Grass cover, such as perennial ryegrass, is typically established to reduce erosion and allow for easier year-round vehicular and equipment access. The use of slow-growing varieties will reduce the need for future mowing, although the grass has to be aggressive enough to compete with weeds and moss. There may be instances, however, where grass cover is not required (e.g., no vehicles will be driven over the orchard), or is even undesirable (e.g., areas with very low rainfall or other droughty sites with no irrigation, where grass cover will use all available moisture). One approach would be to develop sod only after the ramets are well established and have built up a strong root system. As mentioned before, it is customary to spray herbicide in the rows while trees are dormant; this reduces some of the competition for water from grass or other ground vegetation in the establishment phase. Where herbicides cannot be used, mulch matting [3 ft × 3 ft (0.91 m × 0.91 m) or 4 ft × 4 ft (1.2 m × 1.2 m)] can provide a suitable alternative.

Orchard mowing is commonly necessary to permit access, provide a measure of fire prevention, and help control noxious weeds. Although the idea of grazing livestock inside seed orchards, thereby taking advantage of lush grass and reducing the need to mow, can seem very attractive, livestock will destroy young grafts. Sheep, cattle, and horse grazing has been permitted in older established orchards, but requires very good cooperation with the permittee to ensure that grazing is closely controlled to limit damage. Livestock can cause problems even for mature orchards with large ramets by compacting the soil and damaging the roots, disturbing tree tags, and spreading noxious weeds.

Ramets require periodic maintenance during the first and second season after grafting, such as trimming the "ears" (any loose rootstock stem separating above the graft union), removing the first branch whorl above the graft union, and scoring bark to reduce and delay the incidence of incompatibility. Rootstock foliage is removed progressively as the scion foliage grows and becomes capable of supporting the entire graft. It is obviously important that all rootstock foliage is eliminated before seed production begins. Early rootstock pruning also extends the safe herbicide spraying period, as the chemical no longer contacts tree foliage. Painting the graft union and lower stem with light-colored latex paint can reduce damage due to sunscald.

Figure 9. A recently established orchard.

Agricultural areas such as the Willamette Valley can experience difficulties due to periodic population explosions of voles; the voles often use the container media of the potgrafts and vegetation control matting as habitat, damaging the grafts. Tilling the entire new orchard block (except for the area immediately surrounding the grafts) is one way to control or eliminate voles. At some point tilling would have to cease, as it would damage the root systems of the ramets and prevent establishment of sod. Trapping has also been used, but results have been mixed; this technique appears to be best suited for control of small populations. Several chemicals are registered for control of voles. Zinc phosphide, chlorophacinone, and diphacinone can be used in Washington and Oregon. (More details are available on the Washington State University Extension Web site (http://gardening.wsu.edu/library/tree012/tree012.htm) and the Oregon Department of Agriculture Web site (http://www.oregon.gov/ODA/PEST/docs/pdf/meadowmouse.pdf).

Orchards should be monitored periodically through soil and foliar testing to ensure nutrient health, and site-specific fertilizer mixes should be applied to ensure vigor and growth. Nutrition requirements can be met by either broadcasting granular fertilizers or injecting soluble nutrients into irrigation water.

Address correspondence to: Keith J.S. Jayawickrama, Department of Forest Ecosystems and Society, Oregon State University, Corvallis, OR 97331-5752; e-mail: keith.jayawickrama@oregonstate.edu; phone: 541-737-8432.

Acknowledgments

Jeff DeBell (Washington Department of Natural Resources) provided useful suggestions for this manuscript. We also acknowledge the many colleagues from whom we have gathered perspectives and insights on

Douglas-fir seed orchard management over the years, those orchardists who answered the survey on orchard grafting, and reviewers who provided helpful suggestions.

References

Copes, D.L. 1999. Breeding graft-compatible Douglas-fir rootstocks (*Pseudotsuga menziesii* (Mirb.) Franco). Silvae Genetica. 48: 188–191.

Jayawickrama, K.J.S. 2005. Genetic improvement: boosting plantation productivity in the Pacific Northwest. Western Forester. May/June: 10–11.

St. Clair, J.B.; Mandel, N.L.; and Jayawickrama, K.J.S. 2004. Early realized genetic gains for coastal Douglas-fir in the Northern Oregon Cascades. Western Journal of Applied Forestry. 19: 195–201.

Wheat, J.W. 1969. Forest tree improvement work advances in Douglas fir region. Forest Industries. 96(5): 38–40.