The Use of Soil Additives and Root Dips on Noble Fir Christmas Trees

Chal Landgren

Oregon State University Extension Christmas Tree Specialist, North Willamette Research and Extension Center, Forest Engineering Resource Management, Oregon State University

Abstract

Three soil additive treatments and two root dips were applied to noble fir (*Abies procera* Rehd.) seedlings planted at three commercial Christmas tree plantations in Oregon. Survival was unaffected by any root treatment tested, although mortality was remarkably low for all treatments because of a mild summer in the region. The Rootex™ dip treatment resulted in modest increases in leader growth and stem diameter after 1 year of growth. Mycorrhizae colonization was low and no differences among treatments were noted. Seasonal growth and lammas growth was greater on one of the sites relative to the other two, which may be attributed to the use of milk carton enclosures around each seedling to prevent rabbit damage. The significant leader growth apparently provided from the enclosure deserves additional cost-benefit evaluation.

Introduction

Numerous materials can be added to the soil or drenched on tree roots during planting. Published trials on soil additives and root drenches reach back at least to 1950 and include hydrophilic gels, nutritional substances, fungicides, sodium alginate, seaweed products, insecticides, clays, vermiculites, auxins, and more (Sloan 1994). Generally, product claims focus on alleviation of plant water stress, root protection during planting, improved nutrient uptake, improved shoot or root growth, improved soil-water holding capacity, or some combination of the aforementioned. In general, results have been mixed and specific to site conditions, species planted, or seedling conditions such as root desiccation. Nonetheless, new products emerge, older formulations are changed or discontinued, and combinations of multiple products warrant continued testing.

Most conifer plantings that are used for Christmas tree production or forest regeneration do not receive supplemental watering after planting. Any boost in plant available water through the summer and fall is likely to improve establishment success (Talbert 2008) and minimize replanting expenses. Furthermore, any boost in initial plant growth could improve the time-to-market for Christmas tree producers. This study evaluated the effect of various commonly available additives and dips on growth and survival of noble fir (*Abies procera* Rehd.) field Christmas tree plantings.

Methods

Seedlings

Container noble fir seedlings (10 in^3 [164 cm^3]) were grown under operational conditions at the Kintigh Mountain Home Nursery (Springfield, OR). Seedlings were 2 years old and the seed source was from the Pacific Northwest Christmas Tree Association Hostetler seed orchard (Dallas, OR). The same seedling lot and stocktype were used at all test sites.

Sites

Three commercial Christmas tree test sites were selected in Oregon near the towns of Monroe, Banks, and Warren. All test sites were relatively flat, well drained, and were kept free of competing weeds for the duration of the study. Seedlings were hand planted into premarked planting spots using a 5.5 by 5.5 ft spacing (1.7 by 1.7 m).

The Monroe site (figure 1) was planted on March 9, 2011. This site had been planted in 2010 but because of rabbit damage to nearly all of the seedlings, the area was plowed and disked for replanting. To protect from rabbit feeding, planted seedlings at this site were enclosed in 1-quart milk cartons with open ends secured by two bamboo stakes shortly after planting (figure 2). The Banks site was a second rotation field and was planted on May 17, 2011. Site preparation included stump grinding, liming, and disking. At the Warren site, trees were interplanted on February 11, 2011 in a field where a few harvest-sized trees remained uncut. Two planting spaces were left unplanted where existing trees remained to avoid competition or shade.

Figure 1. Noble fir planting and layout of typical plot. (Photo by Chal Landgren, 2011).

Figure 2. Milk carton used for rabbit protection. (Photo by Chal Landgren, 2011).

Treatments

An untreated check, three additives, and two root dips comprised the six treatments (table 1). The additive products were distributed around the container seedling as each tree was planted. The root dip products were applied by immersing seedlings in the liquid mixture for 60 seconds and then keeping them in a planting bucket until planting within 1 hour.

Measurements

Seedling survival and morphology were measured in late September through October 2011 after the season's growth had ceased. Morphology measurements included total tree height, leader growth, stem diameter, and late-season lammas growth (yes = 1 or more buds had regrown; no = no buds had grown). In addition, tree color was evaluated using the Royal Horticultural Society (RHS) Colour Chart system (Royal Horticultural Society 2012). A scale ranging from 1 (yellow) to 5 (very dark green) has been used in evaluating Christmas tree colors in progeny and fertilizer tests for noble fir (Bondi 1993). Each tree was evaluated for color with the observer keeping the sun behind the color charts. For reference, a value of 3 = RHS color # 137A (Green), 4 = #135B (Dark Green), and 5 = # 189A (Dark Gray Green).

A subsample of three trees from each of the six treatments at each test site was excavated and delivered to PlantHealth LLC (Corvallis, OR), where they were evaluated for shoot and root mass (fresh weight) and scored for mychorrizal colonization (0 = no ectomycorrhizae; 1 = 1 to 10 percent ectomycorrhizae, 2 = 11 to 20 percent, and so on).

Table 1. Summary of treatments, product composition, application rates, and manufacturer.

Treatment	Product composition	Rate	Manufacturer
Control			
Soil additives			
Geohumus™ (Geo)	25 percent organic component is a cross-linked, partially neutralized polyacrylic and 75 percent mineral components a mixture of ground rock; minerals and washed sand in a granulate composition.	1 oz. (29.6 ml) per plant	Geohumus International GmbH, (Frankfurt, Germany)
BioTerra plus™ (Ecto)	(Ectomychorrizae mix) Active ingredients—*Pisolinthus tinctorius* (4,700,000 spores/gm), *Scleroderma sp.* (69,000 spores/gm), *Rhizopogon occidentalis* (85,000 spores/gm)	1 oz. (29.6 ml) per plant	Plant Health, LLC, (Corvallis, OR)
Geohumus™+ BioTerra plus™ (Geo+Ecto)	50/50 mix of both products	1 oz. (29.6 ml) per plant	
Root dips			
Zeba™	88 percent starch-g-poly (2-propenamide-co-2-propenolc acid) potassium salt	1.3 oz/4 gal water (36 g/15.1 water)	Absorbent Technologies (Beaverton, OR)
Rootex™	Ammoniacal N 7 percent, Available Phosphoric Acid (P_2O_5) 47 percent, Soluble Potash (K_2O) 6 percent, Inerts 40 percent,	1 lb/5 gal water (0.45 kg/18.9 l water)	Cosmocel (Monterrey, México)

Experimental Design and Statistical Analyses

All sites were planted in a randomized complete block design with five treatment replications. Each replication contained 10 trees randomly assigned to each of the 6 treatments for a total of 300 trees per site. Data were analyzed using SAS 9.2 (SAS Institute, Inc., Cary, NC). Duncan's Multiple Range Test was used to determine significant differences among means.

Results

Survival

Only 35 of the 900 noble fir seedlings (3.8 percent) died in 2011 across all sites. These were evenly divided among the sites and without any meaningful pattern among treatments. The 2011 growing season had good rainfall and was without any significant hot or dry period; in other words, a poor year to evaluate mortality. In a typical year, mortality of noble fir Christmas tree plantings averages 6 to 7 percent.

Morphology

Height and color had significant site-by-treatment interactions; stem diameter and leader length did not (table 2). The Rootex™ treatment resulted in trees with larger stem diameter and longer leaders than all other treatments across the three sites. In addition, the Rootex™, Geo, and Geo+Ecto treatments had larger stem diameters relative to untreated control seedlings across all sites (table 2).

Lammas growth varied among sites but differences were not related to treatment.

At the Monroe site where milk carton enclosures were used, trees were larger and had more lammas growth than those on the other two sites (table 3).

Average values of root and shoot mass and percent mycorrhizae colonization are summarized in table 4. With the limited number of plants, statistical evaluation is limited. It is clear, however, that ectomycorrhizal colonization after the first growing season was minimal.

Table 2. Average height, leader length, stem caliper, and color by site. Means followed by the same letter do not differ significantly at $\alpha \leq 0.05$.

Treatment	Height in (cm)	Leader length in (cm)	Stem diameter mm	Color
Monroe site				
Control	15.3 (39.2) ab	7.4 (18.9) b	6.1 c	4.0 a
Geohumus	15.8 (40.4) a	7.6 (19.5) b	6.6 a	4.1 a
Ecto	15.1 (38.8) ab	7.4 (18.9) b	6.3 abc	3.9 c
Geo+Ecto	15.6 (40.1) a	7.8 (20.0) b	6.5 ab	4.0 a
Zeba	14.6 (37.4) b	7.3 (18.7) b	6.1 bc	3.8 a
Rootex	15.6 (39.9) a	8.9 (22.7) a	6.6 a	3.8 a
Banks site				
Control	10.5 (26.9) b	2.7 (6.9) c	5.2 bc	3.5 b
Geohumus	9.6 (24.6) d	3.2 (8.1) b	5.3 bc	4.5 a
Ecto	9.8 (25.1) cd	2.7 (6.9) c	5.0 c	3.4 b
Geo+Ecto	9.7 (24.9) cd	3.3 (8.5) b	5.5 b	4.1 a
Zeba	10.3 (26.5) bc	2.7 (7.0) bc	5.2 bc	3.3 b
Rootex	11.7 (29.9) a	4.5 (11.5) a	7.5 a	4.1 a
Warren site				
Control	12.1 (30.9) ab	2.3 (6.0) c	6.9 a	3.7 a
Geohumus	11.9 (30.4) ab	2.5 (6.5) bc	7.3 a	3.7 a
Ecto	11.4 (29.3) b	2.7 (6.8) bc	7.2 a	3.4 a
Geo+Ecto	11.7 (30.0) ab	2.8 (7.3) b	7.0 a	3.7 a
Zeba	11.2 (28.8) b	2.6 (6.6) bc	6.9 a	3.9 a
Rootex	12.4 (31.7) a	3.3 (8.5) a	7.2 a	3.5 a

Table 3. Average tree height, leader length, stem diameter, and lammas growth by site.

Site	Height in (cm)	Leader length in (cm)	Stem diameter mm	Number and (percent) trees with Lammas growth
Banks	10.4 (26.4)	3.2 (8.2)	5.4	3 (1%)
Warren	11.9 (30.2)	2.7 (7)	7.1	77 (26%)
Monroe	15.5 (39.3)	7.8 (19.8)	6.4	175 (59%)

Table 4. Average root and shoot mass (fresh weight) and ectomycorrhiza colonization for each treatment.

Treatments	Root mass	Shoot mass oz (g)	Percent ecto colonization rating
Control	0.51 (14.7)	0.80 (22.9)	0.7
Geohumus	0.76 (21.8)	1.00 (28.6)	0.3
Ecto	0.86 (24.8)	1.20 (35.4)	0.4
Geo+Ecto	0.66 (18.9)	0.99 (28.3)	0.1
Zeba	0.79 (22.7)	0.83 (23.7)	0.9
Rootex	1.20 (34.9)	1.10 (31.9)	0.3

Discussion

Soil Additives

Soil additives such as ectomycorrhiza have been shown to improve growth and survival in dry southern pine sites (Echols and others 1990) with inoculated seedlings. On the other hand, additions of *Pisolithius tinctorius* (one of the mycorrhizae in the BioTerra™ plus mix used in this study) on Douglas-fir on a harsh site did not improve seedling field performance (Pilz and Znerold 1986). Cordell (1996) showed both growth and survival benefits with mycorrhizae additions on reclaimed mine sites with acid soils (less than pH 3.0).

The use of Geohumus™ as an additive in conifer plantings in the field is recent. Drought protection has been reported for lettuce (Woodhouse and Johnson 1991) and hydrangea (Owen, pers. comm. 2012). In this study, no major response was evident relative to the untreated control seedlings. The combination of Geo+Ecto did show a modest leader growth improvement relative to the control. Ectomycorrhizae colonization after the first growing season was less than 1 percent, however, and does not appear to significantly influence growth of these container seedlings planted for Christmas trees.

Root Dips

Most root dip experiments suggest minimal (or variable) benefit to conifer seedling survival or growth during the first growing season (Sloan 1994). Landis (2006) noted that few if any studies had looked at container seedlings, and a study by Bates and others (2004) showed negative results when root dips were compared with a water dip alone on bareroot Christmas tree plantings. One noble fir trial (Owston and Stein 1972) showed some root dips reduced desiccation in roots exposed up to 40 minutes before planting. Few trials have evaluated noble fir growth in response to root dips on good sites in moist years. In this trial, the Rootex™ product did provide a benefit in terms of height growth, likely related to a mild fertilization effect rather than moisture conservation or root protection. On the other hand, seedlings treated with Zeba® root dip did not differ in morphology, survival, or color from the untreated control. In addition to adequate soil moisture on the site, planting practices that reduce root exposure from drying will minimize benefits from root dips designed to protect from desiccation. Furthermore, container seedlings are somewhat buffered from root drying by the container media.

Site Differences

Trees planted at the Monroe site were larger and had longer leader growth than those planted on the other two sites after the first year of field growth (table 3). This growth response is likely a "milk carton effect" because of all trees on the Monroe site being enclosed in open milk cartons to reduce rabbit damage (figure 2). Tree shelters, like Tubex™, have been shown to improve survival and growth on dry sites (Bainbridge 1994). The improvement is in addition to that attributed to reductions in browsing or other damages. Anthony (1982) suggested that open Vexar™ tubes provided growth improvements for ponderosa pine beyond simple browse protection from mule deer.

At the Monroe site, 59 percent of the trees exhibited lammas growth compared to 26 percent at Warren and 1 percent at Banks (table 3). Typically, lammas growth is caused by late season rainfall. Rain events were not monitored at individual sites during the study period but based on historical averages; the Monroe site is the driest of the three locations. An untested hypothesis explaining this increased lammas growth would suggest that the milk carton decreased moisture loss via shading. The Banks site was the final location planted, and it is possible that root development was delayed and lammas growth was minimal as a result. In harvest-age noble fir Christmas trees, lammas growth is undesirable along the leader because it tends to result in multiple tops. In seedlings, lammas growth can be beneficial if the growth is uniform because it essentially provides two growth periods in 1 year (though there is risk of damage to actively growing foliage in the event of an early fall freeze).

Milk cartons or similar enclosures may provide an inexpensive alternative to tubes, but the mechanism for this improvement is speculative and was an unexpected result of this study deserving additional exploration.

Foliar Color

Seedling color in this trial started and ended with trees showing good color regardless of treatment. A wide variety of color charts are available, but the RHS and Munsell systems are most common. Color translation tables between RHS and Munsell colors are available (Kelley 1965), and both systems allow for color comparison via the international CIE system.

Conclusion

The year 2011 was an excellent year for survival rates of noble fir container seedlings on three Oregon sites because of a mild, wet growing season. As a result, mortality was unaffected by treatments at the time of planting. It is unknown how these products would influence seedling field performance in a droughty year.

The Rootex™ treatment provided a modest growth improvement. In an operational Christmas tree planting, the addition of Rootex™ as a dip would be a low-cost treatment easily done during hand or machine planting. The value of an additional inch or so of leader growth, however, is debatable, unless the effect increases over time.

The ectomycorrhizae and Geohumus additions resulted in minimal root colonization and minimal growth improvement. The addition of these products at planting is time consuming compared with the root dips. As shown in this study, these soil additives are likely not needed on these productive sites during moist years.

The milk cartons cost roughly $0.08 each, plus each carton needs to be secured with two stakes. The time required to install and secure the carton is a little less than that needed to hand plant the tree itself. If this effort could consistently result in an additional 5 inches of tree growth, it is definitely a practice deserving further investigation.

Address correspondence to:

Chal Landgren, OSU Extension Service, North Willamette Research and Extension Center, 15210 NE Miley Road, Aurora, OR 97002; e-mail: chal.landgren@oregonstate.edu; phone: 503–678–1264, ext. 142.

Acknowledgments

The author thanks the following individuals for their valuable assistance in this study: Dr. Wei Yang for data analysis; Robert Linderman, Stacy Reese, Plant Health LLC, Albany, OR.; Mark Russell, Geohumus; Steve Carlson, Zeba; Raul Moreno, OVS/Rootex; Testing Sites: Stroda Farms, Heritage Plantations, Landgren Tree Farm; and Judy Kowalski, North Willamette Research and Extension Center. Partial funding was provided by the Oregon Nursery Association and Oregon Department of Agriculture.

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