
growth

Abstract: Five years after planting, survival of 2-0 bare root Douglas fir (Pseudotsuga menziesii) seedlings was high on both burned and unburned plots (89 and 87%, respectively), but seedling stem height, diameter, and volume were greater in burned than in unburned plots.

OSU Link
Non-OSU Link

116. Helgerson, O.T., S.D. Tesch, S.D. Hobbs and D.H. McNabb. 1989. Survival and growth of ponderosa pine and Douglas-fir stocktypes on a dry low-elevation site in southwest Oregon. Western-Journal-of-Applied-Forestry 4(4): 124-128.

Keywords: nursery operations
planting operations
growth
tree/stand health

Abstract: Two stocktypes (1+0 container-grown plugs and 2+0 nursery-grown bareroots) of ponderosa pine (Pinus ponderosa) and of Douglas fir (Pseudotsuga menziesii) were planted on a hot, droughty, low-altitude site near Medford, Oregon, which had burned in 1981. The main objective was to assess the potential for reforesting this type of site. After 5 growing seasons, bare rooted stock survived (98%) significantly better than plugs (89%); survival did not differ significantly by species. Douglas fir was taller than pine, pine was larger in diam., and the 2 species had approximately equal stem volumes. Bare rooted stock was consistently larger than plugs. Results show that these species and stocktypes can provide good reforestation after 5 yr on this type of site when seedlings are of good quality, are planted properly, and are given good weed control.

OSU Link
Non-OSU Link

117. Helgerson, O.T., S.D. Tesch, S.D. Hobbs and D.H. McNabb. 1992. Effects of stocktype, shading, and species on reforestation of a droughty site in southwest Oregon. Northwest-Science 66(2): 57-61.

Keywords: nursery operations
planting operations
tree/stand protection
tree/stand health
growth

Abstract: On hot, dry sites, shading may differentially increase survival of planted Douglas fir (Pseudotsuga menziesii) according to seedling size, and Douglas fir may differ from ponderosa pine (Pinus ponderosa) in early survival and growth. The survival and growth of Douglas fir seedlings (1+0 container-grown plugs and 2+0 bare-rooted seedlings, unshaded or shaded with cardboard shadecards at planting) and unshaded 2+0 bare-rooted ponderosa pine were compared on a droughty south facing clear felling in Oregon. The site was clear felled and burned in 1982 and the seedlings were planted in 1983. Shading did not significantly increase survival of plugs, possibly because of a wetter than normal first summer, nor did shading affect growth of either Douglas fir stocktype 5 yr after planting. Bare-rooted Douglas fir remained significantly larger than plugs, but relative growth rates for the initially smaller plugs were significantly greater for diameter and volume. Survival and growth of ponderosa pine tended to be better than those of Douglas fir. It was concluded that both species appeared to be suitable for reforestation after clear felling on sites subject to drought.

OSU Link
Non-OSU Link

118. Henry, C.L. 1987. Growth response, mortality, and foliar nitrogen concentrations of four tree species treated with pulp and paper and municipal sludges. *In* The-forest-alternative-for-treatment-and-utilization-of-municipal-and-industrial-wastes. *Eds.* Cole, D.W., C.L. Henry, and W.L. Nutter. University of Washington Press, Seattle, Washington, USA. pp. 258-265.

Keywords: nursery operations
nursery fertilization
soil properties
growth
tree/stand health
tree physiology

Abstract: Four nursery beds at the University of Washington Charles Lathrop Pack Demonstration Forest were each divided into plots that received 8 sludge treatments before being planted with seedlings of Douglas fir, Abies procera or Pinus monticola, or cuttings of Populus deltoides X P. trichocarpa. Each sludge and the unamended soil were analysed for total solids, total C, P and K, total N and NH4-N. Ht. and diam. were measured after planting in April 1984 and again in Feb. 1985. N was determined in foliage sampled during Oct. (Populus) or Feb. (other species). Addition of pulp and paper sludge alone and combined with municipal sludge provided predictable growth responses when compared with the C : N ratio of each treatment. Av. response was positive when the C : N ratio was more favourable than that of untreated soil, but av. response was negative when soil was treated with primary pulp and paper sludge with a very high C : N ratio. Treatments that produced the greatest growth also increased seedling mortality.

Non-OSU Link

119. Henry, C.L., D.W. Cole, T.M. Hinckley and R.B. Harrison. 1993. The use of municipal and pulp and paper sludges to increase production in forestry. Journal-of-Sustainable-Forestry 1(3): 41-55.

Keywords: nursery operations
nursery fertilization

fertilization
thinning
growth
tree/stand health
soil properties

Abstract: Because of their high nutritional content and soil conditioning properties, municipal and pulp and paper (P&P) sludges (biosolids) can serve as soil amendments for nutritionally deprived or organically poor soils on forest sites. Studies conducted over the past 20 years at an experimental forest site in Western Washington, USA, have largely confirmed the potential of biosolids to increase the productivity of many forest lands. These studies clearly demonstrated that application of biosolids at environmentally acceptable rates will result in growth responses for both young seedlings as well as established stands. Municipal biosolids have been applied to a number of Douglas fir (Pseudotsuga menziesii) stands. Young stands treated with 47 t/ha showed an average of 72, 14 and 2% height responses for Site Class IV, III and II, respectively, over a 10 year period. Thinned versus unthinned 55-year-old Douglas fir treated with 142 dry t/ha averaged 43 and 48%, respectively, for the 12 year period greater than controls. Average growth responses of 65 and 40% occurred in the 65-year-old stand for the Site Class IV and II, respectively, from a 47 dry t/ha application. Growth response resulting from application of P&P biosolids to a number of tree species (Douglas fir, Pinus monticola and Abies procera in nursery beds, and plots of Populus deltoides x P. trichocarpa rooted cuttings) has also been excellent. When properly applied, biosolids can provide an excellent alternative to chemical fertilizers as a means of enhancing forest production. Growth response is typically greater and lasts longer when compared with chemical fertilizers.

OSU Link
Non-OSU Link

120. Hessburg, P.F., D.J. Goheen and H. Koester. 2001. Association of black stain root disease with roads, skid trails, and precommercial thinning in Southwest Oregon. Western-Journal-of-Applied-Forestry 16(3): 127-135.

Keywords: thinning
precommercial thinning
tree/stand protection
tree/stand health

Abstract: The incidence and severity of black stain root disease (BSRD), caused by Leptographium wageneri, were evaluated in a two-stage sample of 500 precommercial-aged Douglas-fir (Pseudotsuga menziesii) plantations on 5 Resource Areas of the Medford District, Bureau of Land Management in Oregon, USA. Black stain was widely distributed throughout the western half of the District. Nearly 19% of the susceptible-aged (10- to 30-year-old) plantations were infected with black stain, but mortality losses were low. In both the extensive and intensive surveys, BSRD was more often distributed in precommercially thinned than unthinned plantations. Black stain occurred with significantly greater frequency adjacent to roads and major skid trails than in the main body of plantations. Roadside strips displayed significantly more injured trees and recent soil disturbance than the main body of plantations. BSRD incidence was high in comparison with other root diseases, but there was minimal impact to precommercial stand management. Low disease severity is somewhat unique among managed forests within this area of known high BSRD hazard. The lack of widespread damage from BSRD was associated

with a lack of extensive tractor yarding and an apparent lack of precommercial thinning. Forest managers within high BSRD hazard areas can maintain low mortality levels by minimizing site disturbance and tree injury associated with timber harvesting, road building, and road maintenance activities and by timing precommercial thinning to avoid vector insect emergence and flight periods. Increased disturbance and injury to precommercial-aged stands will likely result in increased disease.

OSU Link
Non-OSU Link

121. Hildebrand, D.M., J.K. Stone, R.L. James and S.J. Frankel. 2004. Alternatives to preplant soil fumigation for Western forest nurseries. Pacific-Northwest-Research-Station,-USDA-Forest-Service General-Technical-Report PNW-GTR-608. ii + 27 p.

Keywords: nursery operations
nursery fertilization
tree/stand protection
tree/stand health
growth

Abstract: Field trials were conducted at six bare-root forest tree (Pinus ponderosa, Pseudotsuga menziesii, Pinus contorta and Abies magnifica var. shastensis) nurseries in the Western United States: Bend Pine Nursery in Bend and J. Herbert Stone Nursery in Central Point (Oregon), Coeur d'Alene Nursery and Lucky Peak Nursery in Idaho, and Humboldt Nursery near McKinleyville and Placerville Nursery near Camino (California). These field experiments compared cultural treatments including timing and depth of sowing; bare fallow (with and without periodic tilling); organic amendments including sawdust, composts, and cover crops; mulches including pine needles, sawdust, and rice straw; and fumigation with methyl bromide/chloropicrin or dazomet. Measured effects included population levels of potential soil-borne pathogens (species of Fusarium and Pythium), disease incidence, seedbed density, and sizes of conifer seedlings. Several non-fumigation treatments resulted in production of seedlings with densities and sizes similar to or better than those produced in beds treated with chemical fumigation. Results varied within the nurseries depending on conifer species, field history, and disease presence. Beneficial cultural practices included: (1) incorporation of slowly decomposing organic soil amendments, e.g., aged sawdust with additional nitrogen provided later to seedlings; (2) bare fallowing with periodic tilling, and bare fallowing without periodic tilling plus supplemental weed control; and (3) sowing of conifer seed earlier and more shallow than sown conventionally, and covering seed with a nonsoil mulch such as aged sawdust or hydromulch.

OSU Link
Non-OSU Link

122. Hobbs, S.D. 1981. Stocktype selection and planting techniques for Douglas-fir on skeletal soils in southwest Oregon. *In* Reforestation of skeletal soils: proceedings of a workshop, Medford, OR, USA, November 17-19, 1981. *Eds.* S.D. Hobbs and O.T. Helgerson.pp. 92-96.

Keywords: planting operations
tree/stand health

growth

Abstract: Stocktype selection and planting techniques for Douglas-fir can have a significant impact on seedling survival and growth on droughty skeletal soils in southwest Oregon. In these environments important seedling characteristics are stock quality, shoot-root ratio, root morphology, and caliper. Planting and special ameliorative techniques for sites with skeletal soils are discussed.

OSU Link
Non-OSU Link

123. Hobbs, S.D., S.G. Stafford and R.L. Slagle. 1987. Undercutting conifer seedlings: effect on morphology and field performance on droughty sites. Canadian-Journal-of-Forest-Research 17(1): 40-46.

Keywords: nursery operations
tree morphology
growth
tree/stand health

Abstract: One-yr-old barerooted Douglas fir and ponderosa pine seedlings in an Oregon nursery were subjected during Feb.-June 1980 to 5 undercutting treatments that varied by number and depth of cuts and seedling phenology at time of treatment. Eight morphological variables were measured in Jan. 1981 before planting the seedlings at 2 sites in Oregon. Seedling survival and growth was recorded annually for 4 yr. All treatments significantly reduced shoot growth in the nursery, but changes in root system morphology depended on treatment severity and species. Treatment effects were generally more pronounced in ponderosa pine than in Douglas fir. Discriminant analysis showed that seedlings responded similarly in all undercutting treatments relative to control seedlings that were not undercut. No effects of undercutting were apparent after 4 yr in the field.

OSU Link
Non-OSU Link

124. Hobbs, S.D. and K.A. Wearstler, Jr. 1983. Performance of three Douglas-fir stocktypes on a skeletal soil. Tree-Planters' Notes 34(3): 11-14.

Keywords: nursery operations
tree/stand health
growth

Abstract: Plug-1 bare rooted seedlings, initially grown in containers and transplanted to a nursery for 1 yr, 2-0 bare rooted seedlings and 1-0 plug stock were planted on a steep, severe site in the Siskiyon Mts., SW Oregon, in 1980. Height and diameter were recorded after planting and in the autumn in 1980 and 1981. Survival was 91% for 1-0 plug seedlings, 87% for plug-1 seedlings and 56% for 2-0 bare rooted stock. There were n.s.d. in height and diameter growth.

OSU Link
Non-OSU Link

125. Humphreys, N. 1995. Douglas-fir beetle in British Columbia. In Forest-Pest-Leaflet 14. Pacific-Forestry-Centre,-Canadian-Forest-Service.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: Notes are provided on the recognition, detection, biology, injuriousness and control of the scolytid Dendroctonus pseudotsugae on Douglas fir (Pseudotsuga menziesii) (and occasionally western larch (Larix occidentalis)) in British Columbia. The damage caused is described under the headings gallery system; effect on the tree; host susceptibility and attack pattern; association with root disease (including Armillaria ostoyae, Phaeolus schweinitzii and Phellinus weirii); and defoliation (by Choristoneura occidentalis and Orgyia pseudotsugata). Control of D. pseudotsugae is discussed under the headings preventive measures (including log and slash disposal, general logging practices), remedial measures (which include the use of trap trees and pheromones) and brood destruction (by burning and similar measures).

OSU Link
Non-OSU Link

126. Hunt, J.A. 1995. Commercial thinning a coastal second-growth forest with a Timberjack cut-to-length system. Forest-Engineering-Research-Institute-of-Canada FERIC TN-235. 14p.

Keywords: thinning
commercial thinning
economics
tree/stand health

Abstract: In the summer of 1994, after 2 years operation, FERIC monitored a thinning operation of second-growth forest dominated by Douglas fir [Pseudotsuga menziesii] near Cowichan Lake, Vancouver Island, to determine productivities, costs and impacts to sites and residual stands. The thinning treatment was carried out with a Timberjack 1270 harvester and a Timberjack 910 forwarder.

Non-OSU Link

127. Jacobs, D.F., R. Rose, D.L. Haase and P.D. Morgan. 2003b. Influence of nursery soil amendments on water relations, root architectural development, and field performance of Douglas-fir transplants. New-Forests 26(3): 263-277.

Keywords: nursery operations
fertilization
tree physiology
tree morphology
growth
carbon allocation
soil properties
tree/stand health

Abstract: This experiment evaluated the influence of manure, peat, and vermiculite incorporated at low and high rates (0.0118 and 0.0236 m3/m2) and under two soil moisture regimes on Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) seedling (1+0 for 1+1) xylem water potential (Phi xylem), whole-plant growth, root architectural development, and subsequent field performance under fertilized and non-fertilized conditions. Trends in soil moisture retention were observed (high manure > high peat > control) but there were no differences in Phi xylem. Root length in the wetter soil moisture experiment was initially (three months) greatest for seedlings in high vermiculite and least in high manure but there were no differences among treatments at lifting (eight months). Mean height was greatest for seedlings grown in vermiculite and peat (wetter nursery experiment) after two field seasons. Field fertilization (35 g/seedling) with controlled-release fertilizer in the planting hole stimulated height growth initially, but decreased height and diameter growth during the second growing season. Dramatic improvements associated with the use of nursery soil amendments were not realized, but the failure to identify negative effects, a potential reduction in disease incidence, and improvement of nursery soil physical and chemical properties may justify their use.

OSU Link
Non-OSU Link

128. Jaindl, R.G. and S.H. Sharrow. 1988. Oak/Douglas-fir/sheep: a three-crop silvopastoral system. Agroforestry-Systems 6(2): 147-152.

Keywords: planting operations
release treatments
manual release
tree/stand health
growth

Abstract: A small scale agroforestry study started in 1952 was revisited in 1985 to evaluate the long-term influence of site preparation and grazing on tree growth and survival in a system with Douglas fir, white oak (Quercus garryana) and sheep. In 1952-53, 2-yr-old Douglas fir seedlings were planted at the rate of 2500 trees/ha under 3 levels of site preparation: (1) no treatment; (2) oak thinned by 50%; and (3) oak clear felled. From 1954 to 1960, yearling ewes grazed half of each of the 3 thinning treatments for 3-4 wk each spring. The conifers were undisturbed since grazing was discontinued in 1960. Survival of planted conifers averaged 64% in 1985 and did not vary among either site preparation or grazing treatments. From 1964 to 1985, trees on the thinned and clear felled plantations grew an av. ht. of 1060 and 990 cm, respectively, compared with 900 cm on the unthinned plantation. D.b.h. averaged 3.8 and 5.6 cm greater on thinned or clear felled plantations, respectively, than on the unthinned control by 1985. Conifers on grazed plantations had increased ht. and d.b.h. growth during the first 12 yr of plantation life, averaging 63 cm taller and 0.7 cm greater in d.b.h. than the ungrazed plots by 1964. By 1985 the difference in ht. (122 cm) and d.b.h. (1.0 cm) between grazed and ungrazed plantations was not statistically significant. These data suggest that although site preparation can positively influence conifer growth, total clear felling is no better than thinning oaks. Furthermore, proper grazing can increase ht. and d.b.h. growth of the conifers during and immediately after the grazing years.

OSU Link
Non-OSU Link

129. Johnson, G.R. 2002. Genetic variation in tolerance of Douglas fir to Swiss needle cast as assessed by symptom expression. Silvae-Genetica 51(2/3): 80-86.

Keywords: genetic tree improvement
tree/stand protection
tree/stand health
growth
genetic relationships

Abstract: The incidence of Swiss needle cast (caused by Phaeocryptopus gaeumannii) on Douglas fir (Pseudotsuga menziesii) has increased significantly in recent years on the Oregon coast. Genetic variation in symptoms of disease infection, as measured by foliage traits, was assessed in two series of progeny trials to determine whether these "crown health" indicators were under genetic control and correlated with tolerance (tolerance being continued growth in the presence of high disease pressure). Foliage traits generally had lower heritabilities than growth traits and were usually correlated with diameter growth. Foliage traits of crown density and colour appeared to be reasonable indicators of disease tolerance. In the absence of basal area data, assessing crown density and colour can help screen for families that show tolerance to the disease.

OSU Link
Non-OSU Link

130. Joseph, G. and R.G. Kelsey. 1999. Growth of Douglas-fir and ponderosa pine seedlings with foliar applications of methanol and ethanol. Western-Journal-of-Applied-Forestry 14(4): 183-185.

Keywords: nursery operations
growth
tree morphology
tree/stand health

Abstract: Ethanol and methanol have been reported to enhance the growth and development of several agricultural and horticultural species. To test whether methanol or ethanol stimulated growth of coast Douglas fir (Pseudotsuga menziesii var. menziesii) or ponderosa pine (Pinus ponderosa)in the nursery, seedlings were sprayed with concentrations of 1 to 10% (v/v) on the foliage twice a week for 13 wk during the growing season. Foliar applications of methanol and ethanol neither significantly stimulated nor inhibited growth, and signs of damage at these concentrations were lacking.

OSU Link
Non-OSU Link

131. Kamm, J.A., P.D. Morgan, D.L. Overhulser, L.M. McDonough, M. Triebwasser and L.N. Kline. 1983. Management practices for cranberry girdler (Lepidoptera: Pyralidae) in Douglas-fir nursery stock. Journal-of-Economic-Entomology 76(4): 923-926.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: Chrysoteuchia topiaria (Zell.), a known pest of grasses and cranberries, was shown in field-plot studies in Oregon and Washington State in 1980-81 to be a pest of seedlings of Douglas fir (Pseudotsuga menziesii) grown in nurseries. The pyralid was capable of reproduction in nursery beds where feeding larvae partially or completely girdled the taproot of seedlings. Pheromone-trap collections indicated that grasslands bordering nurseries and not nursery beds were the primary source of adults. In addition to Douglas fir, several species of true fir were damaged by larvae, but no feeding damage was observed on pine, cedar, hemlock or spruce. Insecticides applied to control adults and larvae effectively reduced the incidence of damage. It was suggested that, when possible, a pest management programme should include grasslands bordering the nursery, control of weeds and the use of a non-food-plant cover crop in the nursery.

OSU Link
Non-OSU Link

132. Kastner, W.W., Jr., S.M. Dutton and D.M. Roche. 2001. Effects of Swiss needle cast on three Douglas-fir seed sources on a low-elevation site in the northern Oregon Coast Range: results after five growing seasons. Western-Journal-of-Applied-Forestry 16(1): 31-34.

Keywords: genetic tree improvement
tree/stand protection
growth
tree/stand health

Abstract: Douglas-fir (Pseudotsuga menziesii var. menziesii) seedlings grown from three seed sources were evaluated for 5 years for their relative tolerance to Swiss needle cast (caused by the ascomycete Phaeoxryptopus gaeumannii), on a high-disease-hazard site located approximately 3 miles northeast of Tillamook, Oregon, USA. The seed sources were: (1) seed collected from trees showing an apparent degree of tolerance to Swiss needle cast in natural stands in the coastal fog belt, (2) open-pollinated seed orchard seed collected from random single-pair crosses of parent trees in natural stands outside of the coastal fog belt, but west of the Oregon Coast Range summit, whose progeny demonstrated an apparent degree of disease tolerance in coastal Douglas-fir progeny test sites, and (3) standard reforestation seed purchased from a commercial vendor. There were no significant differences among seed sources in basal diameter and total height for all five growing seasons. Needle retention varied among seed sources over the 5-year period, but current-year needle retention did not vary significantly after the fifth growing season, and retention of 1- and 2-year-old needles was relatively low for all seed sources. The intense disease pressure on this site may have overwhelmed expression of disease tolerance among seed sources. We do not recommend planting Douglas-fir on such high-hazard sites.

OSU Link
Non-OSU Link

133. Kelpsas, B.R. 1987. Seasonal impacts of fluroxypyr and triclopyr on conifers and shrubs. Proceedings-of-the-Western-Society-of-Weed-Science (Vol.40): 128-129.

Keywords: release treatments
chemical release
tree/stand health

stand conditions

Abstract: Release of Pseudotsuga menziesii from Rubus spectabilis and Alnus rubra in a plantation in the Pacific Northwest could be achieved by 1.12 kg fluroxypyr/ha applied in May at the early foliar stage without appreciable long-term injury. P. menziesii tolerated 1.12 kg triclopyr/ha but was severely damaged by 1.12 kg and 2.24 kg fluroxypyr when applied during the dormant season in Mar. Both fluroxypyr and triclopyr were more effective against A. rubra than R. spectabilis. Control of R. spectabilis with triclopyr was marginal.

OSU Link
Non-OSU Link

134. Ketchum, J.S., R. Rose and B. Kelpsas. 2000. Comparison of adjuvants used in fall-release herbicide mixtures for forest site preparation. Tree-Planters' Notes 49(3): 66-71.

Keywords: site preparation
chemical preparation
release treatments
chemical release
tree/stand health
stand conditions

Abstract: Tank mixes of the herbicides imazapyr and glyphosate were applied at 3 rates with 3 adjuvants (LI-700Reg., Nu-Film-IRReg., Silwet L-77Reg.) over California hazelnut (Corylus cornuta var. californica), vine maple (Acer circinatum), and brackenfern (Pteridium aquilinum var. lanuginosum) on a 2-year-old clearcut of Douglas fir (Pseudotsuga menziesii) in Oregon. The herbicide 2,4-D was applied at 3 rates with 2 adjuvants (HerbimaxReg., Nu-Film-IR) over greenleaf manzanita (Arctostaphylos patula) on a 4-year-old Douglas fir clearcut in Oregon. Tank mixes of imazapyr and glyphosate with LI-700 or Nu-Film-IR were sprayed at 3 rates over 1-year-old seedlings of Douglas fir on 2 sites in Oregon. The herbicide rate strongly influenced the percentage of foliage injured and percentage of stems killed for all herbicide treatments. The adjuvants evaluated did not influence efficacy of herbicide applications on California hazelnut, vine maple, or brackenfern. Herbimax increased visual foliar damage resulting from 2,4-D application on greenleaf manzanita. Douglas fir foliage was damaged by the higher herbicide rates; the damage was greater from Nu-Film-IR than from LI-700.

OSU Link
Non-OSU Link

135. Kimball, B.A., D.L. Nolte, D.L. Griffin, S.M. Dutton and S. Ferguson. 1998a. Impacts of live canopy pruning on the chemical constituents of Douglas-fir vascular tissues: implications for black bear tree selection. Forest-Ecology-and-Management 109(1/3): 51-56.

Keywords: pruning
tree/stand protection
growth
tree physiology
tree/stand health

Abstract: The impact of live canopy pruning (removal of all live and dead whorls between the ground and 5 m height, resulting in removal of ~40% of the live canopy) on the carbohydrate and terpene content of vascular tissue was investigated in the lower bole of Douglas fir (Pseudotsuga menziesii) on 4 sites in NW Oregon. Cambial zone vascular tissue samples were collected from pruned and unpruned trees in the lower bole and within the live canopy. Current year's radial growth was estimated from the mass of vascular tissue removed from the 800 cmsuperscript 2 area sampled from each tree. Chemical analyses were conducted to determine the concentration of carbohydrates and terpenes in the samples. Results indicated that 2 yr following treatment, pruning resulted in reduced growth and decreased carbohydrate content of the vascular tissue. Pruning had no effect on the terpene concentration of the vascular tissue. The impact of pruning on the foraging selection of black bears (Ursus americanus) was evaluated by surveying bear damaged trees in a 50 acre stand of pruned and unpruned timber. Odds ratios indicate that black bears were 4 times more likely to forage unpruned than pruned Douglas fir. Tree selection may be explained in part by the higher availability of carbohydrates in the unpruned tree with respect to the pruned tree.

OSU Link
Non-OSU Link

136. Kimball, B.A., E.C. Turnblom, D.L. Nolte, D.L. Griffin and R.M. Engeman. 1998b. Effects of thinning and nitrogen fertilization on sugars and terpenes in Douglas-fir vascular tissues: implications for black bear foraging. Forest-Science 44(4): 599-602.

Keywords: fertilization
thinning
tree/stand protection
tree physiology
tree/stand health

Abstract: Analyses of vascular tissue samples from Douglas fir (Pseudotsuga menziesii) trees collected in test plots in W. Washington and NW Oregon, USA, showed that both thinning and N fertilizer application caused the sugar concentration of vascular tissues in the lower bole to increase. However, these treatments had no effect on the concentrations of hydrocarbon monoterpenes, oxygenated monoterpenes or sesquiterpenes. These results may explain the observations that black bears (Ursus americanus) prefer to forage in thinned and fertilized stands, as the bears maximize sugar intake and minimize terpene intake while foraging.

OSU Link
Non-OSU Link

137. King, J.E., D.D. Marshall and J.F. Bell. 2002. Levels-of-growing-stock cooperative study in Douglas-fir: report no. 17 - the Skykomish study, 1961-93; the Clemons study, 1963-94. Pacific-Northwest-Research-Station, USDA-Forest-Service Research-Paper PNW-RP-548. vii + 120 p.

Keywords: thinning
commercial thinning
growth
yield

tree/stand health

Abstract: A study was conducted at the Skykomish Tree Farm, and at the Clemons Tree Farm, Washington, USA, to determine how the amount of growing stock in repeatedly thinned stands of Douglas Fir (Pseudotsuga menziesii) affects cumulative wood production, tree size and growth-growing stock ratios. Initial stands were thinned to the same level of growing stock so that all plots would have virtually the same growth potential except the unthinned controls. The Skykomish and Clemons stands were 24 and 19 years old, respectively, when the studies were started. Stand treatments were completed at ages 42 and 36, and measurements were continued to ages 56 and 50. After 32 years at Skykomish and 31 years at Clemons, the basal area per acre in the eight regimes ranged from 119-244 ft2 at Skykomish and 101-195 at Clemons. The corresponding gross yields in cubic feet per acre were 8709-13 579 at Skykomish and 6329-9072 at Clemons. Volume in thinnings were 18-53% of the gross yield. Stand treatments included four regimes with different combinations of heavy and light thinning and four regimes with constant intensities of thinning. Variable regimes were found to have consistent advantage over constant regimes. Within a given level of growing stock, the constant regimes are recommended for applications where wood production is the primary objective. A substantial increase in the yield was produced in all regimes during the post thinning holding period. Based on standing volume after the last thinning, the holding period of 4 years produced approximately 30% more volume in all regimes. Extending the period to 9 years produced approximately 70% more volume, and at 14 years, the standing volume was more than double the volume remaining after the last thinning. This extra yield enhanced by the high quality of the stands makes the length of the holding period an important factor in the scheduling of final harvest.

OSU Link
Non-OSU Link

138. Knowe, S.A. and W.I. Stein. 1995. Predicting the effects of site preparation and protection on development of young Douglas-fir plantations. Canadian-Journal-of-Forest-Research 25(9): 1538-1547.

Keywords: site preparation
release treatments
tree/stand protection
growth
tree morphology
tree/stand health
stand conditions

Abstract: Diameter prediction models based on the Weibull distribution function and stand-table projection models based on changes in relative diameter were developed for 2- to 10-year-old Douglas fir (Pseudotsuga menziesii) plantations in Oregon. Both modelling approaches incorporated the effects of site preparation, animal protection, and competing vegetation. The diameter distribution approach is appropriate when information on initial diameters is not available. The stand-table projection approach may be applied when tree diameters in a plantation are measured two or more growing seasons after planting. At young ages, the stand-table approach provided more accurate representation of observed diameter distributions than the diameter distribution approach. At age 10 the two methods provided comparable diameter distributions. The equations derived for predicting survival, height growth of dominant trees, height-diameter relationships, and the development of woody vegetation over time will

facilitate the study and comparison of stand structure and dynamics after various site-preparation and animal protection treatments.

OSU Link
Non-OSU Link

139. Koerber, T.W. and G.P. Markin. 1984. Metasystox-RReg. injections increase seed yield of Douglas-fir in California, Oregon, and Washington. *In* Proceedings of the cone and seed insects working party conference, Working Party S20701, Southeastern Forest Experiment Station, Asheville, NC. *Ed.* H. Yates, III. pp. 137-146.

Keywords: tree/stand protection
tree/stand health
reproduction

Abstract: Injections of 1.5 g for each 15 cm of tree girth reduced seed damage caused by Contarinia oregonensis and Barbara colfaxiana, but not that by Megastigmus spermatrophus [M. spermotrophus]. On sites with insect populations high enough to cause substantial seed losses, treatment increased seed yield per cone by 38-162%.

OSU Link
Non-OSU Link

140. Krakowski, J. and Y.A. El-Kassaby. 2003. Effects of stratification and simulated aging on germination of Douglas-fir seed from a clonal seed orchard. Forest-Genetics 10(1): 65-70.

Keywords: nursery operations
tree/stand health
reproduction

Abstract: Seeds from 15 Douglas-fir (Pseudotsuga menziesii) clones were germinated in a factorial design with two pre-treatments (unstratified and stratified) and seven simulated aging periods (0, 2, 4, 7, 10, 12 and 14 days). Simulated aging consisted of high temperature (40 degrees C) and relative humidity (100%) exposure, which simulates physiological stresses and consequent deterioration in long-term storage. Seed deteriorated as aging treatments lengthened; no germination occurred after 12 days. Germination parameters (capacity, peak value, speed, completeness) were calculated, and pre-treatment and aging effects evaluated using a mixed model analysis of variance. Germination completeness and speed were higher after two days of aging for stratified seed, whereas only peak value increased for unstratified seed. After four days aging, all parameters decreased. Two days of aging enhanced germination capacity of unstratified seed by 15%, but stratified seed was still 13% higher. Douglas-fir seed should be stratified before germination, but unstratified seed can be exposed to 40 degrees C and 100% humidity for two days to augment seedling stock during the growing season. Ex situ Douglas-fir genetic resource conservation, as well as more adequate representation of planted genotypes across the landscape, can benefit from two days of aging, which would ensure slowly-germinating genotypes are represented in the population.

OSU Link

141. Lavender, D.P. and S.G. Stafford. 1985. Douglas-fir seedlings: some factors affecting chilling requirement, bud activity, and new foliage production. Canadian-Journal-of-Forest-Research 15(2): 309-312.

Keywords: nursery operations
tree/stand health
tree physiology
tree phenology

Abstract: Potted 2-yr-old seedlings were exposed to a range of natural and artificial environments at the Forest Research Laboratory, Oregon State University during the autumn and winter before a 9-wk period in an environment designed to permit active shoot growth. Seedling response demonstrated (i) that exposure to a period of short (9 h), mild (20 degrees C) days prepared seedlings for the beneficial effects of subsequent chilling (4.4 degrees C) temperatures and (ii) that the physiology of dormancy of Douglas-fir seedlings may be adversely affected by environments that differ markedly from those prevailing in the Pacific Northwest during the autumn.

OSU Link
Non-OSU Link

142. Lee, Y.J. and H.J. Barclay. 1985. Ten-year growth response of a 25-year-old and a 55-year-old Douglas-fir stand to thinning and urea fertilization. Pacific-Forestry-Centre, Canadian-Forest-Service Information-Report BC-X-260. 14 p.

Keywords: fertilization
thinning
growth
tree/stand health

Abstract: In stands of medium site quality in British Columbia, 4 rates of nitrogen (0, 112, 224, and 336 k/ha of N), in the form of urea (46% N), were tested at two thinning intensities. Fertilizer was applied in spring or fall, but the season of application had little effect on growth. Thinning almost doubled diam. growth by 10 yr but affected only net vol. growth; gross vol. was only minimally affected by thinning. Fertilization in the 25-yr-old stand increased mean d.b.h. growth significantly in the second and third yr and increased vol. growth significantly in the first 3 yr, but the effect diminished thereafter. Different rates of fertilizer application on the 55-yr-old stand gave inconsistent results. Combined thinning and fertilizer treatment had the greatest growth response. In both stands the overall effect of 336 kg/ha N was to increase vol. growth by about 20%. Thinning significantly decreased mortality, but the effect of fertilizer was negligible. Combined treatment had the greatest effect on the advancement of trees by the number of d.b.h. classes. The effect of thinning and fertilizing on the cumulative growth will probably continue after 10 yr until crowding sets in.

OSU Link
Non-OSU Link

143. Leininger, W.C. and S.H. Sharrow. 1987. Seasonal diets of herded sheep grazing Douglas-fir plantations. Journal-of-Range-Management 40(6): 551-555.

Keywords: release treatments
tree/stand health
stand conditions

Abstract: The seasonal diets of herded sheep grazing cutover Douglas-fir (Pseudotsuga menziesii) forests in the Coast Range of Oregon were studied during 1981 and 1982. Both 4- to 6-year-old non-grass-seeded and 2-year-old grass-seeded plantations were included. Sheep grazing was monitored in spring, summer and late summer. Forage on offer ranged from 764 to 2459 kg/ha. Vegetational composition of sheep diets varied by year, season and plantation age class. Averaged over the 2 years of grazing, graminoids and forbs were nearly equal, at about 40% each, in sheep diets in older plantations. In contrast, diets of sheep in young grass-seeded plantations averaged 70% graminoids and only 16% forbs. Ferns were a minor component (<2%) of sheep diets in both plantation age classes. Browse averaged 15 and 12% of sheep diets in old and young plantations, respectively. Douglas-fir was most palatable to sheep in spring soon after bud break. It was generally avoided, however, and never comprised more than 3% of sheep diets. Results suggest that sheep can be most effectively used for biological control of unwanted brush species during summer and late summer when differences in relative preference indices for target brush species and Douglas-fir are greatest.

OSU Link
Non-OSU Link

144. Leininger, W.C. and S.H. Sharrow. 1989. Seasonal browsing of Douglas fir seedlings by sheep. Western-Journal-of-Applied-Forestry 4(3): 73-76.

Keywords: release treatments
tree/stand health

Abstract: Controlled sheep grazing for the biological control of unwanted vegetation in regenerating conifer plantations is an alternative to herbicide application. Efficient use of livestock to control brush and herbaceous species requires understanding of potential damage to the tree crop by the grazing animal. Sheep browsing (700 Columbia ewes May-September 1981, 900 Columbia yearling ewes May-September 1982) and mechanical damage to 2- to 6-yr-old Douglas fir (Pseudotsuga menziesii) seedlings were evaluated in the Coast Range of Oregon: browsing was greatest in May, soon after bud break; little browsing occurred during July and August. Percentage of study trees with browsed terminal shoots decreased as seedling height increased above 90 cm. Less than 3% of the study trees were trampled or received other mechanical damage by sheep. The data suggest that Douglas fir forests can be grazed by sheep with little or no damage to conifer regeneration, except in younger plantations in spring.

OSU Link
Non-OSU Link

145. Lindsey, G.D. and J. Evans. 1983. Evaluation of zinc phosphide for control of pocket gophers on Christmas tree plantations. Tree-Planters' Notes 34(2): 11-14.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: In laboratory tests, pocket gophers (Thomomys and Geomys spp.) were offered 5 kinds of treated bait, including 1% Zn phosphide in oats, 0.75% Zn phosphide in fresh carrots, and 0.5% strychnine in rolled oats (3 mixtures). The carrot bait was found to be as effective for killing gophers as the strychnine mixtures. Plots in a 4-yr-old Pseudotsuga menziesii and Pinus monticola plantation in Washington, with occupied T. mazama burrows, were baited with the carrot or one of the strychnine mixtures in Nov. 1981. Both baits produced only a 63% reduction in gopher activity, possibly because of the availability of abundant alternative vegetative food. It was estimated that tree mortality due to root pruning by gophers was >10% on this site. It is recommended that the carrot/Zn sulphide bait be registered for special local needs where safety to wildlife and domestic animals is important.

OSU Link
Non-OSU Link

146. Litvak, M.E., J.V.H. Constable and R.K. Monson. 2002. Supply and demand processes as controls over needle monoterpene synthesis and concentration in Douglas fir [Pseudotsuga menziesii (Mirb.) Franco]. Oecologia 132(3): 382-391.

Keywords: nursery operations
nursery fertilization
tree/stand protection
tree/stand health
tree physiology

Abstract: We measured the relative control that resource availability (as a supply-side control) and wounding (as a demand-side control) exert on patterns of monoterpene synthesis and concentration in Douglas fir [Pseudotsuga menziesii (Mirb.) Franco] needles. While supply-side controls should alter monoterpene production due to changes in the availability of substrate (carbohydrates), demand-side controls alter the need for a defensive product. We examined these relationships by measuring constitutive (preformed) and wound-induced rates of monoterpene synthesis and pool sizes in trees grown under ambient and elevated (ambient +200 micro mol mol-1) CO2, ambient and elevated (ambient +4 degrees C) temperature, and in trees grown under four levels of nitrogen fertilization (0, 50, 100 and 200 micro g g-1 N by weight). Monoterpene pool size decreased at elevated CO2, increased at elevated temperature and did not change in response to nitrogen fertilization. Overall, we did not find that foliar nitrogen, carbon balance, or rate of monoterpene synthesis alone were consistent predictors of monoterpene concentration in current-year Douglas fir needles. In addition, despite a wound-induced decrease in monoterpene pool size, we found no evidence for induction of monoterpene synthesis in response to wounding. The influence of either resource availability or wounding on rates of monoterpene synthesis or accumulation cannot be explained by traditional supply-side or demand-side controls. We conclude that monoterpene synthesis in first-year Douglas fir needles is controlled by fairly conservative genetic mechanisms and is influenced more by past selection than by current resource state.

OSU Link
Non-OSU Link

147. Livingston, N.J. and T.A. Black. 1987b. Water stress and survival of three species of conifer seedlings planted on a high elevation south-facing clear-cut. Canadian-Journal-of-Forest-Research 17(9): 1115-1123.

Keywords: planting operations
tree/stand protection
tree physiology
tree/stand health

Abstract: Container-grown seedlings (1+0) of Douglas fir, western hemlock and Abies amabilis were planted in spring 1981 and 1982 at 1150 m alt. on a 30 degrees S.-facing slope on Mt. Arrowsmith, Vancouver Island, British Columbia. Treatments at planting included inclining seedlings to the SW (thus shading the root collar with the foliage) and provision of shade cards and/or irrigation. Control seedlings received no treatment. Seasonal and diurnal courses of twig xylem water potential, turgor potential and osmotic potential were measured and the relation between transpiration and soil water potential was determined. Seedling survival was recorded in April 1982-84. Douglas fir seedlings showed a high degree of drought tolerance by considerable osmotic adjustment that enabled seedlings to maintain turgor throughout the growing season. Douglas fir seedlings thus survived severe drought and maintained daily transpiration rates that were never less than 50% of those of irrigated seedlings. Transpiration rates were reduced, however, on days of high vapour pressure deficits because of stomatal closure. Western hemlock and, especially, A amabilis lacked both stress avoidance and stress tolerance mechanisms and consequently suffered high mortality. In April 1984, untreated Douglas fir seedlings had 72-82% survival, while treated seedlings had 81-95% survival. Shade cards and/or irrigation increased survival of western hemlock and A. amabilis, but not to the rates shown by Douglas fir.

OSU Link
Non-OSU Link

148. Lopushinsky, W. 1986. Effect of jellyrolling and acclimatization on survival and height growth of conifer seedlings. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Note PNW-RN-438. 14 p.

Keywords: planting operations
growth
tree/stand health
tree physiology

Abstract: Jellyrolling is a preplanting treatment that involves dipping roots of seedlings in a vermiculite/water slurry and wrapping the roots in wet burlap to form a roll. Studies were made at 14 sites in Oregon and Washington during 1984 using bare root seedlings of Pinus ponderosa, P. contorta or Pseudotsuga menziesii. Results showed that there was no advantage in survival, ht. growth or moisture stress from jellyrolling or acclimatizing (storage in a tent or shed at ambient temp. for 24 h before planting) seedlings rather than dipping roots in a peat moss/water slurry at the planting site.

OSU Link
Non-OSU Link

149. Maher, T.F. 1990. Damage appraisal and pheromone trapping studies for the black army cutworm in British Columbia. B.C. Ministry of Forests FRDA-Report 117. iv + 41 p.

Keywords: planting operations

tree/stand protection
tree/stand health
growth

Abstract: Actebia fennica [Dissimactebia fennica] have damaged Picea spp., Pinus contorta, Pseudotsuga menziesii, Larix occidentalis and Populus tremuloides in recently planted stands in British Columbia.

OSU Link
Non-OSU Link

150. Manter, D.K. and K.L. Kavanagh. 2003. Stomatal regulation in Douglas fir following a fungal-mediated chronic reduction in leaf area. Trees: Structure and Function 17(6): 485-491.

Keywords: tree/stand protection
tree physiology
tree/stand health

Abstract: Pathogens can cause chronic premature needle abscission in coniferous species. To assess the potential impacts on tree productivity, stomatal regulation was investigated in Douglas fir with chronic stomatal occlusion and defoliation from varying levels of the Swiss needle cast (SNC) fungus, Phaeocryptopus gaeumannii. Levels of SNC disease and subsequent defoliation were manipulated by choosing six sites with varying levels of disease and by foliar applications of fungicides on six trees per site. Diurnal measurements of leaf water potential (Psi leaf), stomatal conductance (gs) and vapor pressure deficit (D) were made on six fungicide treated and six control trees per site. In addition, leaf specific hydraulic conductance was calculated on a single branch (KL_B) from three trees per treatment per site. Stomatal conductance at D=1 kPa (gsref) was negatively correlated with fungal colonization (number of fruiting bodies present in needle stomata) and positively correlated with KL_B. Despite reduced needle retention in diseased trees, KL declined due to a reduction in sapwood area and permeability (i.e., increasing presence of latewood in functional sapwood). In general, stomatal sensitivity to D for all foliage was consistent with stomatal regulation based on a simple hydraulic model [gs=KL(Psi soil- Psi leaf)/D], which assumes strict stomatal regulation of Psi leaf. However, when fungal presence reduced maximum gs below the potential maximum supported by hydraulic architecture, stomatal sensitivity was lower than expected based on the theoretical relationship: d gs/dln D=0.6.gsref. The results indicate that losses in productivity associated with physical blockage of stomata and defoliation are compounded by additional losses in KL and a reduction in gs in remaining functional stomata.

OSU Link
Non-OSU Link

151. Marshall, D.D. and R.O. Curtis. 2002. Levels-of-growing-stock cooperative study in Douglas-fir: report no. 15 - Hoskins: 1963-1998. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Paper PNW-RP-537. 80 p.

Keywords: thinning
commercial thinning
growth

yield
tree/stand health
tree morphology

Abstract: The cooperative levels-of-growing-stock (LOGS) study in Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco) was begun to study the relations between growing stock, growth, cumulative wood production, and tree size in repeatedly thinned stands. This report summarizes results from the Hoskins installation through age 55. Growing stock has been allowed to accumulate for 19 years since the last treatment thinning was applied in this high site class II natural stand. Volume and diameter growth were strongly related to growing stock. Basal area growth-growing stock relations were considerably weaker. Differences in tree size and volume distribution were considerable. Culmination of mean annual increment has not occurred for any of the treatments, although the control has culminated for total stem cubic volume and is near culmination for merchantable cubic volume. Only small differences are seen in growth percentages between thinning treatments. Results demonstrate potential flexibility in managing Douglas-fir to reach a range of objectives.

OSU Link
Non-OSU Link

152. Mason, R.R. and B.E. Wickman. 1991. Integrated pest management of the Douglas-fir tussock moth. Forest-Ecology-and-Management 39(1-4): 119-130.

Keywords: tree/stand protection
tree/stand health
stand conditions
growth

Abstract: The Douglas-fir tussock moth (Orgyia pseudotsugata) is one of the most destructive forest defoliators of Douglas fir (Pseudotsuga menziesii), grand fir (Abies grandis) and white fir (A. concolor) in western North America. An outline is given of current pest-management programmes used in Oregon, which emphasize the annual monitoring of insects in forests with outbreak histories to determine early changes in population numbers and to predict trends. When outbreaks develop, several environmentally safe chemical and microbial insecticides are effective in reducing larval numbers and preventing serious defoliation. Computer models predicting growth loss, tree mortality, and top-kill during outbreaks are available as aids to making management decisions. Silvicultural practices favouring seral nonhost species on high-risk sites may be the best prescription for reducing the effect of tussock moth outbreaks.

OSU Link
Non-OSU Link

153. McClain, K.M. and D.P. Lavender. 1988. Tissue water relations and survival of conditioned conifer seedlings during drought stress. *In* Proceedings: 10th North American Forest Biology Workshop, 'Physiology and genetics of reforestation', University of British Columbia, Vancouver, British Columbia, July 10-22, 1988. Eds. J. Worrall, J. Loo-Dinkins and D.P. Lester. pp. 177-185.

Keywords: nursery operations

tree/stand protection
tree physiology
tree/stand health

Abstract: Jack pine (Pinus banksiana) and Douglas fir (Pseudotsuga menziesii) 23-week-old seedlings were subjected to an 8-week drought stress period on two soil types (sandy clay loam and loamy sand) in protected cold frames in a nursery in Oregon in July-August 1984. Before transplanting, treatments consisting of daily or weekly irrigations, combined with 0 or 100 p.p.m. KCl, were applied to the seedlings for 6 weeks. The results showed that weekly irrigated (stress conditioned) seedlings maintained higher water potentials than daily irrigated (non-stress conditioned) seedlings. Decreases in water potential were more rapid for seedlings grown on sand than for seedlings grown on loam. By the end of the assessment period, relative water contents of Douglas fir on sand and loam were 88.3% and 91.5%, respectively, and 72.7% and 81.8%, respectively, for jack pine. Turgor pressures were maintained at higher levels in Douglas fir than in jack pine on both soil types. On sand, mortality in both species was dependent on conditioning treatment, indicating that stress conditioning enhanced seedling drought resistance during a period of rapidly increasing soil water deficit. KCl treatment was not implicated in response to drought, but increased mortality of jack pine on sandy clay loam.

Non-OSU Link

154. McDonald, P.M. and G.O. Fiddler. 1996. Development of a mixed shrub-tanoak-Douglas-fir community in a treated and untreated condition. Pacific-Southwest-Research-Station, USDA-Forest-Service Research-Paper PSW-RP-225. iv + 16 p.

Keywords: release treatments
manual release
chemical release
tree/stand health
growth
tree morphology
stand conditions
economics

Abstract: On a medium site in northern California, a tanoak (Lithocarpus densiflorus)-mixed shrub community in a Douglas fir plantation was given several treatments (manual release two and three times, a combination chainsaw and cut surface herbicide (Garlon 3A [triclopyr]) treatment, two foliar herbicides (2,4-D or Garlon 4), and a tank mix of the two herbicides) to study its development in both a natural (control) and treated condition. The herbicides were each applied twice. Survival of planted Douglas fir (Pseudotsuga menziesii) seedlings was recorded for 11 years and growth was quantified for 9 years after the last treatment application. In addition to Douglas fir, data are presented individually for the two most abundant species (tanoak and snowbrush, Ceanothus velutinus var. hookeri), for greenleaf manzanita (Arctostaphylos patula), and for the hardwood tree and shrubs combined. At the study's end in 1992, combined vegetation in the control had a mean density of 1800 plants/acre, foliar cover of 23 700 ftsuperscript 2/acre, and height of 11.2 ft. In contrast, combined tree and shrubs in the most effective treatment for controlling them (cut and spray Garlon 3A) had a mean density of 150 plants/acre, foliar cover of 150 ftsuperscript 2/acre and height of 5.9 ft at study end. Because competition for site resources was low, Douglas fir seedlings developed best in this treatment. Mean

Douglas fir diameter was 4.6 inches at 12 inches above mean ground line, height averaged more than 21 ft, and mean foliar cover was 39 850 ftsuperscript 2 at the end of the study. The cost was $227 per acre.

OSU Link
Non-OSU Link

155. McKay, H.M. 1994. Frost hardiness and cold-storage tolerance of the root system of Picea sitchensis, Pseudotsuga menziesii, Larix kaempferi and Pinus sylvestris bare-root seedlings. Scandinavian-Journal-of-Forest-Research 9(3): 203-213.

Keywords: nursery operations
tree/stand protection
tree physiology
tree/stand health

Abstract: During the winter of 1990-91, fine roots of 2-year-old, undercut and wrenched Pseudotsuga menziesii, Larix kaempferi [L. leptolepis], Pinus sylvestris, and Picea sitchensis (Alaskan, Queen Charlotte Islands and Oregon provenances) were tested using electrolyte leakage for frost hardiness and tolerance to storage at +1 degrees C for 30 and 90 days as excised roots. Pseudotsuga menziesii and Pinus sylvestris showed only minor changes in root frost hardiness with a maximum of -4 degrees C and -7 degrees C respectively. Larix leptolepis and Picea sitchensis developed much greater root frost hardiness; L. leptolepis had a maximum hardiness of -12 degrees C while Picea sitchensis (Queen Charlotte Islands) reached -13 degrees C during the winter. The root frost hardiness of Picea sitchensis increased with the provenance's latitude. There were clear species and provenance differences in the level of long-term cold-storage tolerance attained, increasing in the order Pseudotsuga menziesii, Pinus sylvestris and Picea sitchensis (Oregon), L. leptolepis, Picea sitchensis (Queen Charlotte Islands), and Picea sitchensis (Alaskan). In spite of highly significant correlations between root electrolyte leakage after cold-storage and frosting tests, root frost hardiness did not accurately indicate all aspects of long-term cold tolerance and has limitations as a means of determining safe cold-storage dates.Tr.

OSU Link
Non-OSU Link

156. McKay, H.M. and A.D. Milner. 2000. Species and seasonal variability in the sensitivity of seedling conifer roots to drying and rough handling. Forestry-Oxford 73(3): 259-270.

Keywords: planting operations
tree physiology
tree/stand health
tree phenology

Abstract: The ability of the fine root system of 2-year-old bare-rooted planting stock of Picea sitchensis of Queen Charlotte Islands (British Columbia, Canada), Oregon and Alaskan (USA) provenances, Pseudotsuga menziesii, Larix kaempferi and Pinus sylvestris to withstand standard drying and rough handling treatments was tested at regular intervals from September 1990 until April 1991, at a nursery in NE England. Details are given of nursery treatments (sowing in spring 1989; undercutting in year 2 in June-mid-August, depending on species, and wrenching at 2-wk intervals until mid-October; and lifting

at 2-wk intervals from September-November 1990 to April 1991). Electrolyte leakage was used to quantify the damage to the fine roots. Stressed seedlings had significantly greater leakage values than untreated seedlings and dried seedlings had significantly greater leakage values than roughly handled seedlings, but the responses varied with species and lifting date. After drying, leakage values increased in the order P. sitchensis (Oregon and Queen Charlotte Islands), P. sylvestris, L. kaempferi, P. sitchensis (Alaskan), P. menziesii. Leakage values after rough handling increased in the order P. sitchensis (Alaskan and Queen Charlotte islands), L. kaempferi, P. sitchensis (Oregon), P. sylvestris, P. menziesii. Leakage values were greatest in early September. During September and October there was a rapid downward trend in leakage. From December to February, leakage values decreased very slowly. In March leakage values of untreated and roughly handled seedlings increased slightly but decreased further in dried seedlings. These results indicate that great care must be taken during autumn planting to protect bare-rooted seedlings, particularly P. menziesii, from drying and to a lesser extent rough handling. Fine root leakage values following drying and rough handling had a significant linear relationship with the logarithm of the number of days required for the terminal bud to burst.

OSU Link
Non-OSU Link

157. McLeod, A.A., R.C. Evans and R.K. Scagel. 1993. Conversion of understocked salal sites at Woss Lake, British Columbia. B.C. Ministry of Forests FRDA-Report 194. vi + 15 p.

Keywords: nursery operations
site preparation
mechanical preparation
fertilization
growth
tree/stand health
economics

Abstract: A trial comparing the effect of spot scarification and slow release NPK fertilizer application on stock types of coastal Douglas fir (Pseudotsuga menziesii) was conducted in a 25-year-old backlog site occupied by a thick carpet of salal (Gaultheria shallon) in the CWHxm2 habitat of Vancouver Island, British Columbia. Bare root and container stock types were planted and treated, and mortality and growth were measured for 3 years. Despite the high fertilizer-related mortality of the bare-root stock type in the first year, the 3-year height growth performance of all treatments was better but more variable than that of the untreated seedlings. The value of site preparation and fertilizer for stimulating early growth varied by stock type. Bare-root stock did not respond strongly enough to fertilizer or site preparation to justify the cost of either of these treatments. Container stock types did not respond strongly enough to site preparation alone to justify the high cost of site preparation. The largest growth gains in the container stock types were associated with the combination of site preparation and fertilization.

OSU Link
Non-OSU Link

158. McNabb, D.H., K. Baker-Katz and S.D. Tesch. 1993. Machine site preparation improves seedling performance on a high-elevation site in southwest Oregon. Western-Journal-of-Applied-Forestry 8(3): 95-98.

Keywords: site preparation
mechanical preparation
tree/stand health
stand conditions
growth

Abstract: Douglas fir (Pseudotsuga menziesii) seedlings planted on areas receiving one of four site preparation treatments (scarify, scarify/till, soil removal, and soil removal/till) and on unprepared control areas were compared for 5 yr at a high-altitude, nutrient-poor site in the western Siskiyou Mountains. Fifth-year survival of seedlings was at least 85% among machine-prepared plots, compared to 42% on control plots. Cover of competing vegetation remained less than 25% during the period for all machine treatments. In contrast, vegetation cover on control plots was 30% at the time of planting and increased to nearly 75% after 5 yr. Competing vegetation clearly impeded seedling performance. The effects of unusually droughty conditions at the time of planting in 1982 were examined further by interplanting additional seedlings in the soil-removal treatment in 1985. The interplanting was followed by more normal spring precipitation, and seedlings grew better over 5 yr than those planted in 1982. The slow recovery of competing vegetation and generally poor seedling growth on all treatments during both planting years are attributed to low soil fertility.

OSU Link
Non-OSU Link

159. 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

160. 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

161. Miller, M. and B. Emmingham. 2001. Can selection thinning convert even-age Douglas-fir stands to uneven-age structures? Western-Journal-of-Applied-Forestry 16(1): 35-43.

Keywords: thinning
commercial thinning
growth
yield
tree/stand health
regeneration

Abstract: Uneven-age management of Douglas-fir (Pseudotsuga menziesii) stands can be used to address aesthetic, wildlife habitat, biodiversity and sustainability concerns, but there has been little long-term experience with this type of management. To develop timely information on converting even-age stands to uneven-age forests, we used retrospective stand reconstruction methods to document harvest frequency, intensity and stand structural development at four sites in western Oregon, USA. We studied stands managed by selection thinning and identified strategies for creating and managing uneven-age forests. Selection thinning benefited mid- and understorey trees and stimulated natural regeneration. Although stand growth was less than expected from low thinning, growth per unit of growing stock was similar to that in unmanaged stands. Douglas-fir often dominated natural regeneration and had satisfactory vigour at stocking levels about half that considered full stocking for even-age management, but good growth of regeneration may require even lower overstorey stocking. Shade-tolerant grand fir (Abies grandis) and western hemlock (Tsuga heterophylla), however, were more abundant at higher stocking levels. Selection thinning of young Douglas-fir (Pseudotsuga menziesii) stands can sometimes be effective in promoting viable regeneration while providing regular income and biodiversity. Because this was a retrospective study only, further, long-term testing is necessary.

OSU Link
Non-OSU Link

162. Miller, R.E. 1981. Response of Douglas-fir to foliar fertilization. *In* Proceedings: Forest Fertilization Conference, University of Washington, Seattle, Washington, USA. *Eds.* S.P. Gessel, R.M. Kenady and W.A. Atkinson. pp. 62-68.

Keywords: fertilization
tree/stand health
growth
economics

Abstract: This paper summarizes past research about spray application of 10 to 32 percent nitrogen solutions to seedlings and established stands of Douglas-fir. These investigations establish that Douglas-fir and associated conifers can be foliarly fertilized with concentrated nitrogen solutions at dosages of 50 to 200 pounds per acre; however, fertilization with these solutions requires more critical selection of nitrogen source, dosage, additives, and, perhaps, time of year than does fertilization with urea prill. Some burning, up to about 30 percent of the needle surface, is visually disturbing but probably has no measurable effects on growth. With low dosages and careful application, gains in cubic volume or height growth per pound of applied nitrogen were similar for both spray and prill. Yet costs per pound of applied nitrogen have been about 25 percent more for 32 percent nitrogen solutions than for prilled urea. Hence, foliar application of concentrated nitrogen solutions is currently less cost effective than conventional use of urea solids for fertilizing Douglas-fir and associated conifers.

OSU Link
Non-OSU Link

163. Miller, R.E., M.V. Atherton and J.E. Wilcox. 1986. Comparative effects of three nitrogen fertilizers applied in fall and spring to a 29-year-old Douglas-fir plantation. Canadian-Journal-of-Forest-Research 16(5): 910-917.

Keywords: fertilization
growth
tree/stand health
tree physiology

Abstract: Stand growth and mortality were monitored for 13 yr after application of urea, ammonium nitrate or urea + ammonium sulphate (224 kg N/ha) in autumn 1967 and spring 1968 to plots in a 29-yr-old Douglas fir plantation on Vancouver Island, British Columbia. The treatments and a control were replicated 3 times. Foliar analysis indicated insufficient available N before treatment and an increase in available N 1 and 2 yr after fertilization. Addition of N at this location did not have a practical effect on stand growth and the field experiment was not sufficiently sensitive to detect real differences between N sources or season of application. Suggestions are included for improving field trials.

OSU Link
Non-OSU Link

164. Miller, R.E., J.W. Hazard and D.C. Young. 1991. Effects of foliar spray and prill applications of nitrogen fertilizer on four mixed-conifer stands. Forest-Science 37(3): 741-754.

Keywords: fertilization
growth
tree/stand health

Abstract: Concentrated urea-ammonium nitrate solution (32% N) and urea prill (granules; 46% N) were applied by helicopter at dosages of 56, 112, 224 and 448 kg N/ha before (5 May) and during (14 July) the 1969 growing season to four 40- to 70-year-old mixed stands of Pseudotsuga menziesii and Tsuga heterophylla near Sequim, Washington. Stand growth was measured repeatedly in the next 10 years. Helicopter application of both fertilizers was variable and therefore weakened comparisons between prill and foliar sprays and spring vs. summer applications. Applying 112 kg N/ha or more to these poor-site stands increased gross and net volume growth; volume growth was related linearly to N dosage of both prill and spray. Gains from prill apparently exceeded those from spray, but a subsampling of plots indicated that actual dosages, especially of spray, were less than target dosages. At the target dosage of 224 kg N/ha, 10-year gains in gross growth averaged 34.0 msuperscript 3/ha (30%) and 8.0 msuperscript 3/ha (7%) after prill and spray, respectively. Although fertilizer treatment accelerated tree losses, cumulative volume of dead trees was less than 15% of gross volume growth. Season of fertilization seemed to have no effect on efficiency of either prill or spray, but suspected differences between actual and target dosages may have influenced this comparison. Concentrated N solution applied at dosages up to about 224 kg N/ha caused little or no increase in foliar or tip damage. Doubling this conventional dosage and applying in the growing season, however, increased visible damage and may have reduced gains in volume growth.

OSU Link
Non-OSU Link

165. Miller, R.E., E.L. Obermeyer and H.W. Anderson. 1999. Comparative effects of precommercial thinning, urea fertilizer, and red alder in a site II, coast Douglas-fir plantation. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Paper PNW-RP-513. ii + 25 p.

Keywords: fertilization
thinning
precommercial thinning
growth
yield
tree/stand health
soil properties

Abstract: The number of red alder (Alnus rubra) trees retained with 300 Douglas-fir (Pseudotsuga menziesii) per acre was varied on a high-quality site in coastal Oregon. Alder densities of 0, 20, 40, and 80 per acre were tested. A fifth treatment eliminated nitrogen-fixing alder, but substituted nitrogen fertilizer. Treatment 6 had neither thinning nor alder control. Treatments were randomly assigned within each of three blocks in a 9-year-old plantation. Stand density was reduced within 15 of these 18 experimental units. Surplus conifers were cut, but surplus red alder were controlled by the "hack-and-squirt" method. Because numerous trees of other species regenerated naturally, combined density of all species before thinning ranged from 1400 to 5700 trees per acre. Subsequent 17-year change in

number, average height, basal area, and volume of Douglas-fir were compared. Retaining 20, 40, or 80 alder per acre reduced numbers of associated Douglas-fir by about 10, 17, and 23 percent, respectively. In pure Douglas-fir plots, gross volume growth was similar for non-fertilized and fertilized plots, indicating no measurable benefits of additional nitrogen. In mixed stands, red alder reduced yield of associated Douglas-fir, but not yield of combined species. Similar comparisons are needed at other locations, especially those with known nitrogen deficiency.

OSU Link
Non-OSU Link

166. Miller, R.E., J. Smith and H. Anderson. 2001. Detecting response of Douglas-fir plantations to urea fertilizer at three locations in the Oregon Coast Range. Pacific-Northwest-Research-Station,-USDA-Forest-Service Research-Paper PNW-RP-533. 20 p.

Keywords: fertilization
thinning
growth
tree/stand health

Abstract: Fertilizer trials in coast Douglas-fir (Pseudotsuga menziesii var. menziesii) in the Oregon Coast Range (USA) usually indicate small and statistically non-significant response to nitrogen (N) fertilizers. Inherently weak experimental designs of past trials could make them too insensitive to detect growth differences that actually exist. Ability to detect real differences among treatments should be improved by having more than two replications per treatment and by using covariance analysis to adjust observed treatment means for unequal starting conditions among experimental treatments. To demonstrate these assumptions, we used size at fertilizer application and a pre-fertilizer application (calibration) period of growth as covariates when analysing data from five coastal plantations at three locations: Toledo North, Toledo South and Bone Mountain. The trials had three to six replications per treatment and calibration periods of 6 or 7 years. Nitrogen fertilizer (urea at 200 lb N/acre) was assigned randomly to half the plots at each location when trees were 16 or 17 years old from seed. Our objectives were to quantify 4- or 7-year response to N fertilizer and to demonstrate practical means for detecting response. Effects of fertilizer application on tree diameter and height, and on basal area and volume growth per acre were estimated. Among the five non-thinned plantations, observed gross basal area growth was changed by -2 to 13% in the 4 or 7 years after fertilizer application. In the thinned portion of one plantation, there were few differences in response to fertilizer between thinned and unthinned plots. Observed responses were increased substantially by covariance analyses at some plantations but decreased at others. Random assignment of three to six plots per treatment did not ensure balanced or comparable plots for fertilized and non-fertilized treatments.

OSU Link
Non-OSU Link

167. Minore, D. 1986b. Germination, survival and early growth of conifer seedlings in two habitat types. Pacific-Northwest-Forest-and-Range-Experiment-Station,-USDA-Forest-Service Research-Paper PNW-RP-348. ii + 25 p.

Keywords: planting operations

reproduction
tree/stand health
growth

Abstract: Seed germination, and seedling survival and early growth of Douglas fir, western hemlock, Abies procera and A. amabilis were studied on clear felled sites in the A. amabilis/Achlys triphylla and A. amabilis/Vaccinium membranaceum/Xerophyllum tenax habitat types in the McKenzie River basin, Oregon. Severe seed predation and high surface soil temp. in both habitat types resulted in almost total seedling mortality during the first season when seeds had been sown on a few large, consolidated seedbeds. Seedling survival was n.s.d. between habitat types. Survival of Douglas fir (the only species tested) was better when seeds were sown in small scattered spots. Habitat type and addition of forest humus did not affect survival and growth, but shading by stumps and protection from predation using plastic berry baskets were both beneficial. Soils from both habitats had similar colour, texture, pH and nutrient content. In greenhouse studies, seeds of all species began germinating earlier and continued to germinate for longer in soil from Achlys sites than in soil from Xerophyllum sites. It is suggested that unmeasured biological activity may have been responsible for differences in germination activity between the two soil types.

OSU Link
Non-OSU Link

168. Minore, D. and H.G. Weatherly. 1990. Effects of site preparation on Douglas-fir seedling growth and survival. Western-Journal-of-Applied-Forestry 5(2): 49-51.

Keywords: site preparation
mechanical preparation
prescribed fire
growth
tree/stand health
soil properties

Abstract: The effects of 5 site preparation treatment combinations (A: cable yarding + broadcast burning - B: tractor yarding + broadcast burning - C: machine piling + broadcast burning - D: machine piling + off-site burning - and E: machine piling + off-site burning + tilling) on Douglas fir (Pseudotsuga menziesii) growth and survival were studied in 1984-87. Seedling height, potential seedling height, survival percentages, soil-penetration resistances, and occurrence of visible soil humus were evaluated on 149 progeny-test plantations in westernOregon. Survival was not improved by mechanical site preparation (survival at 5 years was 84.8% for treatment A, 73.7% for C and 78.1% for E). Seedlings grown on compacted soils with low humus, associated with piling slash off site, did not grow as tall during their first 5 years as seedlings grown on similar sites where slash had been broadcast-burned (height 77 cm for treatments D and E, compared to 93 cm for A). Mechanical site preparation was not essential for Douglas fir survival, as long as competing vegetation is controlled. Increased soil compaction, loss of humus, and reduced 5 year height growth associated with mechanized slash removal indicated detrimental effects on site quality as well as tree growth.

OSU Link
Non-OSU Link

169. Montigny, L.d. and S. Stearns-Smith. 2001. Douglas-fir fertilization with biosolids: five-year results at Whistler, B.C. B.C.-Ministry-of-Forests Extension-Note 50. 6 p.

Keywords: fertilization
growth
tree/stand health

Abstract: Biosolids (from municipal waste water treatment facilities) at 750, 1000, and 1500 kg-N/ha and conventional fertilizer at 225 kg-N/ha were applied in each of three seasons (spring, summer, and fall) to a 15-year-old B.C. coastal Douglas-fir (Pseudotsuga menziesii) plantation that had recently been precommercially thinned and pruned. Five-year results showed that rate and timing effects were independent. No height-growth response was evident, but annual diameter growth for all biosolids treatments averaged three times higher than for conventional fertilizer. Seasonal application differences were small but statistically significant. All plots, including the controls, experienced extensive top damage from snow and ice. Similar to growth, damage was greatest with biosolids fertilization. The study shows promise for biosolids fertilization as a viable alternative to conventional fertilization, but application in locations prone to snow and ice damage should be avoided.

OSU Link
Non-OSU Link

170. Morrison, D.J. and A.L.S. Johnson. 1999a. Annosus root disease in pre-commercially thinned stands in coastal British Columbia. Canadian-Forest-Service Technology Transfer Note 20, Pacific-Forestry-Centre, Victoria, BC.

Keywords: thinning
precommercial thinning
tree/stand protection
tree/stand health

Abstract: An outline is given of the strategic importance of Heterobasidion annosum, detection and recognition, damage to roots, factors affecting infection and colonization of stumps and management implications for spacing in juvenile stands. The relative susceptibilities of different species were: Abies amabilis>Picea sitchensis>Tsuga heterophylla>Pseudotsuga menziesii.

OSU Link
Non-OSU Link

171. Morrison, D.J. and A.L.S. Johnson. 1999b. Incidence of Heterobasidion annosum in precommercial thinning stumps in coastal British Columbia. European-Journal-of-Forest-Pathology 29(1): 1-16.

Keywords: thinning
precommercial thinning
tree/stand protection
tree/stand health

Abstract: Coniferous stumps in 83 stands in coastal British Columbia, Canada, were sampled 3-5 years after precommercial thinning between 1981 and 1986. The percentage of stumps and surface area colonized by H. annosum were determined for 25 stumps of each species, in each 5-cm diameter class present in each stand. There were significant differences among species in the percentages of stumps and surface area colonized, with Douglas-fir (Pseudotsuga menziesii) having the lowest values, amabilis fir (Abies amabilis) and Sitkaspruce (Picea sitchensis) the highest and western hemlock (Tsuga heterophylla) being intermediate. For each species, both the percentage of stumps and surface area colonized increased with increasing diameter. In stumps that were grafted to an adjacent tree, there was decreased incidence of H. annosum for Douglas-fir and Sitka spruce and increased incidence for western hemlock and amabilis fir. There were trends in the percentage of stumps and area colonized for season of thinning and biogeoclimatic subzones, with the values for most species decreasing as the amount of precipitation increased. It is suggested that the increase in inoculum can be minimized by thinning trees when less than 15 years old, by cutting only trees less than 10 cm in diameter and by thinning during low risk seasons.

Non-OSU Link

172. Morrison, D.J., M.D. Larock and A.J. Waters. 1986. Stump infection by Fomes annosus in spaced stands in the Prince Rupert Forest Region of British Columbia. Pacific-Forestry-Centre, Canadian-Forest-Service Information-Report BC-X-285. 12 p.

Keywords: thinning
tree/stand protection
tree/stand health

Abstract: Discs 3-5 cm thick were collected after removal of the top 5-10 cm from stumps left by thinning 1-8 yr previously of 12- to 37-yr-old stands of 5 coniferous species, and the occurrence and area of surface colonization with F. annosus [Heterobasidion annosum] were measured. Based on the % of stumps with more than 10% of their area colonized, susceptibility decreased in the sequence Abies amabilis, Picea sitchensis, Tsuga heterophylla, Pseudotsuga menziesii; Pinus contorta was unaffected. Fewer stumps were colonized in a T. heterophylla/A. amabilis stand thinned in winter than in an adjacent stand thinned in late spring: the difference was attributed to effects on spore populations of low temp. and heavy precipitation. There was a significant correlation between % stump area colonized and % root vol. colonized by H. annosum for A. amabilis and T. heterophylla. H. annosum had spread from colonized roots on some excavated stumps to or into adjacent roots of reserved trees.

OSU Link
Non-OSU Link

173. Nelson, E.E. 1989. Black bears prefer urea-fertilized trees. Western-Journal-of-Applied-Forestry 4(1): 13-15.

Keywords: fertilization
tree/stand health

Abstract: Feeding damage by the black bear (Ursus americanus) to urea-fertilized 25-yr-old Douglas fir (Pseudotsuga menziesii) in the Mount Hood National Forest, Oregon, resulted in tree mortality 4x as

severe as among unfertilized trees. Damage was most apparent following application of urea at 448 kg N/ha in 1972, and 224 kg N/ha in 1977. Only Douglas fir, the dominant species in the stand, was attacked (western hemlock (Tsuga heterophylla), western red cedar (Thuja plicata) and red alder (Alnus rubra) were scattered through the stand). Attacked trees were somewhat larger than the stand average but the difference was not significant. Bears appeared to be attracted to the more vigorous trees, which were on fertilized plots.

OSU Link
Non-OSU Link

174. Nelson, E.E., M.G. McWilliams and W.G. Thies. 1994. Mortality and growth of urea-fertilized Douglas-fir on a Phellinus weirii-infested site in Oregon. Western-Journal-of-Applied-Forestry 9(2): 52-56.

Keywords: planting operations
fertilization
tree/stand protection
growth
tree/stand health
soil properties

Abstract: Twelve plots were established in 1972 in an 11-yr-old Douglas fir (Pseudotsuga menziesii) plantation infected with Phellinus weirii, the cause of laminated root rot. All plots were thinned and either interplanted with red alder (Alnus rubra) or fertilized at 5- to 10-yr intervals with urea to determine the effect of nitrogen on tree growth and mortality caused by P. weirii, or left untreated. Interplanted alder, however, failed to survive. Mortality was assessed at intervals of 2 to 3 yr. Plots were inventoried (100% cruise) in 1978 and 1990. Growth over 12 yr appeared better on fertilized than nonfertilized plots, but the difference was not significant. Mortality caused by the preferential feeding of black bears [Ursus americanus] on the inner bark of fertilized trees reduced the overall gain. Mortality caused by laminated root rot did not differ significantly among treatments. Three months after the initial application of urea at 448 kg N/ha, soil sampled to a depth of 30 cm was higher in ammonium and nitrate forms of nitrogen on fertilized than nonfertilized plots, but increases were not significant. Numbers of soil bacteria were directly correlated with soil ammonium content (P = 0.1092). Numbers of aerobic actinomycetes were inversely correlated with soil nitrate content (P = 0.0398).

OSU Link
Non-OSU Link

175. Newton, M. and E.C. Cole. 1989. Where does sulfometuron fit in Pacific northwest silviculture? Proceedings-of-the-Western-Society-of-Weed-Science (Vol. 42): 121-128.

Keywords: release treatments
chemical release
stand conditions
tree/stand health

Abstract: Field trials in the Oregon Coast Range were conducted to evaluate sulfometuron for weed control in established and newly-planted stands of Pseudotsuga menziesii. North Coast sites were aerially-sprayed with 0.11 or 0.22 kg/ha sulfometuron +or- 2.2 kg/ha 2,4-D. South Coast sites received 0.11 or 0.165 kg/ha sulfometuron, and this was compared with 1.65 kg/ha hexazinone, 4.4 + 0.42 or 0.40 kg/ha atrazine + glyphosate +or- 1.25% surfactant (R-11). Weed cover and tree damage were assessed visually. In South Coast sites, all treatments reduced weed cover >50%. Broadleaved weeds and grasses were well controlled, but none of the treatments suppressed shrub growth. Broadleaved weeds were best controlled by hexazinone, and all other weeds by sulfometuron. On North Coast sites, all treatments reduced weed cover. Broadleaved weeds, grasses, shrubs and Rubus ursinus were all suppressed, but ferns were not. 2,4-D enhanced the effect of sulfometuron on broadleaved weeds and R. ursinus, but injury to P. menziesii was also greater. This was acceptable on terminal growth <3-5 cm, above which foliage necrosis, terminal dieback and growth check occurred. Timing of sulfometuron treatment alone was not significant, and the effects of rate of application were not clear from the first season's observations.

OSU Link
Non-OSU Link

176. Newton, M., E.C. Cole and D.E. White. 1986. What influences control of coastal deciduous brush with glyphosate. Proceedings-of-the-Western-Society-of-Weed-Science (Vol.39): 86-92.

Keywords: release treatments
chemical release
stand conditions
tree/stand health

Abstract: The effects of 0.5, 1.0 or 1.5 lb a.e. glyphosate/acre as Rodeo or Roundup applied in July or Aug. at 2 spray vol. with or without surfactant were studied on 5 woody species in the Oregon Coast Range. Glyphosate was more effective in 10 than 3 gallons spray/acre. Aug. applications were best, except in the case of Alnus rubra and conifers which were best controlled by July treatments. Addition of surfactant improved efficiency at low rates and vol. of glyphosate. Rubus spectabilis was most susceptible in Aug. and Sambucus racemosa was equally sensitive at both dates, but R. procerus and R. laciniatus were resistant. In a 2nd trial against Acer macrophyllum, crown reduction ranged from 60 to 85% with no differences between rates but decreasing efficacy with lower spray volumes. Plantings of Pseudotsuga menziesii were injured by all treatments in July but not in Aug.

OSU Link
Non-OSU Link

177. Newton, M., E.C. Cole and D.E. White. 1993. Tall planting stock for enhanced growth and domination of brush in the Douglas-fir region. New-Forests 7(2): 107-121.

Keywords: nursery operations
site preparation
prescribed fire
release treatments
chemical release

growth
tree/stand health

Abstract: Two long-term experiments in Oregon followed the development of planted stock of various sizes, origins, and species. In one experiment, multi-year comparisons of container, 2+0 bare rooted, and 3-yr-old Douglas fir (Pseudotsuga menziesii) transplants showed a strong positive relation between initial height and long-term (10-14 yr) growth under a range of site conditions with high probability of brush development. In another experiment, Douglas fir, western hemlock (Tsuga heterophylla), and Sitka spruce (Picea sitchensis) were planted on brushfield sites (disturbed by logging 0 and 4 yr previously) where salmonberry (Rubus spectabilis) was or had been dominant. Half the seedlings were released with glyphosate 6 months after planting. Western hemlock and Douglas fir bare rooted stock all grew well if planted in a fresh burn, despite rapid regrowth of salmonberry, but virtually all seedlings less than 60 cm tall except Sitka spruce were killed by 4-yr-old salmonberry if not released. Release improved growth of seedlings in the fresh burn by 6%, gaining an average of about 0.6 year toward reaching a height of 6 m. Release improved growth of survivors in 4-yr-old salmonberry by 51% in height, 72% in diameter, and 325% in volume at age 12 yr. Sitka spruce grew well until damaged by insects. Western hemlock growth was equal to or greater than that of Douglas fir of comparable initial height. In all comparisons, the probability of being overtopped by brush decreased with increasing initial stock height, and the effect of suppression on growth was also inversely related to initial height. Tall wilding seedlings had comparable advantages to nursery-grown seedlings, although Sitka spruce survival was not reliable.

OSU Link
Non-OSU Link

178. Omule, S.A.Y. 1984. Results from a correlated curve trend experiment on spacing and thinning of coastal Douglas fir. B.C. Ministry-of-Forests Research-Note 93. ix + 22 p.

Keywords: thinning
precommercial thinning
growth
yield
tree/stand health

Abstract: Plots were established in 1952 in 13-yr-old plantations and given a variety of thinning treatments to produce post-thinning densities of 125-3000 stems/ha. Trees were measured at intervals up to 1980. Analysis showed that diam., ht. and their growth increased with decrease in density. Mortality, b.a., total vol. and b.a. growth decreased as density decreased. Stand merchantable vol. was not affected by density except at extremes. Prolonged early suppression appeared to reduce the ability of a stand to respond to subsequent thinning in terms of b.a. and total vol.

OSU Link
Non-OSU Link

179. Omule, S.A.Y. 1987b. Early growth of four species planted at three spacings on Vancouver Island. B.C. Ministry of Forests FRDA-Report 009. vii + 22 p.

Keywords: planting operations
tree/stand health
growth
yield

Abstract: Seedling survival and 24- to 26-yr growth were measured of (a) Douglas fir (Pseudotsuga menziesii), (b) western hemlock (Tsuga heterophylla), (c) Sitka spruce (Picea sitchensis) and (d) Thuja plicata grown at 2.7x2.7, 3.7x3.7 and 4.6x4.6 m spacings on the W. coast of Vancouver Island, British Columbia. Initial spacing had no significant effect on survival, which was 86% in (a), 56% in (b), 87% in (c) and 91% in (d). Effects of spacing on growth and yield were as expected (little effect on ht.; wider spacings produced larger trees, but vol./ha was lower) in (a), but were delayed or confounded in (b) by poor seedling survival, in (c) by weevil (Pissodes strobi) damage and in (d) by salal (Gaultheria shallon) competition and browsing.

OSU Link
Non-OSU Link

180. Omule, S.A.Y. 1988. Growth and yield 35 years after commercially thinning 50-year-old Douglas-fir. B.C. Ministry of Forests FRDA-Report 021. vi + 15 p.

Keywords: thinning
commercial thinning
growth
yield
tree/stand health

Abstract: Remeasurement data over a period of 35 years from fourteen 0.2023-ha permanent plots were analysed to determine the growth and yield effects of commercially thinning 50-year-old Douglas fir (Pseudotsuga menziesii) stands on a good site on Vancouver Island, British Columbia. Compared to unthinned stands, the commercially thinned stands had: virtually the same total volume gross annual increment, top height and top height increment; 12% more potentially usable total volume yield (including thinnings); 18% less total volume at final harvest age 86 yr; virtually the same crop tree (193 largest diameter trees per hectare) average diameter, but 24% larger entire stand quadratic mean diameter; and 11% less total volume production lost to mortality. These results show that commercial thinning slightly increased total stand yield (including thinnings) and produced larger stand diameter at rotation age 86 yr, but that it also reduced usable total volume at final harvest and had virtually no effect on size of the crop trees. Data from this study are useful for validating growth models, and for constructing and comparing managed stand yield tables for various commercial thinning regimes.

OSU Link
Non-OSU Link

181. O'-Neill, G.A., W.T. Adams and S.N. Aitken. 2001. Quantitative genetics of spring and fall cold hardiness in seedlings from two Oregon populations of coastal Douglas-fir. Forest-Ecology-and-Management 149(1/3): 305-318.

Keywords: genetic tree improvement

tree/stand protection
tree/stand health
genetic relationships

Abstract: Genetics of autumn and spring cold hardiness were investigated in two western Oregon (USA) breeding populations (Coast and Cascade mountains) of Douglas-fir (Pseudotsuga menziesii var. menziesii). Seedlings from 40 open-pollinated families from each population were grown in raised nursery beds and subjected to two soil moisture regimes (well-watered and mild drought) to evaluate the influence of summer drought on ranking of families for cold hardiness. Artificial freeze testing (AFT) of detached shoots, followed by visual scoring of injury, was used to evaluate needle, stem and bud cold hardiness on three dates in the autumn (September, October and November) after the second growing season, and once in the following spring (March). The Cascade population suffered significantly less cold injury than the Coast population in autumn AFT. However, in spring AFT the Cascade population was less cold hardy, although population differences were seldom significant. Families within both breeding zones varied significantly in cold hardiness, with mean estimates of individual heritabilities greater in spring (hi2=0.57) than autumn (hi2=0.37), greater in the Coast (hi2=0.52) than in the Cascade (hi2=0.42) population, and greater in the wet (hi2=0.54) than in the dry moisture regime (hi2=0.40) (autumn means based on October tests). A single test date seems adequate to assess autumn cold hardiness, because estimated genetic correlations for cold injury between autumn test dates were strong (rA=0.80). Genetic correlations between spring and autumn cold injury, however, were moderately negative (rB=-0.66 and -0.21, Coast and Cascade, respectively), indicating that cold hardiness needs to be managed as two traits (i.e. autumn and spring cold hardiness). Selection for cold hardiness based on a single shoot tissue is expected to increase cold hardiness in the other tissues as well, because genetic correlations between tissues in cold injury were moderately-to-strongly positive in both autumn (rB=0.67) and spring (rB=0.84). Seedlings grown under summer drought incurred significantly less cold injury in the autumn than those that were well-watered; nevertheless, strong genetic correlations in autumn cold injury between moisture regimes (rB=0.91) indicate that summer moisture conditions had little influence on family rankings for autumn cold hardiness. Correlations of injury resulting from a natural frost event in November of the first year with injury from AFT in the autumn of the second year (rA=0.72 and 0.78 for needle and bud injury, respectively) confirmed that AFT reliably predicts cold hardiness to natural frost events.

OSU Link
Non-OSU Link

182. Otvos, I.S., J.C. Cunningham and R.I. Alfaro. 1987. Aerial application of nuclear polyhedrosis virus against Douglas-fir tussock moth, Orgyia pseudotsugata (McDunnough) (Lepidoptera: Lymantriidae); II. Impact 1 and 2 years after application. Canadian-Entomologist 119(7-8): 707-715.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: Following aerial application of a nuclear polyhedrosis virus of Orgyia pseudotsugata against this lymantriid on Douglas fir (Pseudotsuga menziesii) in British Columbia in 1982, the impact of treatment was studied in 1983 and 1984. The virus appeared to have spread from treated plots to adjoining areas in 1982, effectively reducing lymantriid populations. This observation suggests the spraying of alternate swaths to reduce the amount of microbial pesticide used. A naturally occurring

viral epizootic reduced lymantriid populations in 2 of 3 check plots in 1983, but severe tree mortality occurred in 2 of these plots, with 60 and 62% of sample trees dead in 1984. The corresponding tree mortality in 2 of 4 treated plots was 4 and 7%.

OSU Link
Non-OSU Link

183. Otvos, I.S. and R.F. Shepherd. 1991. Integration of early virus treatment with a pheromone detection system to control Douglas-fir tussock moth, Orgyia pseudotsugata (Lepidoptera: Lymantriidae), populations at pre-outbreak levels. Forest-Ecology-and-Management 39(1-4): 143-151.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: The development and integration of a pheromone monitoring system with a nuclear polyhedrosis virus treatment is described. Stands of Douglas fir (Pseudotsuga menziesii) in British Columbia susceptible to tussock-moth outbreaks are defined by overlying maps of past outbreaks, forest and habitat types, and climatic zones. Pheromone-baited traps are placed and monitored annually at permanent locations in susceptible areas. Measuring annual trends of moth density indicates time and location of the next outbreak. Trap-catch data provide an early warning of impending outbreaks, confirmed by ground reconnaissance. Insect density and defoliation are predicted from egg-mass and larval sampling. The virus can then be applied from the air or from the ground into threatened stands to initiate an epizootic to prevent development of an outbreak and to minimize tree damage. The virus appears to spread, and field tests with reduced dosages indicate that the small amount of virus applied can still greatly reduce larval populations and prevent tree mortality, at considerably reduced cost.

OSU Link
Non-OSU Link

184. Overhulser, D.L., J.D. Walstad and R.P. Bowers. 1980. Twig weevil damage to Douglas-fir seedlings and a field test of Dursban for control. Tree-Planters' Notes 31(2): 17-20.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: Damage categories are described for young platations in Oregon mostly 2+1 seedlings, planted in 1975-76 and surveyed in 1977 after attack by Cylindrocopturus furnissi in 1976. A test using Dursban 4E (chlorpyrifos) spray at 0-4% a.i., applied in July 1977, showed n.s.d. in % damaged trees between treated and control areas after 4 months, but this may have been due to a natural decline in weevil numbers. Spraying with 2% a.i. Dursban in Aug. 1977 significantly reduced the numbers of weevils present.

OSU Link
Non-OSU Link

185. Owston, P.W., W.G. Thies and W. Fender. 1986. Field performance of Douglas-fir seedlings after treatment with fungicides. Canadian-Journal-of-Forest-Research 16(6): 1369-1371.

Keywords: nursery operations
tree/stand protection
tree/stand health
growth
mycorrhizal response

Abstract: Douglas fir seedlings grown in containers with pasteurized or unpasteurized potting mixture, and treated in the nursery with benomyl, captan, fenaminosulf or ethazol [etridiazole], or left untreated (control) were planted out in the Cascade Range, western Oregon. The seedlings from all treatments appeared to be in similar condition at the time of planting, except for variations in ht. After 7 yr, seedlings grown in pasteurized potting mixture had better survival than those grown in unpasteurized mixture. Benomyl-treated seedlings in pasteurized potting mixture had significantly better survival than control seedlings in pasteurized mixture and seedlings treated with ethazol and grown in unpasteurized potting mixture had significantly lower survival than control seedlings in unpasteurized mixture. Ht. differences after 7 yr were n.s.d. between treatments. Benomyl, captan and ethazol appeared to have no detrimental effect on the development of mycorrhizas after planting non-mycorrhizal seedlings. There were insufficient seedlings to determine the effects of fenaminosulf on mycorrhizas.

OSU Link
Non-OSU Link

186. Peterson, M. and J.R. Sutherland. 1989. Grey mould control by seedling canopy humidity reduction through under-bench ventilation and styroblock aeration. B.C. Ministry of Forests FRDA-Report 077. 15 p.

Keywords: nursery operations
growth
tree/stand health
tree morphology

Abstract: The potential for grey mould control on Douglas-fir seedlings was investigated using under-bench ventilation and aerated styroblocks. Twenty-five percent of all ventilated styroblock seedlings were infected with Botrytis cinerea while 75% of the control seedlings showed signs of infection. The reduced incidence of grey mould in the ventilated treatments was attributed to a more rapid drying of the seedling canopy following watering. The lowest frequency of ideal conditions for B. cinerea infection by spore germination was observed in the seedling canopy of the treatment receiving unheated, forced air ventilation.

OSU Link
Non-OSU Link

187. Peterson, M.J. and J.R. Sutherland. 1990. Controlling gray mold on container-grown Douglas-fir by modified styroblocks and under-bench, forced air ventilation. Western-Journal-of-Applied-Forestry 5(3): 75-79.

Keywords: nursery operations
tree/stand protection
growth
tree/stand health

Abstract: The control of grey mould (Botrytis cinerea) on Douglas fir (Pseudotsuga menziesii) seedlings was investigated in Vancouver, Canada. Incidence of mould on seedlings sown in June 1988 and assessed January 1989 was reduced in 3 treatments of modified styroblocks (vertical holes, allowing air movement from below): vented with heated, forced air; vented with unheated, forced air; and vented with unheated, unforced air. Overall, mould occurred on 25% of 7-month-old seedlings in vented styroblocks, compared with >75% incidence in unmodified styroblocks. No significant differences in seedling height or root collar diameter among treatments were observed. Use of ventilated styroblocks is recommended, to reduce both losses from grey mould and fungicide usage in nurseries.

OSU Link
Non-OSU Link

188. Peterson, M.J. and S.E. Tuller. 1987. Die-back of container-grown Douglas-fir seedlings: associated microclimate. B.C. Ministry of Forests FRDA-Report 035. vii + 43 p.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: Microclimate associated with needle-tip dieback of Pseudotsuga menziesii seedlings in containers was studied in 2 greenhouses in British Columbia. The effects of 2 kinds of grit cover on soil temperature were also examined.

OSU Link
Non-OSU Link

189. Petruncio, M., D. Briggs and R.J. Barbour. 1997. Predicting pruned branch stub occlusion in young, coastal Douglas-fir. Canadian-Journal-of-Forest-Research 27(7): 1074-1082.

Keywords: pruning
tree/stand protection
tree/stand health
wood quality

Abstract: This study examined occlusion of 335 pruned branches from 38 coastal Douglas fir (Pseudotsuga menziesii) trees sampled from 13 stands (5 in British Columbia, 8 in Oregon) that were pruned between age 9 and 22 years. Regression models were developed for predicting number of years to occlude, the width of the occlusion region, and radius-over-occlusion which is the distance from the stem pith to the onset of clear wood production. Study results indicate that years to occlude is a function of stem size, stub length, stem growth rate, live or dead branch condition, and whether pruning produced smooth or nonsmooth cuts. Distance to occlude is a function of stem size, stub diameter, stem growth rate, live or dead branch condition, and whether pruning produced smooth or nonsmooth cuts.

Radius-over-occlusion is a function of stem size, stub length, stub diameter, stem growth rate, and whether pruning produced smooth or nonsmooth cuts.

OSU Link
Non-OSU Link

190. Piatek, K.B., C.A. Harrington and D.S. DeBell. 2003. Site preparation effects on 20 year survival and growth of Douglas-fir (Pseudotsuga menziesii) and on selected soil properties. Western-Journal-of-Applied-Forestry 18(1): 44-51.

Keywords: site preparation
mechanical preparation
prescribed fire
tree/stand health
growth
soil properties

Abstract: Long-term effects of site preparation on tree performance and soil properties are not well known. Five site preparation treatments were evaluated to determine how they affected survival and growth of Douglas-fir (Pinus menziesii) 3, 10, and 20 years after planting, and soil bulk density, C, N, P, and organic matter concentrations at 0 to 20 cm soil depth 21 years after planting. The site preparation treatments were imposed following logging of three harvest units of old-growth forest on a volcanic soil in southwestern Washington, USA; the units were logged to leave 17, 38, and 53 tonnes/ha of woody residue. The site preparation treatments were hand-pile-and-burn, machine-pile-and-burn, scarification, broadcast burn, and control. Mean survival ranged from 86% at age 3 to 70% at age 20, and average tree heights at 3, 10, and 20 years were 0.6, 4.1, and 11.7 m. The scarification treatment had the best growth; at age 20, its average tree was 21% taller, 26% larger in diameter, and 82% greater in volume than the control. The hand-pile-and-burn treatment did not differ from the control in tree growth; the machine-pile-and-burn and broadcast burn treatments were intermediate in their growth response. Average soil bulk density was 0.74 g/cm3, organic matter concentration was 118 g/kg, and C, N, and P concentrations were 49, 1.6, and 0.7 g/kg with no significant treatment effects. Site preparation may have benefited growth of the trees on these units by decreasing competition from invading and regrowing vegetation, increasing nutrient availability, or increasing soil temperature.

OSU Link
Non-OSU Link

191. Pilkerton, S.J., H. Han and L.D. Kellogg. 1996. Quantifying residual stand damage in partial harvest operations. *In* Planning and implementing forest operations to achieve sustainable forests: Proceedings of papers presented at the joint meeting of the Council on Forest Engineering and International Union of Forest Research Organizations. North-Central-Forest-Experiment-Station, USDA-Forest-Service General-Technical-Report NC-GTR-186. *Eds.* C.R. Blinn and M.A. Thompson. 62-72 pp.

Keywords: thinning
tree/stand health

Abstract: Stand damage studies were conducted on 2 cable thinning operations in 33-year-old Douglas fir (Pseudotsuga menziesii) stands having residual stockings of 74, 148 and 247 trees/ha in the Oregon Coast Range. The percent of residual stems damaged increased with decreasing residual density. Average scar sizes were significant, but at levels lower than cited as major. Observed thinning damage from helicopter logging was smaller and higher on the stem, characteristics associated with a lower incidence of decay. Line plots, random plots, strip transects and blocks on corridors are compared for sampling damage.

OSU Link
Non-OSU Link

192. Pilz, D. and R.M. Znerold. 1986. Comparison of survival enhancement techniques for outplanting on a harsh site in the western Oregon Cascades. Tree-Planters' Notes 37(4): 24-28.

Keywords: nursery operations
planting operations
growth
tree/stand health
mycorrhizal response

Abstract: Bare rooted 2+0 seedlings of Pseudotsuga menziesii survived and grew better during the first year than container-grown 1+0 stock on a droughty site. After 3 yr, survival still differed significantly, but height growth did not. Shading improved survival and growth. Application of a liquid suspension of spores of Pisolithus tinctorius was ineffective and no mycorrhizas developed from this fungus.

OSU Link
Non-OSU Link

193. Poulsen, K.M. 1996. Prolonged cold, moist pretreatment of conifer seeds at controlled moisture content. Seed Science and Technology 24:75-87.

Keywords: nursery operations
reproduction
tree/stand health

Abstract: Cold pretreatment of imbibed seed (stratification) and seed kept at controlled moisture contents for 3-14 weeks was tested for commercial seedlots of Abies nordmanniana, Abies procera, Pseudotsuga menziesii and Picea sitchensis in order to give recommendations for nursery practice. The temperature tolerance of treated seed was tested by germinating seed at four temperature regimes. It was possible to pretreat Abies nordmanniana seed at controlled moisture content, but the performance was not improved compared to the traditional six weeks stratification of imbibed seed. For Abies procera seed pretreatment at controlled moisture content for 2 + 8 weeks (2 weeks imbibed followed by 8 weeks at controlled moisture content) or more, significantly improved the performance at the germination temperatures 15 and 30°C. For Pseudotsuga menziesii seed pretreatment at controlled moisture content for up to 2 + 12 weeks was superior, especially at low germination temperatures, and it was possible to redry pretreated seed to 8% moisture content without loss of the pretreatment effect or germination capacity. For Picea sitchensis seeds the controlled moisture content method for a

duration of 7-10 weeks proved efficient and pretreated seed of this species also tolerated redrying. It is recommended that these improved pretreatment methods should be introduced into the nurseries.

OSU Link
Non-OSU Link

194. Puettmann, K.J., D.W. Hann and D.E. Hibbs. 1993. Evaluation of the size-density relationships for pure red alder and Douglas-fir stands. Forest-Science 39(1): 7-27.

Keywords: planting operations
growth
tree/stand health

Abstract: Using previously published data, size-density relations were developed for pure red alder (Alnus rubra) and pure Douglas fir (Pseudotsuga menziesii) stands in Oregon, Washington and British Columbia, using quadratic mean diameter of the stand as the tree-size variable. The resulting self-thinning or maximum size-density line for red alder had a steeper slope (-0.64) than that for Douglas fir (-0.52). The assumption of a common slope for all species is, therefore, not supported by this study. For red alder, the shape of the size-density trajectory and the height of the maximum size-density line were not influenced by initial density or stand origin. Red alder and Douglas fir mortality started at a relative density of 44% and 58%, respectively.

OSU Link
Non-OSU Link

195. Puttonen, P. 1987. Abscisic acid concentration in Douglas-fir needles in relation to lifting date, cold storage, and postplanting vigor of seedlings. Canadian-Journal-of-Forest-Research 17(5): 383-387.

Keywords: nursery operations
growth
tree/stand health
tree physiology
tree phenology

Abstract: Spring-lifted seedlings (2+0) were grown outside in pots at Corvallis, Oregon, in 1982. In late July pots were watered weekly to induce dormancy. From early Sep., plants received either a natural photoperiod or an extended (16 h) photoperiod for 6 wk. In mid-Nov. 1982 or mid-Jan. 1983, the plants were lifted and stored in a cold room (4 degrees C) for 25 days, bare rooted in polyethylene bags in the dark, or in pots in the dark or with an 8 h photoperiod. After storage, seedlings were planted in a cold frame or in pots in a growth room with 16-h photoperiod and day/night temp. of 21/16 degrees . In Sep. 1983, seedling ht., length of leader for 1982 and 1983, root collar diam. and survival were recorded. ABA concn. in needles was analysed after 48h and 25 days in storage, after 48h in a cold frame or growth room and at bud break. Lifting times and storage treatments did not have a significant effect on ABA concn. Seedling vigour was not indicated by ABA concn. There were treatment differences in performance after storage. Compared with seedlings lifted in mid-Jan., those lifted in mid-Nov. had reduced survival and more days to bud burst.

OSU Link
Non-OSU Link

196. Randall, W. and G.R. Johnson. 1998. The impact of environment and nursery on survival and early growth of Douglas-fir, noble fir, and white pine - a case study. Western-Journal-of-Applied-Forestry 13(4): 137-143.

Keywords: nursery operations
planting operations
tree/stand protection
growth
tree/stand health

Abstract: Survival and third-year height were examined on 2383 reforestation units in Cascade Range of western Oregon, USA, from 1983 to 1994, to determine which factors affect reforestation success. The three species examined made up 92% of the total trees planted in the region. Survival of Douglas fir (Pseudotsuga menziesii) varied by as much as 20% from year to year. The most significant factor affecting reforestation success was the nursery that provided the seedlings. Nursery affected both survival and height of Douglas fir and height for noble fir (Abies procera) and white pine (Pinus monticola). No nursery was best for all species. Other factors that were important for all three species were the administrative unit where the seedlings were planted, initial plant height, aspect, and length of storage prior to planting. Other significant factors that were important for Douglas fir were seed origin, planting month, protection, stock type, and aspect. For noble fir, other important factors were planting month and stock type; for white pine, the other important factor was slope. Altitude of the seed source and the planting unit affected Douglas fir survival and height but did not affect the other two species. This supports the smaller altitudinal bands for Douglas fir compared with noble fir and white pine.

OSU Link
Non-OSU Link

197. Rappaport, N.G. and D.L. Wood. 1994. Pityophthorus orarius Bright (Coleoptera: Scolytidae) in a northern California douglas-fir seed orchard: effect of clone, tree vigor, and cone crop on rate of attack. Canadian-Entomologist 126(5): 1111-1118.

Keywords: tree/stand protection
tree/stand health

Abstract: The geographic range of Pityophthorus orarius was extended beyond the original provenance of southern British Columbia to northern California. A survey of 457 Pseudotsuga menziesii trees in 1985 revealed that those with heavy cone crops were more likely to be infested by P. orarius than were those with a light crop. Furthermore, attack rates differed among clones. A 2nd survey in 1987 confirmed the importance of clone and cone crop in attack rate. In this survey, stressed trees were attacked at a higher rate than unstressed trees. The distribution of P. orarius appeared clumped in both surveys, possibly because of semiochemicals or oviposition behaviour.

OSU Link
Non-OSU Link

198. Reddy, M.S., L.M. Funk, D.C. Covert, D.N. He and E.A. Pedersen. 1997. Microbial inoculants for sustainable forests. Journal-of-Sustainable-Forestry 5(1/2): 293-306.

Keywords: tree/stand protection
tree/stand health

Abstract: A bacterial culture collection of 500 strains was assessed for biological control of fungal root pathogens and/or plant growth promotion of conifer seedlings. Seven of these strains showed significant suppressive effects on various soil-borne fungal pathogens. On Douglas fir [Pseudotsuga menziesii], two strains, Burkholderia cepacia RAL3 and Pseudomonas fluorescens 64-3, reduced disease caused by Fusarium by 7-42% in repeated growth room assays. The same strains significantly increased the percentage of healthy white spruce [Picea glauca] seedlings inoculated with Fusarium and Pythium in a conifer nursery, increased the survival of bare-root white spruce seedlings planted on a reforestation site in Saskatchewan by 19-23%, and increased new root growth and dry weight of Engelmann spruce [Picea engelmannii] seedlings planted in Prince George, British Columbia, and white spruce at 4 sites in Saskatchewan and British Columbia. Strain RAL3 in commercial formulation maintained a viable population of about log 8-9 cfu/ml for over a year when stored at 5 degrees C. Strain survival on seed varied with conifer species. No decreases in bacterial populations were observed on seeds of jack pine [Pinus banksiana] or Douglas fir after 37 to 44 days storage at 5 degrees C, but decreases were observed on seeds of white spruce and Scots pine [Pinus sylvestris].

OSU Link
Non-OSU Link

199. Reynolds, P.E., K. King, R. Whitehead and T.S. MacKay. 1986. One-year results for a coastal British Columbia glyphosate conifer release trial. Proceedings-of-the-Western-Society-of-Weed-Science (Vol.39): 107-117.

Keywords: release treatments
chemical release
stand conditions
growth
tree/stand health

Abstract: In trials on the W. coast of Vancouver Island in 1984, fir plantations on a reclaimed watershed were aerially treated with 2 kg glyphosate/ha. A single spray gave good control of Rubus spectabilis but very variable control of Alnus rubra ranging from 0 to 100%. Gaultheria shallow [G. shallon] was not controlled by glyphosate. Control of many species was greater on upper slopes than in the watershed valley bottom. There was minor crop tree injury to Tsuga heterophylla and Thuja plicata with recovery after 1 year, but no injury to Picea sitchensis, Pseudotsuga menziesii, Abies amabilis or A. grandis. Some increases in crop tree height were noted after herbicide treatment.

OSU Link
Non-OSU Link

200. Richmond, R.M. 1983. Problems and opportunities of forestland grazing in the Pacific Northwest. *In* Forestland Grazing: Proceedings of a Symposium held February 23-25,

1983, Spokane, Washington. *Eds.* B.F. Roche, Jr and D.M. Baumgartner, Pullman, USA:Washington State University. pp. 71-73.

Keywords: release treatments
stand conditions
tree/stand health

Abstract: Grazing as a means of brush control in Douglas-fir plantations after clearcut timber harvest was investigated in 1980-2 near Alsea, Oregon. Plots were restricted to clearcut areas with dominant vine maple [Acer circinatum]/sword fern [Polystichum munitum] communities. In 1980-1 a flock of 600 ewes with lambs was used and in 1982 900 dry ewes were used. The sheep were kept as a single flock and moved from clearcut to clearcut on a scheduled basis from mid-May to late Aug. Approx. 6 acres were used per day. This management reduced brush competition with Douglas fir seedlings, did not significantly damage fir seedlings, stimulated regrowth of grazed plants improving forage quality for big game and controlled Senecio jacobaea. Av. daily weight gain of lactating ewes in 1981 was less than for the dry ewes in 1982. Forage digestibility was adequate for dry ewes, but did not always meet the requirements of the lactating ewes with lambs. These results are discussed in the general context of forest management in the Pacific Northwest.

OSU Link
Non-OSU Link

201. Riley, C.M., C.J. Wiesner, D.W. Scott, J. Weatherby and R.G. Downer. 1992. Evaluating the field efficacy of Bacillus thuringiensis Berliner against the western spruce budworm (Lepidoptera: Tortricidae). *In* Pesticide formulations and application systems: 11th volume.*Eds.* L.E. Bode and D.G. Chasin, ASTM, Philadelphia, USA. pp. 271-290.

Keywords: tree/stand protection
stand conditions
tree/stand health

Abstract: A detailed assessment of spray deposition and efficacy of 2 formulations of Bacillus thuringiensis was carried out as part of a control programme against Choristoneura occidentalis on Pseudotsuga menziesii and Abies grandis in Oregon in 1988. An analysis of covariance model that was used to examine the relationship between deposit density and field efficacy (larval mortality and defoliation) could not be justified, and the relationships between variables were investigated using chi-squared analysis. This paper was presented at a conference on pesticide formulations and application systems, held in San Antonio, USA, on 14-15 November 1991.

OSU Link
Non-OSU Link

202. Ritchie, G.A. 1984. Effect of freezer storage on bud dormancy release in Douglas-fir seedlings. Canadian-Journal-of-Forest-Research 14(2): 186-190.

Keywords: nursery operations
tree phenology

tree/stand health

Abstract: Two-yr-old seedlings from 4 western Washington and Oregon provenances were lifted from the nursery on Dec. 11, 1979 and Jan. 21, Feb. 13 and March 11, 1980, following the accumulation of about 600, 1170, 1550, and 1800 chilling hours (temp. less than 5 degrees C), respectively. They were tested for bud dormancy intensity and vigour immediately after lifting and following 2 and 6 months in freezer (-1 degrees C) storage. Dormancy weakened exponentially with accumulated nursery chilling, with seedlings from all 4 provenances responding similarly. The rate of dormancy release was substantially retarded by freezer storage, so that by late March stored seedlings were more dormant than those remaining in the nursery beds. Dormancy weakened in storage more rapidly in high-altitude provenances than in provenances from lower altitudes. Early-lifted seedlings lost dormancy more rapidly in storage than did late-lifted seedlings. Vigour following a 6-wk greenhouse trial was good or excellent in all but the Dec.-lifted unstored seedlings and the March-lifted unstored and 6-month stored seedlings.

OSU Link
Non-OSU Link

203. Ritchie, G.A. 1986. Relationships among bud dormancy status, cold hardiness, and stress resistance in 2+0 Douglas-fir. New-Forests 1(1): 29-42.

Keywords: nursery operations
tree/stand protection
growth
tree/stand health
tree phenology
carbon allocation

Abstract: Seedlings were lifted from a western Washington nursery on six dates spanning the 1980-81 lifting season. On each date samples of seedlings were subjected to the following treatment: tumbling for 5 min, desiccation of roots for 30 min at 30 degrees C and 2.1 kPa vapour deficit, exposure of shoots to temp. of -10 degrees C, -15 degrees C or -20 degrees C for 2 h, and unstressed control. On two lift dates sub-samples of seedlings were placed into -1 degrees C storage and held for 2 months before the above treatments were administered. Bud dormancy status was determined, using a bud break test, on seedlings from each lift date before and after storage. After one growing season in the field, percent survival, vigour, height growth and shoot and root weight were determined on stressed and unstressed seedlings. Survival and vigour were less affected by treatments than were height and weight. Severity of stress was in the order -20 degrees C>-15 degrees C>desiccation> handling>-10 degrees C. Degree of cold injury was directly related to seedling dormancy status whether dormancy status had been attained in the nursery from natural chilling or in frozen storage. Seedlings in a mid-range of dormancy release (between deep rest and quiescence) were most resistant to all imposed stresses.

OSU Link
Non-OSU Link

204. Ritchie, G.A., Y. Tanaka, R. Meade and S.D. Duke. 1993. Field survival and early height growth of Douglas-fir rooted cuttings: relationship to stem diameter and root system quality. Forest-Ecology-and-Management 60(3-4): 237-256.

Keywords: nursery operations
tree/stand health
growth

Abstract: In 1990, three studies involving 11 half-sib families of Douglas fir (Pseudotsuga menziesii) rooted cuttings were established at three sites in western Washington State (two with low regeneration difficulty (RD) and one with high RD). One of the studies, a grading study, compared performance of nine classes of rooted cuttings based on stem diameter and root system quality. A second, cull, study evaluated five different types of putative culls. A third study determined the correlation between number of initial roots and field performance. In the grading study, survival and height growth reflected stem diameter and relative root quality on all three sites. Mean survival by treatment was in the range 92-100%, 82-97% and 66-87% for good, fair and poor relative root quality, respectively. First year height growth varied from approximately 10 cm to 20 cm and was greatest on low RD sites. Second year height growth was from 3 to 4x greater than first year height growth on low RD sites and 2 to 3x greater on the high RD site. Performance of seedlings and transplants was nearly identical to that of rooted cuttings of corresponding stem diameter and root system quality. In the cull study, only trees with stem diameter <less or =>4 mm were deemed true culls owing to significantly reduced survival and height growth. In the root number study, rooted cuttings generally increased in size in the nursery in proportion to root number. However, after 2 years in the field, root number was a very poor predictor of survival and height growth. Results are discussed in the context of the development of culling standards for rooted cuttings of Douglas fir nursery stock, and the use of root morphology as an indicator of stock plant quality and potential.

OSU Link
Non-OSU Link

205. Rose, R., M. Atkinson, J. Gleason and T. Sabin. 1991. Root volume as a grading criterion to improve field performance of Douglas fir seedlings. New-Forests 5(3): 195-209.

Keywords: nursery operations
fertilization
tree/stand health
growth

Abstract: Three Oregon seed sources of Douglas fir (Pseudotsuga menziesii) were grown as 2+0 bare-root seedlings, and graded into three root-volume categories (<9, 9-13, and >13 cmsuperscript 3) before outplanting in Columbia County, Oregon in January 1987. The following were assessed: (1) differences in survival and growth after one and two growing seasons in the field; (2) relation(s) of seedling height after one and two seasons to preplanting nursery root volume, total fresh weight, root-collar diameter, and height; and (3) differences in field performance due to application of NPK fertilizer at planting. Field survival was >90% among all root-volume categories. Seedlings in the largest category grew significantly better than those in the two smaller categories over two seasons. Fertilization at time of planting had no effect on survival or growth because of shallow placement (3 cm below soil surface) of the fertilizer

pellet. The results suggest that using root volume as well as height and diameter as a seedling grading parameter is worthwhile where morphological quality must be maximized to improve field performance.

OSU Link
Non-OSU Link

206. Rose, R. and D.L. Haase. 1995. Effect of the antidesiccant Moisturin on conifer seedling field performance. Tree-Planters' Notes 46(3): 97-101.

Keywords: nursery operations
growth
tree/stand health

Abstract: Two concentrations of the antidesiccant Moisturin were applied to Douglas fir (Pseudotsuga menziesii) and ponderosa pine (Pinus ponderosa) seedlings after lifting by either dipping or spraying. Seedlings were outplanted to 5 typically dry sites in Oregon and to a garden plot at Oregon State University. Seedling performance was assessed at the end of the first growing season. Despite trends in plant moisture stress measurements that suggest reduced transpirational loss, there were no significant treatment effects on height growth, survival, or stem diameter growth at any of the study sites nor in the garden plot.

OSU Link
Non-OSU Link

207. Rose, R., D.L. Haase, F. Kroiher and T. Sabin. 1997. Root volume and growth of ponderosa pine and Douglas-fir seedlings: a summary of eight growing seasons. Western-Journal-of-Applied-Forestry 12(3): 69-73.

Keywords: nursery operations
growth
tree/stand health

Abstract: Survival, growth, and stem volume were determined for 2+0 bare-root ponderosa pine (Pinus ponderosa) and Douglas fir (Pseudotsuga menziesii) seedlings, 8 growing seasons after planting in 1987 on sites near, respectively, Wamic or Vernonia, Oregon. For each species, seedlings from three seedlots were assigned to one of three root-volume categories (<4.5, 4.5-7 and >7 cmsuperscript 3 for ponderosa pine; <9, 9-13 and >13 cmsuperscript 3 for Douglas fir). On a dry harsh ponderosa pine site on the eastern slopes of Mt. Hood, where gopher [Thomomys sp.] and cattle damage decreased the number of seedlings, more seedlings in the highest root-volume category survived (70%) than in the smaller root-volume categories (62% and 50%). Douglas fir on a good site in the Coast Rangeshowed significantly greater height and stem volume for the largest root-volume category, whereas annual shoot growth and survival did not differ. Root volume is one of several potentially useful criteria for predicting long-term growth and survival after outplanting.

OSU Link
Non-OSU Link

208. Rose, R. and J.S. Ketchum. 2002. Interaction of vegetation control and fertilization on conifer species across the Pacific Northwest. Canadian-Journal-of-Forest-Research 32(1): 136-152.

Keywords: fertilization
release treatments
chemical release
growth
tree/stand health
tree physiology
stand conditions

Abstract: An experiment evaluating three levels of vegetation competition control (no control, 1.5 m2 of vegetation control, and 3.3 m2 of vegetation control), each with two fertilizer application treatments (fertilizer application at the time of planting with complete slow-release fertilizer (WoodaceReg. IBDU), or no fertilizer application), was installed at five sites. Two of these sites were planted with Douglas-fir (Pseudotsuga menziesii) in the Oregon Coast Range, one with ponderosa pine (Pinus ponderosa) in eastern Washington, one with western hemlock (Tsuga heterophylla) in the coastal hemlock zone in Oregon, and one with coastal redwood (Sequoia sempervirens) in northern California, USA. At four of the five sites, mean stem volume, basal diameter, and height of seedlings increased significantly with increasing area of weed control, and the magnitude of difference between treatments increased with time. Fertilizer application significantly increased seedling size only at the two sites with adequate soil moisture; increases were marginally significant at a third. Response to fertilizer application was less than from weed control and impacted growth for only the first year, whereas the influence of weed control continued to influence growth the entire length of the study (4 years). Area of vegetation control and fertilizer application did not interact significantly at any site.

OSU Link
Non-OSU Link

209. Rose, R. and J.S. Ketchum. 2003. Interaction of initial seedling diameter, fertilization and weed control on Douglas-fir growth over the first four years after planting. Annals-of-Forest-Science 60(7): 625-635.

Keywords: nursery operations
fertilization
release treatments
chemical release
growth
tree/stand health
stand conditions

Abstract: Planting larger stock, fertilizer application and added years of weed control are often employed to increase growth rate of plantations. We evaluated these techniques using a replicated factorial study design repeated in two diverse locations in western Washington State, USA. Two different sizes of planting stock, NPK fertilizer application at planting and in the following year, and two or three years of weed control using herbicides were tested. No significant interactions among the treatment levels were found with all treatments influencing Douglas-fir (Pseudotsuga menziesii) growth in an additive manner. Fourth year stem volume gains were greatest from planting larger initial stock:

planting seedlings 2 mm larger in basal diameter resulted in fourth-year stem volume gains of 35 and 43%. The fertilizer application treatments used produced early gains, but they were short lived. The third-year weed control treatment had no observable effect on fourth-year stem volume or on volume growth in years three or four.

OSU Link
Non-OSU Link

210. Rose, R., J.S. Ketchum and D.E. Hanson. 1999. Three-year survival and growth of Douglas-fir seedlings under various vegetation-free regimes. Forest-Science 45(1): 117-126.

Keywords: release treatments
chemical release
growth
tree morphology
tree/stand health
stand conditions

Abstract: Responses of Douglas-fir (Pseudotsuga menziesii) seedlings were studied for 3 yr (1993-96) following eight vegetation-control treatments in three western Oregon clearcuts. The objectives were to determine seedling growth response to different areas of spot vegetation control and to determine the relative influence of early woody and herbaceous competition on seedling growth. Herbicide treatment areas varied in size from those receiving no control to full control (9.3 msuperscript 2). Controlled areas were maintained free of herbaceous vegetation for 2 yr and all woody vegetation was controlled for 3 yr. Two additional treatments, complete control of woody vegetation only and complete control of herbaceous vegetation only, were also examined. On two sites (Summit and Marcola), seedling growth parameters were maximized at or near full vegetation control with a tree spacing of 3 m x 3 m. On the third site (Pedee), maximum growth response occurred between 5 and 6 msuperscript 2 of control. Herbaceous vegetation control resulted in increased seedling growth at all sites while woody vegetation control yielded increased seedling growth only at the Pedee site. Cumulative 3 yr herbaceous cover accounted for 68% and 41% of the variability in stem volume at Summit and Marcola, respectively. Adding cumulative 3 yr woody cover to the model accounted for an additional 18% and 49% of the variability in stem volume at Summit and Marcola, respectively. At Pedee, neither herbaceous nor woody cover significantly influenced 3 yr stem volume, suggesting that factors other than vegetation cover were responsible for differences measured.

OSU Link
Non-OSU Link

211. Ross, D.W. and G.E. Daterman. 1994. Reduction of Douglas-fir beetle infestation of high-risk stands by antiaggregation and aggregation pheromones. Canadian-Journal-of-Forest-Research 24(11): 2184-2190.

Keywords: tree/stand protection
tree/stand health

Abstract: A combination of antiaggregation and aggregation pheromones were tested for protecting stands of Douglas fir (Pseudotsuga menziesii) at high risk for infestation by Douglas fir beetle (Dendroctonus pseudotsugae) at a site in Oregon. The antiaggregation pheromone, 3-methylcyclohex-2-en-1-one (MCH), was applied in a bubble capsule formulation to the perimeter of 1 ha circular plots at a rate of 60 g/plot. Treated plots also had three or four clusters of four Lindgren funnel traps baited with frontalin, seudenol, 1-methylcyclohex-2-en-1-ol, and ethanol located outside of the plot, but within 160 m of the boundary. Mean (+SD) accumulated catches in all traps per plot were 73 658 + 19 721 Douglas fir beetles and 12 892 + 2513 Thanasimus undatulus, a predator of the Douglas fir beetle. The mean percentage of Douglas fir trees with a diameter at breast height (d.b.h.) <more or =>20 cm that were mass attacked was reduced by 80% within the treated plots compared with the untreated plots. However, there was an 8-fold increase in the percentage of trees mass attacked in the area outside the treated plots in the vicinity of the funnel traps. The net effect of the treatment was to concentrate mass attacked trees within a limited area outside of the protected stand. The results indicated that Douglas fir beetle antiaggregation and aggregation pheromones can be used effectively to reduce the probability of infestation in small, high value stands.

OSU Link
Non-OSU Link

212. Ross, D.W., G.E. Daterman and K.E. Gibson. 2002. Elution rate and spacing of antiaggregation pheromone dispensers for protecting live trees from Dendroctonus pseudotsugae (Coleoptera: Scolytidae). Journal-of-Economic-Entomology 95(4): 778-781.

Keywords: tree/stand protection
tree/stand health

Abstract: The antiaggregation pheromone 3-methylcyclohex-2-en-1-one (MCH) is highly effective in preventing the infestation of high-risk trees by Douglas-fir beetle, Dendroctonus pseudotsugae. A large portion of the cost of an MCH treatment is related to the time applicators spend walking through an area dispersing the formulated pheromone. Application of fewer MCH dispensers eluting at a higher rate than those currently registered for operational use could potentially reduce treatment costs. Two higher elution rates, 6 and 18 mg/d per dispenser, were compared with the current standard of 2 mg/d per dispenser and an untreated control on 1-ha circular plots. Dispensers were spaced 5, 15, and 44 m apart around the plot perimeters eluting 2, 6, and 18 mg/d, respectively. The nominal dose of MCH was 144 mg ha-1 d-1 on all plots. Percentages of Douglas-fir trees <more or =>20 cm diameter at breast height mass attacked by Douglas-fir beetle were significantly lower on plots treated with dispensers eluting 2 and 6 mg/d and spaced 5 and 15 m apart, respectively, compared with the untreated control. Infestation rate on plots treated with dispensers eluting 18 mg/d and spaced 44 m apart was not significantly different from the control. Douglas-fir beetle abundance and host tree availability were similar on all plots. These results indicate that MCH dispensers eluting 6 mg/d (three times the current standard rate) and spaced 15 m apart (three times existing standard distance) can effectively prevent Douglas-fir beetle infestations.

OSU Link
Non-OSU Link

213. Ross, D.W., K.E. Gibson, R.W. Thier and A.S. Munson. 1996. Optimal dose of an antiaggregation pheromone (3-methylcyclohex-2-en-1-one) for protecting live Douglas-fir from attack by Dendroctonus pseudotsugae (Coleoptera: Scolytidae). Journal-of-Economic-Entomology 89(5): 1204-1207.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: The Dendroctonus pseudotsugae antiaggregation pheromone, 3-methylcyclohex-2-en-1-one (MCH), was applied to stands of Douglas fir, Pseudotsuga menziesii
in Oregon, Montana, Idaho and Utah, at high risk for infestation to determine the lowest effective dose for protecting live trees. MCH was applied at rates of 50, 100, and 150 bubble capsules per hectare (20, 40, and 60 g/ha, resp.) in 1994, and 15, 30, and 50 bubble capsules per hectare (6, 12, and 20 g/ha, resp.) in 1995. Mean release rates throughout the beetle flight periods in 1994 and 1995 were 1.63 and 1.23 milligrams per capsule per day, resp. For both years, catches of Douglas fir beetles in pheromone-baited traps located at the plot centers were significantly lower on all MCH-treated plots compared with untreated plots, but there were no differences among the 3 doses of MCH. In contrast, MCH had no effect on the numbers of 3 predators (Thanasimus undatulus, Enoclerus sphegeus and Temnochila chlorodia [Temnoscheila chlorodia]) collected in the traps during either year. In 1994, the percentage of Douglas fir <more or =>20 cm diameter at breast height (dbh) that were mass attacked was significantly lower on MCH-treated plots compared with the untreated control, and all 3 doses were equally effective. In 1995, there were no significant differences in the percentage of mass-attacked trees among the treatments. These results demonstrate that MCH applied at rates as low as 20 g/ha (50 bubble capsules per hectare) can reduce the probability that high-risk Douglas fir will become infested.

OSU Link
Non-OSU Link

214. 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

215. Rosso, P. and E. Hansen. 1998. Tree vigour and the susceptibility of Douglas fir to Armillaria root disease. European-Journal-of-Forest-Pathology 28(1): 43-52.

Keywords: fertilization
thinning
pruning
tree/stand protection
growth
tree/stand health
carbon allocation

Abstract: The effects of thinning, fertilization and pruning on the vigour of Douglas fir (Pseudotsuga menziesii) and its susceptibility to Armillaria root disease were investigated in Oregon, USA. Tree vigour was defined as the relative capacity for tree growth, expressed as the above-ground biomass increment per unit of photosynthetic tissue, or growth efficiency (GE). It has been hypothesized that trees with higher GE can better resist pathogen attack, and that GE can be used as a predictor of tree susceptibility to disease. In a previous study, four P. menziesii plantations were thinned, fertilized and pruned in all combinations, and the effects of these treatments on tree vigour were measured after 10 years. Root disease was not a factor in the initial study design, and mortality was ignored until 8 years after the treatments were applied. The results of an earlier study were utilized and the correlation between Armillaria root disease incidence and the effects of earlier stand treatments on tree growth was investigated. A. ostoyae [A. obscura] was the primary cause of mortality in the study area. The disease incidence of infected subplots ranged from 2 to 20%. A. obscura incidence was the highest at medium tree density (6.1%), slightly lower on the low density (5.6%) and lowest on the unthinned plots (3.8%). There were no significant correlations between disease incidence and previous tree growth. The vigour of trees that became symptomatic or died by 1993 was not significantly different from the vigour of trees that remained asymptomatic in 1983-85. On these sites, in areas of infection, A. obscura was causing mortality of the largest, fastest growing trees, as well as less vigorous trees. It is concluded that Armillaria continues to cause mortality, regardless of the growth efficiency or growth rate of the host.

OSU Link
Non-OSU Link

216. Roth, B.E. and M. Newton. 1996a. Role of Lammas growth in recovery of Douglas-fir seedlings from deer browsing, as influenced by weed control, fertilization, and seed source. Canadian-Journal-of-Forest-Research 26(6): 936-944.

Keywords: planting operations
release treatments

chemical release
fertilization
tree/stand protection
growth
tree/stand health

Abstract: This study examined the effects of weed control, nitrogen fertilizer, and seed source on Lammas growth (second flushing) in Douglas fir (Pseudotsuga menziesii) seedlings on 3 sites in the Oregon Coast Range. It also assessed the occurrence of deer (Odocoileus hemionus columbianus) browsing as related to these silvicultural treatments and examined the role of Lammas growth in seedling recovery and escape from deer browsing. Seedlings (averaging 54 cm tall, 6 mm diameter at 15 cm above ground) were planted in February 1992, and measured at the time of planting and in autumn 1992 and 1993. Complete weed control with hexazinone (annual applications + spot treatments as necessary) significantly increased the occurrence of Lammas growth. Nitrogen fertilizer (220 kg/ha urea) decreased Lammas growth significantly, at least in part by favouring weed growth. Lammas growth was not influenced by seed source (genetically improved from a seed orchard or local wild stock). The increased Lammas growth associated with weed control mediated the effects of deer browsing. Although multiple-year browsing occurred more commonly on weeded than unweeded seedlings, after two growing seasons weeded seedlings that were repeatedly browsed were twice as large as unbrowsed, unweeded seedlings. On one site, stock of wild origin was more heavily browsed than that from a seed orchard.

OSU Link
Non-OSU Link

217. Roth, B.E. and M. Newton. 1996b. Survival and growth of Douglas-fir relating to weeding, fertilization, and seed source. Western-Journal-of-Applied-Forestry 11(2): 62-69.

Keywords: planting operations
fertilization
release treatments
chemical release
growth
tree physiology
tree morphology
tree/stand health

Abstract: The goal of this study was to quantitatively evaluate the individual and interactive effects of weed control, nitrogen fertilizer, and seed source on Douglas fir (Pseudotsuga menziesii) survival and growth in plantations on a range of sites and growing conditions in western Oregon. Weed control with hexazinone (broadcast application after planting) was the dominant factor influencing seedling survival and growth and accounted for 49% of the explained variation in seedling volume after 2 years. Nitrogen fertilizer (urea) had no effect when used in conjunction with weed control and a negative effect when used without weed control. Seedlings from a seed orchard source were significantly larger in diameter and volume than those from a wild local source after two growing seasons, but second-year heights were similar for the two seedling types. Initial seedling size was positively correlated with growth rate.

OSU Link
Non-OSU Link

218. Sachs, D. and J.A. Trofymow. 1991. Testing the performance of FORCYTE-11 against results from the Shawnigan Lake thinning and fertilization trials on Douglas-fir. Canadian-Forest-Service, Pacific and Yukon Region Information-Report BC-X-324. viii + 58 p.

Keywords: fertilization
thinning
precommercial thinning
growth
yield
tree physiology
carbon allocation
tree/stand health
computer modeling

Abstract: FORCYTE-11 is an ecosystem-based forest growth simulation model. Its performance was evaluated with data on stand and tree biomass, height, stocking (mortality) and foliar assimilation and loss rates for Douglas fir (Pseudotsuga menziesii) in thinning/fertilizer trials in British Columbia.

OSU Link
Non-OSU Link

219. Scagel, C.F., R.G. Linderman and R.K. Scagel. 2000. Ten-year growth and survival of Douglas-fir seedlings treated with plant growth regulating substances at transplant. Canadian-Journal-of-Forest-Research 30(11): 1778-1787.

Keywords: nursery operations
growth
tree/stand health
tree morphology

Abstract: Commercially available plant growth regulators (PGRs) or moisture retention gels, applied to the roots of Douglas fir (Pseudotsuga menziesii) before planting, can modify IAA levels in roots, root growth responses, and tree survival. Two different 1+0 stock types (PSB313B and PSB323, interior and coastal Douglas fir, respectively, the latter having a larger root mass) were treated with IBA, ethephon (Ethrel), alginate, or a combination of IBA and alginate. New root growth and IAA levels in roots were measured 2 weeks after planting, and aboveground growth and tree survival were monitored over 10 growing seasons after planting in May 1988 on a site clear felled in winter 1988 in British Columbia, Canada; no site preparation was carried out. Treatment with IBA or the combination of IBA and alginate increased IAA conjugate and free IAA levels in roots, root growth, and tree survival. Alginate treatment alone increased new root growth and tree survival, but did not increase free IAA levels in roots. Ethephon treatment increased free IAA levels and root growth, but had no effect on IAA conjugates or tree survival. A cost analysis suggested that use of certain PGRs or alginate decreased the cost required to attain target stocking and increased tree size. The results suggest that application of PGRs or other

root-promoting materials to the roots of Douglas fir before planting has the potential to be a cost-beneficial method for increasing root growth and tree survival.

OSU Link
Non-OSU Link

220. Schneider, W.G., S.A. Knowe and T.B. Harrington. 1998. Predicting survival of planted Douglas-fir and ponderosa pine seedlings on dry, low-elevation sites in southwestern Oregon. New-Forests 15(2): 139-159.

Keywords: site preparation
mechanical preparation
prescribed fire
tree/stand health
tree morphology
stand conditions

Abstract: Four equations were developed by logistic regression for predicting the probability of Douglas fir (Pseudotsuga menziesii) and ponderosa pine (Pinus ponderosa) survival for the first (0-1) and first to third (1-3) growing seasons after applying mulching, radial scalping (removal of all vegetation and a thin layer of soil in a 1-m radius area around each tree), or artificial shading (shade cards) treatments in plantations in SW Oregon. Most of the sites had been burned by wildfire or prescribed fire before planting. Variables describing conifer size, levels of competing vegetation, presence of silvicultural treatments, site factors, and climate factors were collected from 13 sites up to 6 yr after planting and examined as potential predictors of survival. Age, stem diameter, a competition index for shrubs, severity of growing season at time of treatment, average annual precipitation, aspect, and slope angle were predictors of Douglas fir survival during 0-1 and 1-3 growing seasons after treatment; the presence of silvicultural treatments was also a predictor only during the first growing season after treatment. Age, aspect, and slope angle were predictors of ponderosa pine survival over both 0-1 and 1-3 growing seasons after treatment; height-diameter ratio, competition indices for herbs, shrubs, and hardwoods, silvicultural treatment, severity of growing season at time of treatment, and average annual precipitation were also predictors only during the first growing season after treatment; crown width was a predictor of survival only during 1-3 growing seasons after treatment. When significant in the models (equations), predicted probability of survival increases with treatments, less severe weather conditions, diameter, crown width, age, and precipitation; probability decreases with increasing height-diameter ratio and competition indices for herbs, shrubs, and hardwoods.

OSU Link
Non-OSU Link

221. 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

222. Schowalter, T.D. 1987. Abundance and distribution of Lygus hesperus (Heteroptera: Miridae) in two conifer nurseries in western Oregon. Environmental-Entomology 16(3): 687-690.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: Seasonal patterns of abundance and distribution of Lygus hesperus were observed at 2 conifer nurseries in western Oregon during 1985. Abundance differed significantly among conifer seedling types (age class-species combinations) and sampling dates. Highest densities were observed in lodgepole pine (Pinus contorta) and ponderosa pine (P. ponderosa) seedlings germinated during 1985, in Douglas fir (Pseudotsuga menziesii) seedlings germinated in 1984 and in late July samples. Significant interaction between seedling type and sample date reflected a shift in L. hesperus occurrence among seedling types during the growing season, especially from 1984 Douglas fir seedlings early in the season to 1985 seedlings later in the season. This shift coincided with the dispersal of the first L. hesperusgeneration and with pruning of the 1984 seedlings for height control. The results indicate that L. hesperus abundance and distribution in conifer nurseries result from L. hesperus phenology in combination with seasonal changes in the spatial pattern of available resources. The implications for nursery management are discussed.

OSU Link
Non-OSU Link

223. 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

224. 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

225. 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.

226. 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

227. Schowalter, T.D. and J.D. Stein. 1987. Influence of Douglas-fir seedling provenance and proximity to insect population sources on susceptibility to Lygus hesperus (Heteroptera: Miridae) in a forest nursery in western Oregon. Environmental-Entomology 16(4): 984-986.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: The effect of Lygus hesperus feeding on seedlings of Douglas fir (Pseudotsuga menziesii) was measured in seedlings representing 2 elevation zones, for each of 2 seed zones, and each of 2 seedling age classes in a forest nursery in Oregon during 1984. Damage frequency and height reduction both indicated significant effects of seed source. Examination of seedling distance from the nursery's west boundary with a lucerne field (a major source of L. hesperus in the nursery) indicated a significant effect of proximity to alternative hosts. These results suggest that seedling susceptibility to damage by L. hesperus is a function of seedling condition and location within the vegetation matrix.

OSU Link
Non-OSU Link

228. 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

229. Sharrow, S.H., D.H. Carlson, W.H. Emmingham and D.P. Lavender. 1992a. Direct impacts of sheep upon Douglas-fir trees in two agrosilvopastoral systems. Agroforestry-Systems 19(3): 223-232.

Keywords: release treatments
tree/stand health

Abstract: Livestock may provide important service and production functions in agroforestry systems. However, use of livestock in conifer/improved pasture agrosilvopastoral [silvopastoral] systems is currently limited by concerns about potential damage to trees by livestock. The effects of sheep grazing on Douglas fir (Pseudotsuga menziesii) trees in two patterns of sheep/pasture/conifer agroforest (cluster and grid plantations) at a site near Corvallis, Oregon, were studied from 4 yr after planting (1983) until the first precommercial thinning at 10 yr old (1988). The plantations had been established in 1979 using 2+0 Douglas fir seedlings planted as 5-tree clusters in 1.5 m diameter circles 7.7 m apart (840 trees/ha) and as a standard square grid of single trees 2.5 m apart (1600 trees/ha). In 1982, half of the plantations were rototilled and sown with inoculated Trifolium subterraneum. Trees averaged >1 m in height when grazing began in summer 1983. Some browsing of tree lateral branches by sheep occurred regardless of grazing season in 1983-85. However, the 2-10% of current year's lateral branch growth removed by grazing sheep was too low to affect tree growth. Sheep removed the terminal leaders from only 3-9% of trees each year during 1983-85. Most browsing of terminals occurred in the summer when other forages had become mature and were relatively unpalatable to sheep. Less than 13% of agroforest trees were barked by sheep each year during 1983-87. By the end of grazing in 1987, <8% of agroforest trees had sustained a level of barking likely to affect future growth (>50% of tree circumference barked). Mean forage utilization was greater in the cluster plantations, while browsing, barking and tree damage was greater in the grid plantations. Grazing had no discernible effect on tree diameter or height in any year ($P > 0.05$). Total tree mortality attributable to sheep grazing during 1983-87 was only 0.9%, including three trees girdled by sheep and two barked trees which were subsequently attacked by insects. Overall, grazing had no detrimental effect on timber stand growth or mortality.

OSU Link
Non-OSU Link

230. Sharrow, S.H., W.C. Leininger and K.A. Osman. 1992b. Sheep grazing effects on coastal Douglas fir forest growth: a ten-year perspective. Forest-Ecology-and-Management 50(1-2): 75-84.

Keywords: release treatments
tree/stand health
stand conditions
growth

Abstract: In a study evaluating effects of controlled sheep grazing on Douglas fir (Pseudotsuga menziesii) growth, tree diameter and height growth were measured during 1981-1990 in ungrazed and grazed tree stands in the Siuslaw National Forest, Oregon. Grazed stands were intensively used by a herded flock of 700-900 sheep for 3-4 days each May and August 1981 and 1982. The stand had been clear felled in 1977, burned in 1978, and planted with 3-year-old trees in 1980. Orchardgrass (Dactylis glomerata) was also sown aerially in 1980 to provide a food source for large indigenous herbivores and help slow the establishment of unwanted woody vegetation. Understorey vegetation phytomass and its utilization by sheep was evaluated using a before-and-after technique in 1981 and 1982. Sheep removed 28% and 64% of new tree lateral branches in 1981 and 1982, respectively. The major effect of browsing, however, appeared to be removal of terminal leaders which reduced 1990 Douglas fir tree height by 61 cm and diameter at breast height (d.b.h.) by 1.9 cm for each terminal removed. Sheep browsed terminal leaders of 38% and 77% of grazed plantation trees in 1981 and 1982, respectively. Grazing proved very effective in reducing red alder (Alnus rubra) establishment and growth. Total tree basal area in 1990 was similar for grazed and ungrazed stands. However, red alder trees contributed over 45% of tree basal area on ungrazed stands compared with 19% on grazed stands. Vegetation control by sheep, without associated browsing of terminal leaders, increased 1990 Douglas fir height by 16% and d.b.h. by 34%. Net effect of grazing (taking into account the negative effects of browsing together with the positive effects of reduced competing vegetation) was to increase 1990 Douglas fir height by 6% and d.b.h. by 22% on grazed compared with ungrazed timber stands.

OSU Link
Non-OSU Link

231. Shepherd, R.F. 1994. Management strategies for forest insect defoliators in British Columbia. Forest-Ecology-and-Management 68(2/3): 303-324.

Keywords: tree/stand protection
growth
tree/stand health
stand conditions

Abstract: A synthesis is presented of outbreak characteristics of common defoliating insects in forests (mainly Pseudotsuga menziesii) in British Columbia. Two types of outbreak are identified: fast-cycling and sustained outbreaks. Species with fast-cycling outbreaks rise quickly to visible defoliation levels, cause significant growth loss, tree deformation and mortality, and disappear just as quickly. Fast-cycle species noted include the Douglas fir tussock moth (Orgyia pseudotsugata), western blackheaded

budworm (Acleris gloverana), black army cutworm (Actebia fennica [Ochropleura fennica]), western hemlock looper (Lambdina fiscellaria lugubrosa), false hemlock looper (Nepytia freemani), greenstriped forest looper (Melanolophia imitata), and the saddleback looper (Ectropis crepuscularia). The effect of such outbreaks is closely related to the severity of defoliation during the first year; consequently, the objective of managing these species should be to reduce populations before defoliation occurs, i.e. to prevent the outbreak. To accomplish this objective, identification of susceptible habitats and monitoring with sensitive pheromone traps in areas of expected outbreaks are necessary to detect upwelling populations. Species with sustained outbreaks (typified by the various species of spruce budworms (Choristoneura spp.), e.g., the western spruce budworm, C. occidentalis, the 2-year cycle budworm, C. biennis, and C. orae) cause significant growth losses only after defoliation continues for a number of years. Tree mortality usually is not important except where regeneration is being nurtured under a selective or shelterwood silvicultural system. Impact can be significant over the life of a stand because of the length and frequency of outbreaks, but treatments effective for only 1 year usually cannot be justified except where it is important to retain a full crown. Long-term cultural methods appear to be the preferred management system and, of these, utilizing non-host species or resistant or phenologically asynchronous host species may be the best option. Again, determining the location of expected outbreaks is an important component of a management system and, at present, identifying stands by frequency of outbreak within zones of climatic suitability would be useful in selecting treatment areas.

OSU Link
Non-OSU Link

232. Shepherd, R.F., T.G. Gray, R.J. Chorney and G.E. Daterman. 1985. Pest management of Douglas-fir tussock moth, Orgyia pseudotsugata (Lepidoptera: Lymantriidae): monitoring endemic populations with pheromone traps to detect incipient outbreaks. Canadian-Entomologist 117(7): 839-848.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: The numbers of adults of Orgyia pseudotsugata caught in sticky delta-shaped pheromone traps baited with different concentrations of synthetic lures were compared with egg-mass densities and subsequent tree defoliation throughout a population cycle in British Columbia. A lure containing 0.01% pheromone by weight in the form of a 3 x 5-mm poly(vinyl chloride) rod provided more consistent catches than pheromone concentrations of 0.0001, 0.001, 0.1 or 1.0%. Trap saturation occurred when over 40 moths per trap were caught. To achieve a standard error of 30%, 6 traps were required at each site. There was a poor correlation between numbers of moths caught and egg-mass density or defoliation estimates in the following generation, but a threshold density was found that provides a warning of an incipient outbreak. Ground surveys for egg-masses are recommended to confirm suspected infestations after continuous increases in moth catches for 2-3 years or if an average of 25 moths or more per trap has been caught.

OSU Link
Non-OSU Link

233. Shepherd, R.F., I.S. Otvos and R.J. Chorney. 1984a. Pest management of Douglas-fir tussock moth (Lepidoptera: Lymantriidae): a sequential sampling method to determine egg mass density. Canadian-Entomologist 116(7): 1041-1049.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: A sequential egg-mass sample system for Orgyia pseudotsugata (McDunn.) was designed, based on visual scanning of the lower branches of Douglas firs (Pseudotsuga menziesii) in British Columbia. A branch was removed from each quadrant from the upper, middle and lower crown level, and from the lowest whorl of a total of 59 non-defoliated trees in 10 areas. No consistent trend in egg-mass density per branch could be found between crown levels, so the lower whorl of branches was selected for survey purposes. Sample stop lines were determined from egg-mass density and variability data collected on 55 sites, and subsequent defoliation estimates were related to these densities. The system is designed as an early detection tool to be used only in non-defoliated stands at the incipient stage of an impending outbreak.

OSU Link
Non-OSU Link

234. Shepherd, R.F., I.S. Otvos, R.J. Chorney and J.C. Cunningham. 1984b. Pest management of Douglas-fir tussock moth (Lepidoptera: Lymantriidae): prevention of an outbreak through early treatment with a nuclear polyhedrosis virus by ground and aerial applications. Canadian-Entomologist 116(11): 1533-1542.

Keywords: tree/stand protection
tree/stand health
stand conditions

Abstract: Two application methods were tested using a nuclear polyhedrosis virus as a biological control agent at an early stage in an outbreak of Orgyia pseudotsugata on Douglas fir [Pseudotsuga menziesii] in British Columbia in 1981. The virus, which often leads to the development of an epizootic late in the outbreak cycle, was propagated in O. leucostigma. Four plots were treated from a helicopter at a dosage of 2.2 x 1011 polyhedral inclusion bodies (PIB) in an emitted spray volume of 11.3 litres/ha; 5-8 weeks after spraying, 77-100% of live larvae were infected. Two plots were treated from the ground at 2.4 x 1010 PIB in 4.5 litres/tree; 8 weeks after treatment 83-85% of live larvae were infected. No egg-masses could be found in the treated plots in the autumn of 1981, and no larvae were found on sample trees in 1982 or 1983. The treatment was effective over a range of initial mean larval densities of 41-206/msuperscript 2 foliage. Populations in untreated areas nearby increased in 1982. Little foliage protection was obtained the year of application, due to the lengthy virus incubation period, but the trees recovered quickly when larval populations disappeared.

OSU Link
Non-OSU Link

235. Simpson, D.G. 1984. Filmforming antitranspirants: their effects on root growth capacity, storability, moisture stress avoidance, and field performance of containerized conifer seedlings. Forestry-Chronicle 60(6): 335-339.

Keywords: nursery operations

tree physiology
growth
tree/stand health

Abstract: One of 6 antitranspirants was sprayed on Pinus contorta, Picea glauca, Tsuga heterophylla and Pseudotsuga menziesii seedlings before or after a 12-wk storage period at 2 degrees C. Root growth capacity and pre-dawn water potential were measured immediately after treatment or after storage. Sample seedlings were planted out in British Columbia in April and May 1981 and survival and growth recorded after one season (Sept.). XEF-4-3561-A, Wilt Pruf, Folicote and Vapor Gard increased moisture stress avoidance (water potential) in all species. Plantgard and Clear Spray increased it only in T. heterophylla. Root growth capacity was reduced by Folicote and Vapor Gard in Pinus contorta, and by XEF, Wilt Pruf and Vapor Gard in Pseudotsuga menziesii. Growth in the first season was reduced by XEF and Wilt Pruf in P. menziesii, T. heterophylla and Picea glauca, and by Vapor Gard in T. heterophylla and Pseudotsuga menziesii. Growth in Pinus contorta was significantly increased by Wilt Pruf and unaffected by the others. Further trials of Wilt Pruf and XEF on Pinus contorta are recommended.

OSU Link
Non-OSU Link

236. Simpson, D.G. 1990. Frost hardiness, root growth capacity, and field performance relationships in interior spruce, lodgepole pine, Douglas-fir, and western hemlock seedlings. Canadian-Journal-of-Forest-Research 20(5): 566-572.

Keywords: nursery operations
tree/stand protection
tree physiology
tree/stand health
growth

Abstract: Interior spruce (Picea glauca-P. engelmannii complex), lodgepole pine (Pinus contorta), interior and coastal Douglas fir (Pseudotsuga menziesii) and western hemlock (Tsuga heterophylla) were grown from seed for 20 wk in containers in a greenhouse, with 18-h photoperiods. Seedlings were then acclimatized under natural daylength and temperature conditions at Vernon, British Columbia, for up to 12 wk (7 September-1 December). To create planting stock batches of varying quality, at 2-wk intervals during the acclimatization period separate samples of seedlings were taken (1) for immediate measurement of foliage frost hardiness or (2) for overwinter storage at 2 degrees C (western hemlock and coastal Douglas fir) or -2 degrees C (interior spruce, lodgepole pine and coastal Douglas fir). After storage, samples were used either for root growth capacity (RGC) measurement or for outplanting at various forest sites in British Columbia. In all species, frost hardiness and RGC increased with increasing weeks of acclimatization. Frost hardiness and RGC were correlated with each other in western hemlock, lodgepole pine and Douglas fir, and with field performance (survival or growth) in interior spruce, lodgepole pine and Douglas fir.

OSU Link
Non-OSU Link

237. Sorensen, F.C. 1996. Effects of length of seed chilling period and sowing date on family performance and genetic variances of Douglas-fir seedlings in the nursery. New-Forests 12(3): 187-202.

Keywords: nursery operations
tree phenology
growth
tree/stand health

Abstract: Seeds of four full-sibling Douglas fir (Pseudotsuga menziesii) families (F) - randomly chosen from about 30 control-pollinated crosses in a second-growth stand in the central Oregon Cascade Range (USA) - were moist chilled (C) for 14, 33, and 77 days and sown (S) 29 March, 26 April, and 24 May at two densities (D = 111 and 200 seeds/msuperscript 2), grown for 2 years in nursery beds and phenology and size traits recorded. The study was analysed in two parts: part I evaluated seed treatment effects and their interactions with families; and part II investigated the effect of treatments on genetic variances, particularly among-family (sigma superscript 2F) and within-plot (sigma superscript 2w) components and the intraclass correlation for families (tf). In part I there were large and highly significant differences associated with C and S and among F for all traits. Early S combined with long C resulted in early emergence and gave large seedlings with little loss and damage. Many interactions between C and F, and S and F, were significant. Interactions involved rank changes for size but not for phenology traits, and were larger for CxF than for SxF. Seedling density affected seedling size but not phenology, did not interact with seed treatments, and interacted significantly but weakly with families. In part II, C and S, but not D, had significant effects on sigma superscript 2F, sigma superscript 2w, and tf, but not in a predictable manner. Because of significant interactions, it is recommended that standardized seed treatments be used in family nursery tests. This should help to keep the results from these tests as repeatable as possible. Long chilling and sowing as early as practicable are recommended to minimize disease losses and winter damages and to provide good nursery stock.

OSU Link
Non-OSU Link

238. Sorensen, F.C. 1997. Effects of sib mating and wind pollination on nursery seedling size, growth components, and phenology of Douglas-fir seed-orchard progenies. Canadian-Journal-of-Forest-Research 27(4): 557-566.

Keywords: genetic tree improvement
nursery operations
growth
tree/stand health
tree morphology
tree phenology

Abstract: Polymix outcross (X), full-sib (FS), and wind-pollination (WP) families were produced on 25 seed trees and 10 half-sib families on 10 of the same trees in a Pseudotsuga menziesii var. menziesii seedling seed orchard in Oregon. Seedlings were raised at 2 sowing densities for 2 years in the nursery, and inbreeding depression (ID) in seedling size related to inbreeding effect on growing season length and growth rate. Seedling mortality was light and not affected by inbreeding. Mean ID for 2-year size traits was 6% (height) and about 8% (diameter) per 10% increase in F, the inbreeding coefficient, and was linear with the increase in F over the range of F used. Both amount of ID and its fit to linearity

differed greatly among seed trees. Elongation season was significantly and slightly shorter for FS than for X families; second-year relative elongation rate was nonsignificantly larger for FS than for X families. Inbred families had nonsignificantly larger within-plot variance and significantly larger coefficients of within-plot variance than X families. Sowing density was not a significant factor except in diameter and height/diameter ratio. Results are discussed in terms of plant growth habit and possible gene action. WP compared with X families were significantly shorter by 3.8% and significantly smaller in diameter by 4.6%, with much variation among family groups. About half of the height difference could be explained by seed weight; the remainder could have been due to pollen contamination or natural inbreeding. Progenies of the two pollen types did not differ for phenological traits, even though the seed orchard was in a drier, more inland location than the parent-tree locations. Progenies of WP had nonsignificantly larger within-plot variance than X progenies.

OSU Link
Non-OSU Link

239. 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

240. 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

241. 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

242. Stein, W.I. 1984. Wrenching Douglas-fir seedlings in August: immediate but no lasting effects. Pacific-Northwest-Forest-and-Range-Experiment-Station,-USDA-Forest-Service Research-Paper PNW-RP-317. 12 p.

Keywords: nursery operations
tree morphology
growth
carbon allocation
tree/stand health

Abstract: Seedlings in a nursery in Oregon were wrenched in their 2nd growth season in 1976. Wrenched and unwrenched seedlings were sampled at intervals from Aug. 1976 until Jan. 1977, and measured. The entire bed was lifted in Jan. and 100 treated and 100 control seedlings were planted out. After 24 days (Aug.), the number of lateral roots, shoot length, and root dry wt. were significantly smaller in wrenched seedlings. Shoot/root ratio was also smaller and remained so until early Oct. By late Oct., shoot length and the number of lateral roots were significantly greater in wrenched seedlings. During the first 5 yr after planting out, there were n.s.d. between wrenched and unwrenched trees in survival and growth, which were both good.

OSU Link
Non-OSU Link

243. Stein, W.I. 1988. Nursery practices, seedling sizes, and field performance. *In*: Proceedings, combined meeting of the Western Forest Nursery Associations; 1988 August 8-11; Vernon, British Columbia. *Tech Coord.* T.D. Landis. Rocky Mountain Forest and Range Experiment Station, USDA Forest Service General Technical Report RM-GTR-167. 15-18 pp.

Keywords: nursery operations
growth
tree morphology
tree/stand health

Abstract: Highlights are presented from a large cooperative study in Oregon to determine the combined effects of nursery cultural practices on the size and field performance of 2+0 Douglas fir [Pseudotsuga menziesii] seedlings. Seedlings were grown in 3 nurseries using seed from 7 sources; field plantings were made over 3 yr on 28 sites in SW Oregon. Seedbed density had more effect than irrigation frequency, undercutting or wrenching on seedling size, and survival and growth 4 yr after planting.

OSU Link
Non-OSU Link

244. Stein, W.I. 1997. Ten-year survival and growth of planted Douglas-fir and western redcedar after seven site-preparation treatments. Western-Journal-of-Applied-Forestry 12(3): 74-80.

Keywords: site preparation
chemical preparation
prescribed fire
tree/stand protection
growth
tree/stand health
stand conditions

Abstract: Western redcedar (Thuja plicata) and Douglas fir (Pseudotsuga menziesii) were planted together after applying seven site-preparation methods at one cable-logged site in the Oregon Coast Ranges. The treatments, applied during 1980, were: untreated control; spot clear by cutting; aerial spraying with glyphosate; broadcast burning; slash and burn; spray with Tordon 101 (picloram + 2,4-D) and burn; and burn and sow grass. Planting was done in early 1991, and vegetation and trees were measured periodically to 1990. Survival and growth of cedar were markedly less than Douglas fir on this favourable site where both species were components of the original stand. Repeated browsing severely impeded the cedar. Site preparation by broadcast burning generally yielded the best results, but sowing grass after broadcast burning produced Douglas fir responses similar to those for no site preparation. Where grass was sown, herbaceous cover was more abundant and taller, salmonberry (Rubus spectabilis) differed little in density but was slightly taller, and development of red alder (Alnus rubra) was delayed. Red alder is currently overtopping conifers in all treatments, and release is needed to ensure sufficient conifer survival.

OSU Link
Non-OSU Link

245. Steinfeld, D., D. Davis, S. Feigner and K. House. 2002. Fall versus spring transplanting of container seedlings: a comparison of seedling morphology. *In* National Proceedings: Forest and Conservation Nursery Associations 1999, 2000, and 2001, USDA-Forest-Service Rocky-Mountain-Research-Station RMRS-P-24. 196-200 pp.

Keywords: nursery operations
growth
tree/stand health
tree morphology

Abstract: In a study in Oregon, USA, containerized seedlings of Engelmann spruce (Picea engelmannii), sugar pine (Pinus lambertiana), Douglas-fir (Pseudotsuga menziesii), western redcedar (Thuja plicata), and western hemlock (Tsuga heterophylla) transplanted in the early fall and later in the early spring were compared for differences in stem diameter, height, root area, and shoot area. Fall-transplanted Pseudotsuga menziesii and the Thuja plicata showed an increase in stem diameter of 13 (2.0 mm) and 4% (0.4 mm), respectively. Fall-transplanted seedlings developed larger root systems - Picea engelmannii by 18%, Pinus lambertiana by 48%, Pseudotsuga menziesii by 58%, and Tsuga heterophylla by 47%.

Non-OSU Link

246. Stelzer, M.J. and R.C. Beckwith. 1988. Comparison of two isolates of Bacillus thuringiensis in a field test on western spruce budworm (Lepidoptera: Tortricidae). Journal-of-Economic-Entomology 81(3): 880-886.

Keywords: tree/stand protection
stand conditions
tree/stand health

Abstract: Two isolates of Bacillus thuringiensis (Thuricide 32LV [B. thuringiensis subsp. thuringiensis] and SAN-415 32LV) were compared for efficacy against Choristoneura occidentalis on Douglas fir (Pseudotsuga menziesii) and grand fir (Abies grandis) in Oregon. The insecticides were applied aerially at 20 and 30 billion International Units in a spray volume of 7.1 litres/ha. The 30 BIU/ha dosage provided better population control than 20 BIU/ha dosage with both formulations; however, only the difference between dosages for the SAN-415 32LV formulation was significant. Differences in efficacy between the isolates were not significant. The application of B. thuringiensis improved foliage protection by 15-25% compared with untreated plots.

OSU Link
Non-OSU Link

247. Stevenson, J.F., B.J. Hawkins and J.H. Woods. 1999. Spring and fall cold hardiness in wild and selected seed sources of coastal Douglas-fir. Silvae-Genetica 48(1): 29-34.

Keywords: genetic tree improvement
tree/stand protection
tree/stand health
tree phenology
growth

Abstract: Breeding for increased growth in coastal Douglas fir (Pseudotsuga menziesii) could affect the level of cold hardiness of seedlings used for reforestation. If increased growth is achieved by initiating growth earlier in the spring or prolonging growth later into autumn, cold hardiness could be reduced during these seasons. Cold hardiness was measured in top-cross and first generation seed orchard trees selected for increased growth rates, and wild stand trees on Vancouver Island and near Mission, BC, throughout one growing season by visual assessment of artificial freeze tests. Significant differences in freezing damage between genetically selected and wild stand trees were found during both spring and autumn. In April, LT50 of top-cross trees was 0.7-2.4 degrees C below that of wild stand trees, while in October, LT50 of wild stand trees was 1.9-3.4 degrees C below that of top-cross trees. Mitotic index was investigated as an indicator of dormancy, and a negative correlation between mitotic index and cold hardiness was found. A significant difference in mitotic index between the genetic groups was found once in March when mitotic index in wild stand and seed orchard trees was 1.4% and mitotic index in top-cross trees was 0.9%. There were no significant differences in mitotic index at any other times during the year. Date of bud burst and rates of shoot extension were related to levels of cold hardiness in the three groups of seedlings. The stage of bud burst in May was significantly correlated with levels of hardiness found earlier in March and April. Trees that completed shoot extension earlier in the season were significantly more hardy in autumn. Top-cross trees may extend their growing season later into the fall, thereby gaining a height advantage over wild stand seedlings. These top-cross families do not have an increased mid to late autumn frost damage risk, and in fact may have reduced risk of critical spring frost damage due to delayed deacclimation.

OSU Link
Non-OSU Link

248. Stjernberg, E.I. 1997. Mechanical shock during transportation: effects on seedling performance. New-Forests 13(1/3): 401-420.

Keywords: nursery operations
tree physiology
tree/stand health
growth

Abstract: A study was carried out to monitor shocks to seedling planting stock during transport from nursery to the planting site in normal commercial reforestation operations. Size and exact time of mechanical shocks were measured by a recorder placed inside seedling boxes. Seedling shipments by refrigerated semi-trailer, 5-t truck, pickup truck, small trailer and all-terrain vehicles were monitored in Alberta and British Columbia. Number of shocks, peak acceleration and average drop height were tabulated for travel on both paved and gravel roads. Twenty-two trials involving 7 conifer species (Douglas fir, Pseudotsuga menziesii; western hemlock [Tsuga heterophylla]; western red cedar [Thuja plicata]; amabilis fir [Abies amabilis]; white spruce, Picea glauca; lodgepole pine, Pinus contorta; Engelmann spruce, Picea engelmannii) were established at nurseries and field locations covering several ecological zones in both provinces. Frozen-stored, cool-stored, and freshly lifted seedlings were used in the trials. Seedlings were given 2 mechanical stress treatments by dropping them 30 times from 0.5 or 1 m height. Control seedlings were not dropped. Treatments were applied to nursery-trial seedlings not exposed to normal handling and transport, and to field-trial seedlings after transport to the planting site. Six root growth potential tests were made with treated and control seedlings in conjunction with the nursery trials. Seedling survival and volume growth were recorded for two growing seasons and the results are statistically analysed. They indicated that seedlings should not be affected by normal transport and handling activities - some of the shock treatments tested were much more stressful than those resulting from normal procedures. There was some evidence that mechanical shocks could reduce the growth and survival of bare rooted stock, but normal mechanical stresses had no effect on containerized stock. However, it is recommended that care be taken to reduce extreme mechanical shocks during planting stock transportation.

OSU Link
Non-OSU Link

249. 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

250. Sturrock, R.N., E.J. Phillips and R.G. Fraser. 1994. A trial of push-falling to reduce Phellinus weirii infection of coastal Douglas-fir. B.C. Ministry of Forests FRDA-Report 217. vi + 22 p.

Keywords: tree/stand protection
economics
tree/stand health
soil properties

Abstract: In push-falling, whole trees are pushed over by a bucket- and thumb-equipped excavator then grapple skidded to a landing where root masses are cut off and stems are bucked into logs. Harvesting of trees and removal of diseased roots is thus achieved with one stand entry. The productivity and economics of push felling were evaluated in a second-growth Douglas fir (Pseudotsuga menziesii) stand in coastal British Columbia. Results indicated that costs are comparable to those for conventional harvesting alone and that push felling can effectively remove infected roots. Before harvest <80% of the site was undisturbed but disturbed soils occupied 50.6% of the site after harvest. Changes in total bulk densities were relatively minor.

OSU Link
Non-OSU Link

251. Sullivan, T.P. and D.S. Sullivan. 1985. Operational direct seeding of Douglas-fir and lodgepole pine with alternative foods in British Columbia. B.C.-Ministry-of-Forests Research-Note 97. vi + 16 p.

Keywords: planting operations
tree/stand protection
tree/stand health
economics
reproduction

Abstract: Direct sowing of clear-felled areas in temperate coniferous forests of N. America has often been hampered because of seed predation by rodents and birds. In trials in British Columbia, seed predation was considerably reduced when Douglas fir (Pseudotsuga menziesii) seed was mixed with sunflower seed (7:1 sunflower to Douglas fir) or with sunflower seed and oat kernals (5:2:1 sunflower/oats/Douglas fir) or when lodgepole pine (Pinus contorta) seed was mixed with sunflower seed (2:1 sunflower to pine). The economics of providing alternative food for the predators and operational considerations are discussed.

OSU Link
Non-OSU Link

252. Sumaryono and G. Crabtree. 1989. Differential tolerance of woody nursery crop seedlings to napropamide. Weed-Technology 3(4): 584-589.

Keywords: nursery operations

release treatments
chemical release
tree/stand health

Abstract: Field studies at Corvallis, Oregon and greenhouse experiments were conducted to evaluate the tolerance to napropamide of black locust (Robinia pseudoacacia), honeylocust (Gleditsia triacanthos), apple, Douglas fir (Pseudotsuga menziesii), ponderosa pine (Pinus ponderosa) and Japanese black pine (Pinus thunbergii) in the seedling stage. Deciduous species were more susceptible to napropamide than coniferous species. Apple had the slowest seed germination and root development and was more susceptible. The deciduous species had more secondary roots in the shallow soil layer which contained most of the herbicide than the coniferous species. The roots of all woody species tested in vitro were inhibited significantly by contact with the herbicide, but only shoot growth of apple and black locust was inhibited. Injury to woody nursery crop seedlings may be avoided by delaying herbicide application.

OSU Link
Non-OSU Link

253. 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

254. Tait, D.E. 1988. The dynamics of stand development: a general stand model applied to Douglas-fir. Canadian-Journal-of-Forest-Research 18(6): 696-702.

Keywords: planting operations
thinning

growth
tree/stand health

Abstract: A linked pair of hypotheses are developed that represent causal explanations for plant growth and stand mortality for an even-aged stand. The pair of dynamic equations lead to a four-parameter Douglas fir simulation model that relates the development of stand volume and density to site quality, initial stocking density and alternative thinning regimes. The mortality hypothesis, a dynamic hypothesis related to stand density and stand growth, generates the -superscript 3/2 power law as an equilibrium solution.

OSU Link
Non-OSU Link

255. Tanaka, Y., B. Carrier, A. Dobkowski, P. Figueroa and R. Meade. 1988. Field performance of mini-plug transplants. Rocky-Mountain-Forest-and-Range-Experiment-Station,-USDA-Forest-Service General-Technical-Report RM-GTR-167. 172-181 pp.

Keywords: nursery operations
tree/stand health
growth

Abstract: Mini-plug transplants (MPTs) are grown for 5-6 months in the greenhouse under extended daylength and are transplanted by machine into nursery beds in May when the plants are 4-5 inches tall. Seedlings are grown for one season before planting. Field performance of MPTs was compared with that of other stock types of Douglas fir [Pseudotsuga menziesii] in 6 regions
of Washington and Oregon. Based on survival, vigour and height growth, MPTs generally performed as well as or better than other bare rooted stock.Because of their smaller initial height, MPTs had less total height than other stock types after 3 yr. MPTs were not preferred over other stock types in terms of frequency of big-game browsing and rabbit clipping, but, because of their small size, they were unable to withstand heavy animal damage.

256. Tappeiner, J.C., J.F. Bell and J.D. Brodie. 1982. Response of young Douglas-fir to 16 years of intensive thinning. Forest-Research-Laboratory,-Oregon-State-University

Keywords: thinning
growth
yield
tree/stand health
economics

Abstract: The report of the thinning study in the Oregon Coast Range includes a financial analysis of representative thinning regimes.

OSU Link
Non-OSU Link

257. Tesch, S.D., G.M. Filip, S.A. Fitzgerald and D.D. Marshall. 1994. Silvicultural treatments for enhancing tree value, vigor, and growth in 70- to 120-year-old stands dominated by noble fir on the Warm Springs Indian Reservation: a synthesis of the literature. ForestResearch Laboratory, College of Forestry, Oregon State University. iii + 21 p.

Keywords: fertilization
thinning
pruning
tree/stand protection
growth
yield
tree/stand health

Abstract: The Warm Springs Indian Reservation, Oregon, apparently contains some 30 000 acres of naturally regenerated, largely unmanaged stands of 70- to 120-year-old mixed conifer forest dominated by noble fir (Abies procera), with Douglas-fir [Pseudotsuga menziesii], and some Pacific silver fir [Abies amabilis] and western hemlock [Tsuga heterophylla]. The synthesis focuses on growth and yield, thinning, pruning, fertilizer treatment, disease, minimizing stand damage during thinning, and insect pests.

Non-OSU Link

258. Thies, W.G. and C.Y. Li. 1988. Movement of Lauricidin in Douglas-fir stumps infested by Phellinus weirii. Northwest-Science 62(1): 16-20.

Keywords: tree/stand protection
tree/stand health

Abstract: Two concentrations of Lauricidin (monolaurin) in a carrier solution of dimethyl sulfoxide and EDTA, and the carrier solution alone were applied to holes drilled in the tops of Douglas fir (Pseudotsuga menziesii) stumps infested by Phellinus weirii. Half of the stumps were evaluated after 4 months and the rest after 32 months. Lauricidin did not appear to move significantly in the stumps or roots. Any effect of the treatments on survival of P. weirii occurred near the treatment application holes and appeared to be caused by the carrier solution. It was concluded that the formulation of Lauricidin tested in this study was relatively immobile in wood and for that reason a poor choice as a chemical for treating stumps to control P. weirii.

OSU Link
Non-OSU Link

259. Thies, W.G. and E.E. Nelson. 1987a. Reduction of Phellinus weirii inoculum in Douglas-fir stumps by the fumigants chloropicrin, Vorlex or methylisothiocyanate. Forest-Science 33(2): 316-329.

Keywords: tree/stand protection
tree/stand health

Abstract: Chloropicrin, Vorlex (both liquids) and methyl isothiocyanate (a waxy solid and an active ingredient in Vorlex) were placed in holes in stumps of Douglas fir, 47 yr old, on a site clear felled near Apiary, Oregon. Stumps with liquids were unsealed or sealed with a layer of asphalt roofing compound. Stumps of trees dead when felled were sealed with a plastic covering to reduce loss of fumigant through decayed or weathered wood. All fumigants at the lowest tested dosage reduced or eradicated P. [Inonotus] weirii from infested stumps and roots. There were small, if any, increases in effectiveness as a result of increased dosage, sealing with asphalt or covering with plastic. Chloropicrin and Vorlex were more effective than methyl isothiocyanate. Absence of significant effects may have resulted from large variations within treatments. Assessments of inoculum survival in untreated stumps were similar with aseptic isolation techniques and observations of fungal regrowth on cut surfaces of incubated root discs. Isolations from fumigated stumps indicated greater survival of I. weirii in roots than shown by fungal regrowth. Viable I. weirii was not found in most root discs where fumigant was detected by bioassay.

OSU Link
Non-OSU Link

260. Thies, W.G. and E.E. Nelson. 1987b. Survival of Douglas-fir injected with the fumigants chloropicrin, methylisothiocyanate or Vorlex. Northwest-Science 61(1): 60-64.

Keywords: tree/stand protection
tree/stand health

Abstract: The fumigants were introduced into holes drilled past the centre of trees uninfected, probably infected or definitely infected with Phellinus [Inonotus] weirii in a 47-yr-old stand near Apiary, Oregon. Test dosages of chloropicrin or methyl isothiocyanate (MIT) were applied in Mar. 1982 and of chloropicrin or Vorlex (containing MIT) in Apr. 1983. Of 120 trees treated with fumigant, 95 trees were still alive in mid-Sep. 1984. After 3 growing seasons, all 45 trees treated with MIT and 21 of 45 trees treated with chloropicrin were still alive. After 2 seasons, crown condition was poorer in trees treated with Vorlex than in untreated trees or those treated with MIT. Attempts were made to isolate I. weirii from trees that died during the study. The fungus was isolated from all discs of an untreated tree, but from only 22% of root discs from 25 trees treated with chloropicrin or Vorlex. Roots have not been examined in trees still alive.

OSU Link
Non-OSU Link

261. Thies, W.G. and E.E. Nelson. 1996. Reducing Phellinus weirii inoculum by applying fumigants to living Douglas-fir. Canadian-Journal-of-Forest-Research 26(7): 1158-1165.

Keywords: tree/stand protection
tree/stand health

Abstract: In 1982, Douglas fir (Pseudotsuga menziesii) trees in the Oregon Coast Range were placed in three disease classes based on signs and symptoms of laminated root rot caused by Phellinus weirii. Eight fumigation treatments and an untreated check were applied to five replicate trees within each disease class. The dose applied to each tree was based on the estimated biomass in the below-ground portion of the bole, large roots, and first 2.4 m of the above-ground bole. The highest dosages tested

were 1.5 g of methylisothiocyanate (MITC), 6.7 ml of chloropicrin (trichloronitromethane), and 6.7 ml of Vorlex (v/v 20% MITC, 80% chlorinated C3 hydrocarbons) per kg biomass. In 1991 the roots of all surviving trees were excavated (roots of other trees were excavated at time of death), dissected, and sampled for viable Phellinus weirii. Twenty-four of the 30 trees treated with the two highest dosages of chloropicrin were killed, presumably by the fumigant. None of 45 trees treated with MITC and only 3 of 15 trees treated with Vorlex died, as did 3 of 15 untreated check trees. Volume of stained and decayed roots occupied by viable Phellinus weirii was reduced 78-90% by MITC or Vorlex compared with reductions of 51-65% by chloropicrin at the two lower, less phytotoxic doses (0.5 or 0.25 times the maximum dose), and 9% for untreated checks.

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262. Thies, W.G., E.E. Nelson and D. Zabowski. 1994. Removal of stumps from a Phellinus weirii infested site and fertilization affect mortality and growth of planted Douglas-fir. Canadian-Journal-of-Forest-Research 24(2): 234-239.

Keywords: site preparation
mechanical preparation
fertilization
tree/stand protection
tree/stand health
growth
soil properties

Abstract: A field study was established in a 4.9 ha clearcut on the west slope of the Cascade Range (44 degrees 21'N, 122 degrees 39'W), Oregon, to evaluate the effects of stump removal (of both infested and non-infested stumps) and fertilizing with ammonium nitrate on the incidence of laminated root rot (caused by Phellinus weirii) in Douglas fir (Pseudotsuga menziesii) seedlings. A 2x4 set of factorial treatments of stump removal in combination with nitrogen fertilizing was applied in August 1980 to 0.04-ha circular plots within the clearcut. Treatments included stump removal (either all stumps removed or the plot left undisturbed) and broadcast application of ammonium nitrate (0, 336, 672, or 1345 kg N/ha). Diameter at breast height and height of Douglas fir, planted as 2+1 bare root seedlings 4 months after treatment (in January 1981), were recorded 5 and 9 seasons after outplanting. Soil bulk density in the upper 20 cm was measured with a single-probe neutron densimeter. Stump removal reduced the number of seedlings killed by laminated root rot but had no significant effect on seedling growth. Stump removal increased soil bulk density only 7% as measured 9.7 years after treatment. Fertilizer increased the growth in diameter at breast height, and height growth of the seedlings but had no effect on mortality. There were no significant interactions between fertilizing and stumping treatments. Increased total soil N could still be detected on fertilized, nonstumped plots 9.7 years after treatment.

OSU Link
Non-OSU Link

263. Thies, W.G. and R.N. Sturrock. 1995. Laminated root rot in Western North America. Pacific Northwest Research Station, USDA Forest Service General Technical Report GTR-PNW-349. iv + 32 pp. p.

Keywords: planting operations
site preparation
mechanical preparation
fertilization
thinning
tree/stand protection
tree/stand health

Abstract: Laminated root rot, caused by Phellinus weirii, is a serious root disease affecting Douglas fir (Pseudotsuga menziesii) and other commercially important species of conifers in northwestern North America. This report gives an overview of the disease as it occurs in the Pacific Northwest in Canada and the USA. Information on recognizing crown symptoms and signs of the disease is presented. The disease cycle of laminated root rot, from initiation to intensification and distribution within infected stands, is described. Finally, disease management strategies during stand development and at stand regeneration are discussed. Features on the nomenclature of the fungus and on its management by silvicultural and mechanical approaches also are included.

OSU Link
Non-OSU Link

264. Trotter, D.B. and G.M. Shrimpton. 1989. Oxyfluorfen (Goal) trials with bareroot forest seedlings in British Columbia 1987. B.C. Ministry of Forestry FRDA Report 092. vi + 22 p.

Keywords: nursery operations
tree/stand health
stand conditions

Abstract: Oxyfluorfen was evaluated at various rates for weed control and crop tolerance on 1+0 and 2+0 bare rooted seedlings of Douglas fir (Pseudotsuga menziesii) and lodgepole pine (Pinus contorta) at Surrey Nursery, British Columbia.

OSU Link
Non-OSU Link

265. Tung, C.H., J. Batdorff and D.R. DeYoe. 1986a. Survival and growth of Douglas-fir seedlings with spot-spraying, mulching and root-dipping. Western-Journal-of-Applied-Forestry 1(4): 108-111.

Keywords: nursery operations
release treatments
chemical release
manual release
tree/stand health
growth

Abstract: In trials near Coos Bay, Oregon, 480 bare-rooted 2+0 Douglas fir seedlings, half of which had roots treated with Terra Sorb (a hydrolysed starch material capable of absorbing large amounts of water), were planted on a harsh site where several regeneration attempts had failed. After planting,

seedlings received no further treatment, or glyphosate or paper mulch were applied around seedlings for 1 or 2 yr. Root dipping in Terra Sorb did not enhance survival or growth. Survival was significantly greater after the third season when competing vegetation was controlled with mulch or glyphosate during the first one or two seasons. Survival of seedlings treated twice with glyphosate was 26, 23 and 21% greater, respectively, than seedlings receiving one glyphosate treatment and one or two mulch applications. Ht. growth was n.s.d. among treatments.

OSU Link
Non-OSU Link

266. Tung, C.H., L. Wisniewski and D.R. DeYoe. 1986b. Effects of prolonged cold storage on phenology and performance of Douglas-fir and noble fir 2+0 seedlings from high-elevation sources. Canadian-Journal-of-Forest-Research 16(3): 471-475.

Keywords: nursery operations
tree phenology
tree/stand health
growth
carbon allocation

Abstract: Seedlings of Douglas fir and noble fir (Abies procera) were lifted on 7 Nov. 1981 and 1 Mar. 1982 at Wind River Nursery, Washington, and stored at 1-2 degrees C until planting during the third week of June 1982 at 1500 m alt. in the Oregon Cascade Range. There was no difference in survival of Douglas fir attributable to storage treatment during the first two growing seasons. Noble fir seedlings stored for 7 months survived better during the first season than seedlings stored for 3 months, but no difference was evident after the second growing season. Time of bud burst did not differ between treatments for either species and no difference between treatments in rate of bud burst was seen in Douglas fir. Rate of bud burst was significantly greater in noble fir seedlings stored for 7 months than in those stored for 3 months. Shoot/root ratio decreased significantly during the first season for both species and treatments, but stabilized during the second season. Regardless of species, no differences were found in ht. growth and diam. increment between storage treatments. Results suggest that seedlings of these species originating from high alt. sources can be lifted in autumn and cold-stored for 7 months without adverse effects on performance after planting.

OSU Link
Non-OSU Link

267. Walker, R.B., S.P. Gessel and R.E. Miller. 1994. Greenhouse and laboratory evaluation of two soils derived from volcanic ash. Northwest-Science 68(4): 250-258.

Keywords: fertilization
growth
tree/stand health
carbon allocation
tree morphology
tree physiology

Abstract: This study assessed the mineral nutrient status of two soils derived from volcanic ash in SW Oregon. The study was initiated because conifers in some of the field plots on such soils had failed to give an expected yield response to the application of nitrogen fertilizer. Soil pot tests were carried out using both Romaine lettuce (Lactuca sativa) and Douglas fir (Pseudotsuga menziesii) seedlings, with a wide range of fertilizer treatments. Heavy phosphorus fertilization was necessary for satisfactory growth of lettuce, which also showed a 26% response to sulfur addition. With Douglas fir, pot tests showed no response to nitrogen alone, but gave a statistically significant response to phosphorus fertilization together with nitrogen (seedlings were non-mycorrhizal), and some suppression of yield with sulfur additions. There was a favourable effect of sulfur fertilization on foliar colour, and a chlorosis in younger foliage probably attributable to iron deficiency. Most of the tissue analyses showed low concentrations of magnesium (<0.05%), and also of calcium (<less or =>0.08%), iron (<70 mg/kg), boron (mostly 20 mg/kg) and copper (<less or =>2.6 mg/kg) in the younger foliage. Thus there is an implication from the field trials, and evidence from the greenhouse and laboratory study, that elements besides nitrogen need to be added to provide proper nutrition on these volcanic ash soils. The information can aid in guiding further fertilizer trials in forests on volcanic ash derived soil in SW Oregon and elsewhere.

OSU Link
Non-OSU Link

268. 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

269. White, D.E. and M. Newton. 1983. Effects of glyphosate and two formulation of hexazinone in young conifer plantations. Proceedings-of-the-Western-Society-of-Weed-Science (Vol.36): 54-56.

Keywords: release treatments
chemical release
growth
stand conditions
tree/stand health

Abstract: In April 1979, 1 month after transplanting 3-yr-old Douglas fir (Pseudotsuga menziesii), hexazinone liquid and solid formulations at 0, 1.11, 1.68 or 2.23 kg/ha were applied to the plots separately and in combination with 0 or 0.62 kg glyphosate/ha. There was no significant difference between formulations of hexazinone in effect on the herbaceous community which was dominated by Arrhenatherum elatius, Holcus lanatus, Elymus glaucus and Rubus ursinus. However, addition of glyphosate increased the mean weed-free condition from 67.25 to 85.1%. At the same time, in glyphosate-treated plots, mean ht. of 4th yr trees was 149.9 cm compared with 162.6 cm in hexazinone-only plots. Survival of 2nd yr trees was also affected.

OSU Link
Non-OSU Link

270. White, D.E. and M. Newton. 1990. Herbaceous weed control in young conifer plantations with formulations of nitrogen and simazine. Canadian-Journal-of-Forest-Research 20(11): 1685-1689.

Keywords: release treatments
chemical release
fertilization
stand conditions
tree/stand health
growth

Abstract: Weed control and second year survival and growth of newly planted 2+0 Douglas fir (Pseudotsuga menziesii) and 2+0 noble fir (Abies procera) seedlings were measured at 3 sites in Oregon after application of herbicide and fertilizer in a replicated complete factorial experiment with 4 levels of simazine (0, 2.2, 4.4, 8.8 kg/ha), 3 levels of N (0, 110, 220 kg/ha), 2 types of N (urea prill; urea + trimamino-s-triazine (TST) prill) and 2 kinds of formulations (co-granular prill of simazine + nitrogen; nitrogen prill followed by liquid simazine). For the first growing season, total weed and grass control increased with increasing simazine rates. Total weed control was better when urea + TST, rather than urea alone, was applied in conjunction with simazine. Formulation and nitrogen rate were not significant. After plot treatment with 1.1 kg liquid hexazinone/ha at the beginning of the second growing season, Douglas fir survival decreased as the rate of urea alone increased; survival decreased with little or no weed control and remained constant or increased with good weed control as the rate of urea + TST increased. Noble fir height and diameter, and Douglas fir diameter, decreased with poor weed control, but increased at least to the levels of untreated seedlings with good weed control. Noble fir diameter responded positively to added nitrogen. Although simazine may be toxic to first year conifers, this study suggests that more complete weed control in conjunction with fertilization may benefit young conifer plantations.

OSU Link
Non-OSU Link

271. White, D.E., L. Witherspoon-Joos and M. Newton. 1990. Herbaceous weed control in conifer plantations with hexazinone and nitrogen formulations. New-Forests 4(2): 97-105.

Keywords: release treatments
chemical release
fertilization
stand conditions
growth
tree/stand health

Abstract: In order to determine if herbicide efficacy is affected by nitrogen fertilizer, and to examine the effects of treatments on growth and survival of newly-planted 2-year-old Douglas fir (Pseudotsuga menziesii) and 3-year-old noble fir (Abies procera), the influence of different nitrogen fertilizers applied in different combinations with hexazinone formulations were evaluated on three herbaceous weed communities in Oregon. Field studies comparing three application methods in conifer plantations showed greatest reduction in total weed cover with a co-granular formulation of hexazinone and the slow-release nitrogen fertilizer triamino-s-triazine (TST). Slightly less control was achieved with separate applications of liquid hexazinone and TST granules, and poorest control with granular urea followed by liquid hexazinone. Weed control increased with an increase in hexazinone rate. Statistical analysis of the effect on conifers showed that the highest hexazinone rate significantly increased survival of noble fir, stem diameter of both noble fir and Douglas fir, and that the highest nitrogen rate significantly reduced survival of both species but did not affect stem diameter. Survival of noble fir and diameter of both noble fir and Douglas fir were significantly increased where a co-granular formulation of hexazinone and TST granules was used.

OSU Link
Non-OSU Link

272. White, T.L. 1987. Drought tolerance of southwestern Oregon Douglas-fir. Forest-Science 33(2): 283-293.

Keywords: genetic tree improvement
tree/stand protection
tree phenology
tree/stand health

Abstract: Seedlings of 2 open-pollinated families from each of 36 seed sources were tested for their ability to survive simulated drought in a growth room, greenhouse and cold frame. Generally, seedlings of sources from higher alt. and, to a lesser extent, drier sites were more drought tolerant. Seedlings from drought-tolerant sources tended to have earlier bud set, smaller initial ht. and less winter injury (needle mortality). The main selective force leading to earlier bud set and smaller ht. growth appeared to be the colder temp. regime at higher alt. Seedlings from higher alt. entered dormancy sooner and were better able to survive drought.

OSU Link
Non-OSU Link

273. Williamson, R.L. 1982b. Response to commercial thinning in a 110-yr-old Douglas-fir stand. Pacific-Northwest-Forest-and-Range-Experiment-Station, USDA-Forest-Service Research-Paper PNW-RP-296. i + 16 p.

Keywords: thinning
commercial thinning
growth
tree/stand health

Abstract: [See FA 28, 584] A stand in Washington was thinned in 1952 to 75 or 50% of normal b.a. After 19 yr the plots were remeasured and thinned again and stem analyses made for felled trees. Overall growth was similar in thinned and control plots, although mortality was 3-5x higher on control plots. The growth response relative to control trees was significantly greater for suppressed trees in the heavily thinned plots.

OSU Link
Non-OSU Link

274. Wilson, J. 2004. Vulnerability to wind damage in managed landscapes of the coastal Pacific Northwest. Forest-Ecology-and-Management 191(1/3): 341-351.

Keywords: planting operations
thinning
tree/stand protection
computer modeling
tree/stand health

Abstract: Managed forested landscapes in the coastal Pacific Northwest follow a pattern of transition from dominance by naturally regenerated second growth to dominance by planted stands. This transition should have dramatic influence on many characteristics of these landscapes and the larger region, including susceptibility to wind damage. In this paper, inventory and spatial information from an example landscape are integrated using the Landscape Management System to produce alternative management scenarios and evaluate the projections using a wind damage vulnerability rating system. Planted Douglas-fir stands tend to develop higher height to diameter ratios in the dominant trees, are thinned more often, and tend to have more exposed windward edges; characteristics which increase susceptibility to wind damage. In this analysis, the increasing vulnerability factors are mostly compensated for by the reduced rotation lengths expected in the plantations. The pattern of transition in managed landscapes generates an associated pattern of vulnerability to wind damage. Homogeneously and heterogeneously aged landscapes have distinct patterns of vulnerability. These differences could be harnessed to enhance the particular goals associated with managing individual ownerships.

OSU Link
Non-OSU Link

275. Wilson, J.S. and P.J. Baker. 2001. Flexibility in forest management: managing uncertainty in Douglas-fir forests of the Pacific Northwest. Forest-Ecology-and-Management 145(3): 219-227.

Keywords: planting operations
thinning
yield
tree morphology
economics
tree/stand health

Abstract: Long planning horizons generate substantial uncertainty in forest management, making management flexibility, the ability to choose between multiple options or opportunities, a desirable attribute of managed forests. Flexibility in forest management reflects both the relative rigidity of intervention requirements and the potential range of development pathways for a stand. The wind stability of Pacific Northwest Douglas-fir (Pseudotsuga menziesii) plantations is used to demonstrate the concept of management flexibility. Dense Douglas-fir plantations develop high height to diameter ratios in the dominant trees making them unstable and prone to wind damage. The management of these plantations is inflexible, because without early and timely thinning, the stands do not contain stable trees that could be expected to survive long rotations or late thinnings. A combination of reduced planting densities and site-specific management reduces both the necessity and rigidity of intervention requirements (e.g., thinning) and expands the number of potential developmental pathways for these stands. The cost of greater management flexibility is reduced efficiency of wood volume production; however, greater adaptability to changing markets, labour conditions, and management objectives may be more important for many forest owners. While this approach to management is complex, it frees owners and managers from rigid management requirements and allows for a wider range of future stand conditions.

OSU Link
Non-OSU Link

276. Wilson, J.S. and C.D. Oliver. 2000. Stability and density management in Douglas-fir plantations. Canadian-Journal-of-Forest-Research 30(6): 910-920.

Keywords: planting operations
thinning
tree/stand protection
tree morphology
tree/stand health

Abstract: Limited tree size variation in Douglas fir (Pseudotsuga menziesii) plantations in coastal Oregon, Washington, and British Columbia makes them susceptible to developing high height to diameter ratios (H/D) in the dominant trees. The H/D of a tree is a relative measure of stability under wind and snow loads. Experimental plot data from three large studies were used to evaluate the impact of initial planting densities and thinning on plantation H/D values. The H/D predictions from the experimental plot data match spacing trial results closely but are substantially different from distance-independent growth model predictions. The results suggest that plantation H/D values can be lowered and stability promoted through reduced planting densities or early thinning; however, later thinnings may not be effective in promoting stability, since they do not appear to lower H/D values. Higher initial planting densities shorten the time period during which thinning can be expected to effectively lower future H/D values. Time-sensitive thinning requirements in dense plantations make their management

inflexible. The flexibility with which a stand can be managed describes the rigidity of intervention requirements and/or potential range of stand development pathways.

OSU Link
Non-OSU Link

277. Witmer, G.W., M.J. Pipas and J.C. Bucher. 1998. Field tests of denatonium benzoate to reduce seedling damage by pocket gophers (Thomomys talpoides Rich.). Crop-Protection 17(1): 35-39.

Keywords: tree/stand protection
tree/stand health

Abstract: The repellency of a bitter compound, denatonium benzoate, to reduce pocket gopher damage to conifer seedlings was tested in two independent field trials in Oregon and Idaho. In the Oregon trial (1992 to 1993), treatments included a denatonium benzoate tablet placed in-ground with the seedling roots; a tablet plus denatonium benzoate foliar spray applied to both roots and foliage; and no chemical application (i.e. control). No significant difference between treatments was noted for ponderosa pine (Pinus ponderosa) or Douglas fir (Pseudotsuga menziesii) seedlings suffering gopher-related mortality. Non-animal mortality (58.2% of all seedlings) accounted for a greater loss of seedlings than gophers (38.2%). Composite foliage and composite soil samples collected from the treatment plots were all negative for the presence of denatonium benzoate. In the Idaho trial (1993 to 1994), similar treatments (but with an additional spray-only treatment) were used on ponderosa pine seedlings. There was no significant difference in gopher-related mortality levels between treatments. A large portion (72.5%) of all seedlings was destroyed by gophers. It appears that the bitter compound, denatonium benzoate, as evaluated in these trials, is not an effective gopher repellent.

OSU Link
Non-OSU Link

278. 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.

OSU Link
Non-OSU Link

279. Woods, J.H., T. Wang and S.N. Aitken. 2002. Effects of inbreeding on coastal Douglas fir: nursery performance. Silvae-Genetica 51(4): 163-170.

Keywords: genetic tree improvement
growth
tree/stand health
reproduction
genetic relationships

Abstract: In advanced generation seed orchards, low levels of inbreeding may be inevitable as relatedness among individuals in breeding populations increases with each generation. Unlike selfing, low level inbreeding can produce relatively large number of viable seeds. Following previous study on the effects of inbreeding on coastal Douglas fir (Pseudotsuga menziesii var. menziesii) filled seed production, the present study investigated inbreeding on nursery performance over various cross-types, including outcrosses (inbreeding coefficient F=0), crosses between half-sibs (F = 0.125), between full-sibs (F = 0.25), between parents and offspring (F = 0.25), and selfing (F = 0.5). Significant differences were found among cross-types for germination, seedling mortality, seedling diameter and height, and nursery cull rate. Inbreeding also increased among-family genetic variability. Cumulative losses of seedlings at the nursery stage were 18, 33, 31, 36 and 43%, respectively for the above types of crosses. This result indicates that seeds with low levels of inbreeding may produce relatively large numbers of seedlings that meet nursery culling standards and could be used for reforestation, resulting in negative impacts on the genetic gain realized in field plantations.

OSU Link
Non-OSU Link

280. Yarris, L. 1983. Cranberry girdlers eat trees, too. Agricultural-Research-USA 31(12): 14-15.

Keywords: nursery operations
tree/stand protection
tree/stand health

Abstract: Field observations and pheromone-trap monitoring carried out in Oregon, USA, by J.A. Kamm & L.M. McDonough showed that adults of the cranberry girdler [Chrysoteuchia topiaria (Zell.)], which is a serious pest of cranberries and grasses, migrated into nurseries of Douglas fir [Pseudotsuga menziesii], where eggs were laid and the hatching larvae fed on tap-roots, reducing seedling quality and vigour and in some cases killing the seedlings. This problem could be practically eliminated by applying diazinon to nurseries during the flight period of the pest, usually from mid-June to mid-July, followed by 1 or 2 applications of chlorpyrifos to control any larvae. In addition, wherever possible, grasslands bordering a nursery should be re-seeded to a crop on which C. topiaria does not feed, to reduce migration into the nursery, and weeds should be removed from vacant beds and a non-host cover crop planted.

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