Can Treatments at Planting Improve Noble Fir Seedling Survival?

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Abstract

Noble fir (*Abies procera* Rehd.) plantings for Christmas tree production have experienced poor to variable survival over the past decade. With little ability to provide supplemental irrigation, Christmas tree growers investigated first-year seedling survival results in response to a variety of pre- and post-planting treatments, root dips, and foliar sprays. In three separate trials, wood chip mulch or shade screens increased survival (though not consistently) in moderately dry summers in Oregon. None of the dips, sprays, or amendments, however, resulted in significant survival improvements.

Introduction

Over the past decade, Christmas tree growers have experienced significant seedling mortality in noble fir (*Abies procera* Rehd.) plantings due to prolonged summer droughts in the Pacific Northwest (PNW). Most Christmas tree plantings, like forest plantings, receive no supplemental watering. Of the commonly planted Christmas tree species in the PNW, noble fir is the species most planted and most affected by summer drought.

Because of the increased mortality, Christmas tree growers have experimented with providing supplemental water to boost seedling survival, especially in the year of planting. Since irrigation systems are absent at most sites, however, the distribution and application of water is expensive and near impossible on remote sites.

In prior studies (Landgren 2012) ectomycorrhizae and GeoHumus® additions at planting provided no growth improvement of planted noble fir seedlings. In the same study, Rootex™ root dip provided a modest growth improvement and shade produced the largest benefit. Cregg et al. (2009) showed improved growth and survival in Christmas tree plantings in Michigan using wood chips as mulch.

The objective of this 2-year project was to investigate a range of products and treatments that were deemed promising by growers for improving first-year seedling survival.

Materials and Methods

Seedlings and Sites

Two-year-old noble fir container seedlings (15 in^3 [245 cm^3]) were machine planted in May 2018 and 2019. All noble fir sources were from Oregon coastal mountain collections.

Studies were established on two successful second-rotation noble fir commercial Christmas tree plantations near Molalla, OR. In 2018, seedlings were planted on the Kirk site (figure 1) and in 2019, seedlings were planted on both the Kirk site and the Christmas Tree Business Mexico (CBM) (figure 2) site. At both sites, seedlings were planted in bare, weed-free soil. At both sites, post-planting weed control consisted of one application of Atrazine applied 2 days after planting. The soil type at the Kirk site is a Jory silty clay loam and at the CBM site, the soil is a Molalla cobbly loam.

Treatments and Measurements

With the exception of shade and wood mulch, all treatments were selected by the grower at each site and the study was established to meet their desire for an objective review of results. Treatments included a variety of root dips, foliar sprays, and planting amendments, in addition to a nontreated control,

Figure 1. The 2018 Kirk site trial on noble fir seedling with shade screens installed. (Photo by Judith Kowalski 2018)

shade, and mulch (figure 3). Treatment details and application methodologies for each site are summarized in tables 1, 2, and 3.

Initial planting survival at both sites in both years was above 99 percent as evaluated 2 weeks following planting. At the end of the growing season (October), survival was recorded for seedlings in all treatments. Seedlings were considered dead if all needles were red and all buds desiccated. Evaluations were conducted after the fall rains had completely saturated the rooting profile.

Experimental Design and Statistics

The project was conducted as a series of three trials: Kirk 2018, CBM 2019, and Kirk 2019.

Figure 2. The CBM site during planting of noble fir trees for the 2019 trial. (Photo by Judith Kowalski 2019)

Table 1. Treatments applied to noble tree seedlings in the 2018 trials at the Kirk site. Treatments were applied in a factorial combination of 2 shade treatments (with or without), 3 pre-planting dip treatments (Rootex™, water, or none), and 3 foliar treatments (Moisture-Loc™ applied once, twice, or none).

Treatment	Product	Application methodology
Shade	Mesh shade of non-toxic polyolefin and wire wicket support, (Terra Tech, LLC, Eugene, OR)	Placed on SW side of tree Installed at time of planting
Root dip: Water	n/a	Pre-planting dip
Root dip: Rootex™	7:47:6 (NH_4: P_2O_5:K_2O) with 40 percent inerts (Redox Ag, West Burley, ID)	1 lb/5 gal water (0.45 kg/18.9 L water) pre-planting dip
Foliar spray: Moisture-Loc™	Vinyl acetate polymer antitranspirant (Zorro Technology, Clackamas, OR)	10-percent solution applied once at budbreak and a second 6 weeks post budbreak application given to a sub-set

Table 2. Treatments applied to noble tree seedlings in the 2019 trials at the Kirk site. Treatments were applied in a factorial combination of 2 shade treatments (with or without), 2 mulch treatments (with or without), and 2 root dip treatments.

Treatment	Product	Application methodology
Shade	Non-toxic polyolefin mesh with wire wicket support (Terra Tech, LLC, Eugene, OR)	Placed on SW side of tree
Mulch	Mixed wood chips from local tree service	Applied to a depth of 2 in (5 cm) with a 12-in (30-cm) radius
Root dip: Stomaboost™ Supreme 7-17-4 + Dynahume™ SW 0-0-1	7:17:4 (N: P_2O_5:K_2O) with 0.003 microbial inoculum extracts (Schaeffer's Crop Enhancements, St. Louis, MO) + 1 percent K_2O, 10 percent humic acid, and seaweed extracts (Schaeffer's Crop Enhancements, St. Louis, MO)	Pre-planting dip 14-percent solution Stomaboost™ + 23-percent solution Dynahume™

Table 3. Treatments applied to noble tree seedlings in 2019 at the CBM site. Treatments were applied in a factorial combination of 2 shade treatments (with or without), 2 mulch treatments (with or without), and 2 root dip treatments (with or without), and 2 amendment treatments (with or without).

Treatment	Product	Application methodology
Shade	Non-toxic polyolefin mesh with wire wicket support (Terra Tech, LLC, Eugene, OR)	Placed on SW side of tree
Mulch	Mixed wood chips from local tree service	Applied to a depth of 2 in (5 cm) with a 12-in (30-cm) radius
Root dip: Vitamin B-1 Transplant Solution 0-2-0	Two percent K_2O with 0.1 percent iron (Fe) and 0.1 percent thiamine mononitrate (B-1) (Liquinox Company, Orange, CA)	14-percent solution Pre-planting dip
Amendment: Solid Rain®	Potassium polyacrylate (Lluvia Sólida, Santiago de Querétaro, Mexico)	1.5 to 2.0 g (0.05 to 0.07 oz) into planting hole

In the Kirk 2018 trial, the experimental design was a 3 x 3 x 2 factorial combination of pre-planting root dips (Rootex™, water, or none), antitranspirant foliar spray (Moisture-Loc™ applied once [July 18; 1X], twice [June 6 and July 18; 2X], or none), and shade (with or without) (table 1). A total of 1,264 trees were evaluated in the Kirk 2018 trial. Due to logistical limitations Moisture-Loc™ treatments (1X or 2X) were applied to 250 trees each and 300 trees were shaded. Thus, treatment assignment resulted in a variable number of seedlings in each treatment combinations with a minimum of 20 per combination.

For the Kirk 2019 trial, the study design was a 2 x 2 x 2 factorial combination of root dip (with or without Stomaboost™ + Dynahume™), shade (with or without), and mulch (with or without) (table 2). A total of 1,120 seedlings were evaluated in the Kirk 2019 trial. Seedlings were evenly divided between root dip treatments; 280 seedlings were shaded, and 130 seedlings were mulched with a minimum of 30 seedlings per treatment combination.

At the CBM 2019 trial, the experimental design was a 2 x 2 x 2 x 2 factorial combination of Vitamin B-1 root dip (with or without), Solid Rain® amendment (with or without), shade (with or without), and mulch (with or without) (table 3). A total of 840 seedlings were evaluated in the CBM 2019 trial. Seedlings were evenly divided among Vitamin B-1 root dip and Solid Rain® combinations, 300 seedlings were shaded, and 175 seedlings were mulched, with at least 20 seedlings in each treatment combination (n>=20).

Data for each experiment were analyzed by analysis of variance as a 3-way or 4-way factorial in a completely randomized design. Analyses were conducted using PROC GLM procedure in SAS (SAS Institute, Inc., Cary, NC) assuming all independent

Figure 3. This noble fir seedling at the Kirk site was treated with a combination of shade and mulch (Photo by Judith Kowalski 2019)

variables as fixed factors. For each experiment, usually only one or two main effects or two-way interactions effects were significant. Therefore, we focus our graphical summaries on those significant in each experiment.

Results

In the 2018 trial at the Kirk site, the shade treatment significantly increased overall survival ($P<0.0001$) from 64 percent without shade to 88 percent with shade (figure 4). Root dip and foliar spray treatments did not have a consistent effect on seedling survival. Mulch was not included in 2018.

In the 2019 trial at the Kirk site, average survival was 80.4 percent for seedlings in the no mulch + no shade treatments. For seedlings that were not shaded, mulch increased ($p \leq 0.05$) survival to 97.3 percent. Mulch provided less benefit when seedlings were shaded as survival increased from 88.4 to 94.7 percent (figure 5). The addition of Dynahume™ and Stomaboost™ did not affect survival ($p > 0.05$).

In the 2019 trial at the CBM site, application of Solid Rain® increased seedling survival from 91.0 percent to 98.6 percent in the absence of B-1 ($p \leq 0.05$; figure 6). Solid Rain® did not affect survival, however, when B-1 was applied ($p > 0.05$). Neither shade nor mulch affected seedling survival at the CBM site.

Discussion

The 2018 and 2019 years generally had more summer rainfall and better tree survival than was experienced in PNW Christmas tree plantations from 2015 to 2017. For example, average survival of noble fir in 2016 was only 30 to 50 percent, depending on site.

Despite testing numerous combinations of root dips, foliar treatments, and planting amendments, none of those used in these trials consistently improved survival. These finding are generally consistent with other trials. Landis (2006) showed variable and negative results with a range of root dips on a variety of bare root species. Bates et al. (2004) showed no improved survival when comparing root dips with water alone on four species of Christmas trees. Starkey et al. (2012) found that seedling survival was highly variable depending on the particle size and composition of the polymer dip, and, in some cases, actually increased seedling mortality. New products claiming the ability to improve survival regularly show up in the market. Our advice is to always test before investing at an operational scale. Often, products do not live up to their claims.

Our results show that wood mulch and, to a lesser extent, shade screens can improve noble fir seedling survival. Improvements in tree survival and growth have frequently been associated with mulch (Adams 1997, Johansson et al. 2005). Mulch can benefit newly planted seedlings by controlling weeds (Bartley et al. 2017, Saha et al. 2020) and improving soil moisture availability (Pardos et al. 2015). Mulching around seedlings can also moderate soil temperatures (Cregg et al. 2009) and increase soil organic matter (Flint 1987). Shade screens have been used

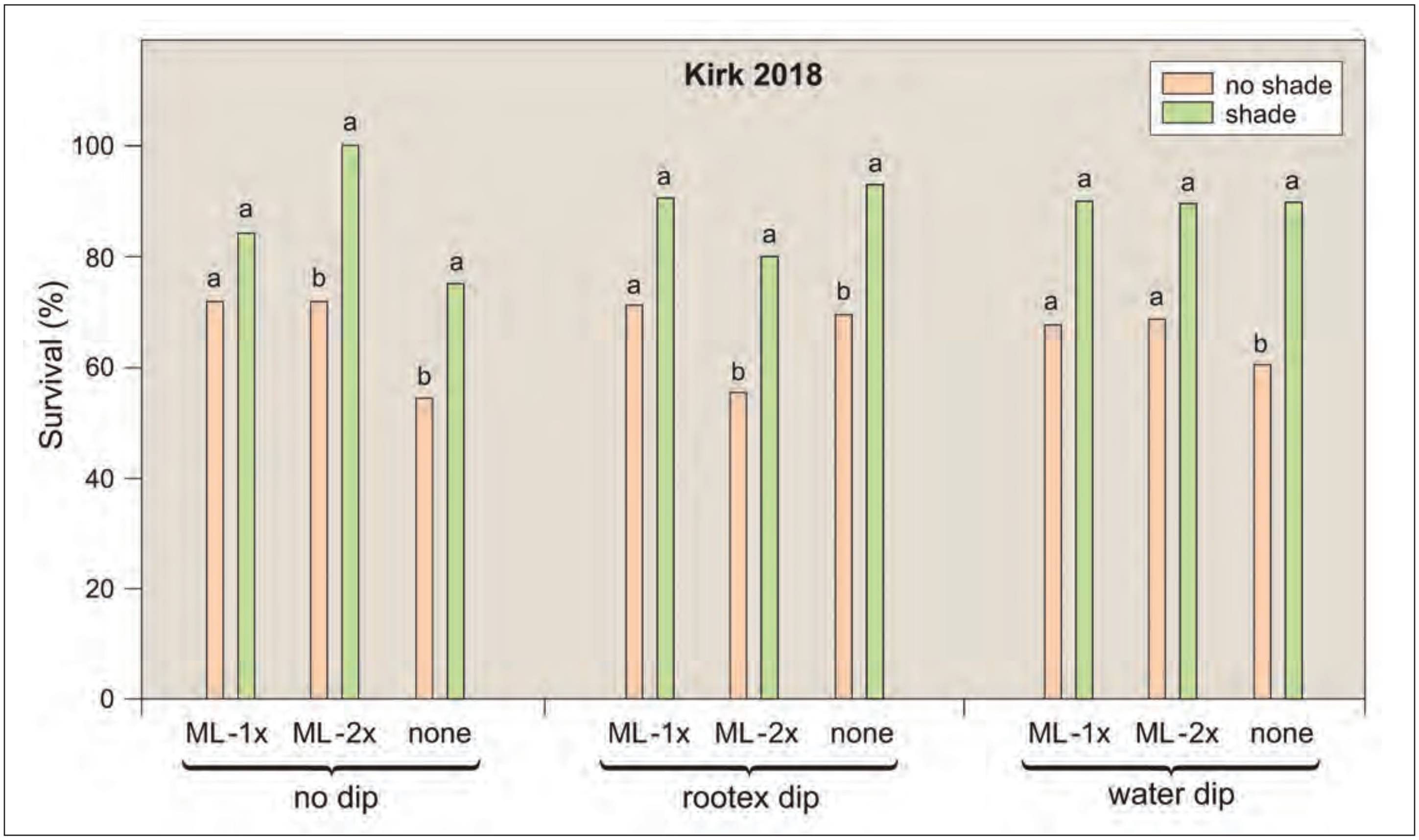

Figure 4. Mean survival of noble fir seedlings at the Kirk 2018 trial in response to root dip treatments (Rootex™, water, or no dip), applications of moisture-Loc™ (ML), and shade screens. Means within a pair of bars with the same letter are not different at P<0.05.

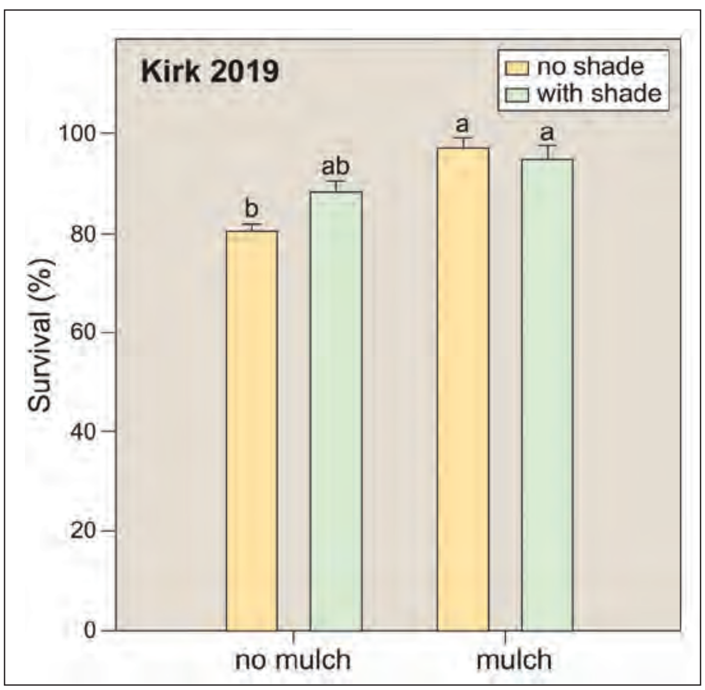

Figure 5. Mean survival of noble fir seedlings at the Kirk 2019 trial in response to mulch application and shade screens. Bars with the same letter are not different at P<0.05.

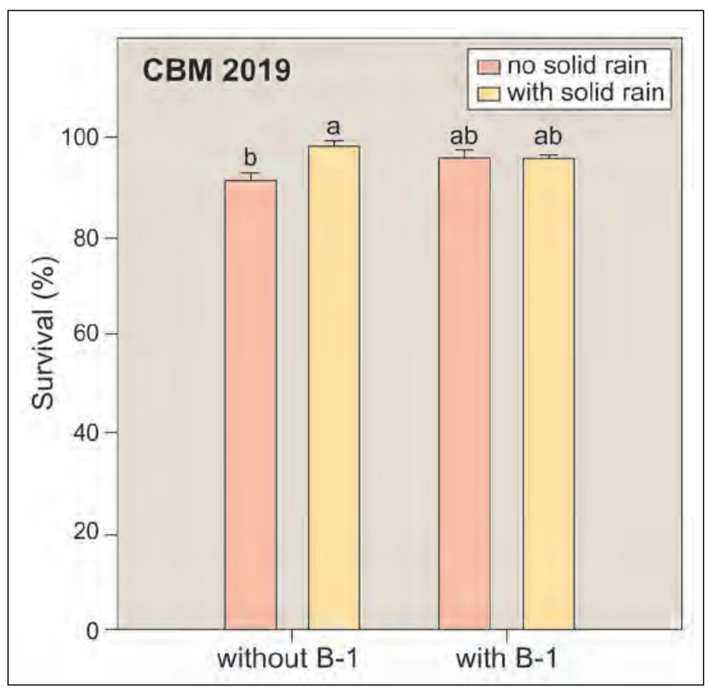

Figure 6. Mean survival of noble fir seedlings at the CBM 2019 trial in response to root treatment (dip with Vitamin B-1) and application of potassium polyacrylate gel (Solid Rain®). Bars with the same letter are not different at P <0.05.

Table 4. Cost benefit analysis for application of shade or mulch treatments based on 1,200 trees per acre.

Treatment	Material cost ($USD)	Installation cost ($USD)	Approx. total cost ($USD)	Potential savings ($USD)[2]
Shade	126[1]	30	156	180
Mulch	0-311[3]	30	30-341	0-306

[1]Unit Cost = $0.42 each (4-year useful life)
[2]Assumed 14-percent increased survival for each treatment (168 trees at $2 per tree= $336)
[3] Assumes 23 yd^3 (17.6 m^3)

to improve seedling survival on harsh sites in forest plantings for decades (Peterson 1982, Adams et al. 1966, Helgerson 1989). Shade can lower temperature and reduce moisture loss. Neither mulch nor shade, however, are substitutes for adequate soil moisture, especially in coarse soils.

Cost Analysis

Both mulch and shade incur installation and material costs. The shade screens and associated wire wickets cost approximately $0.42 each (TerraTech 2020) and should last at least 4 years. The mulch requires about 23 yd^3/ac (44 m^3/ha) for application of 2 in [5 cm] of mulch in a 12-in [30-cm] radius around 1,200 trees (Cregg 2020). Mulch cost varies significantly. In some cases, it can be very low cost (or even free) from local arborists, but in other cases, it may need to be purchased.

A cursory financial analysis of these treatments summarizes the costs and potential savings benefits (table 4). These rough estimates are subject to many unknowns. One never knows the fate of planted trees in advance. In a year with favorable conditions and excellent seedling quality, shade or mulch treatments would be a waste of money. In other years, a 14-percent increase in survival, which is achievable with shade or low-cost wood chips, would be “worth” about $336/ac ($830/ha). With even higher increases in survival such as the 24-percent improvement on the Kirk site, the cost benefits would be even more attractive.

It’s important to note that the fields used in these experiments were weed free at planting and weed competition was partially mitigated by post-planting herbicide applications. These weed control measures likely contributed to seedling survival and moisture preservation as noted by Cregg et al. (2009).

This study only reviewed first-year survival. Future studies, particularly of the mulch/wood chip option, could include an assessments of seedling growth during a rotation and subsequent weed control benefits (or not) from mulch.

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