Influence of Mulching on Growth and Development of Christmas Trees

Agricultural Experiment Station • Research Report 448

CONTENTS

SUMMARY

Mulches of clear and black plastic, sawdust, and straw were used alone and in combination on plantings of white fir, Austrian pine and Scotch pine.

Clear or black plastic mulches alone increased survival of white fir. Plastic and organic mulches did not benefit Austrian or Scotch pine survival. Black plastic combined with straw reduced survival of all three species. Clear plastic with straw reduced survival of white fir and Scotch pine.

Clear plastic with organic mulches reduced the number of laterals (breaks) of white fir. Black plastic with straw reduced fresh and dry weights of Austrian pine shoots. All mulches except straw promoted shoot growth of Scotch pine.

No species x treatment interaction resulted.

June 1981 Las Cruces, New Mexico

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Influence of Mulching on Growth and Development of Christmas Trees

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Fall planting of Christmas tree seedling stock in northern New Mexico generally results in unacceptably high mortality and slow growth (2). The roots do not grow enough before the onset of low soil temperatures, and the seedlings are exposed to desiccating winter winds and early spring drought.

Container seedlings can be successfully planted through July, but plantings in the middle of August begin to decline in survival. There are simply too few days remaining of suitable soil temperatures to allow even container seedlings to become established.

Mulching, the practice of covering the soil around plants to improve conditions for growth and development, has been shown to raise soil temperature and hasten crop maturity. Mulches also conserve moisture, reduce leaching of soil nutrients and, if organic, can elevate ambient CO_2 levels. Organic mulch applied to a white spruce plantation more than doubled early growth (8). Plastic mulch improved the growth of slash pine (4), Douglas fir (5), and shrubs planted on a low-rainfall site in northern New Mexico (7).

In 1978 an experiment was initiated at the Espanola Valley Branch Station to determine the influence of various mulch treatments on survival, growth and development of Austrian pine (*Pinus nigra* Arnold), Scotch pine (*P. sylvestris* L.) and white fir (*Abies concolor* (Gord. and Glend.) Lindl.) The results of this study are presented in this report.

METHODS AND MATERIALS

Seedlings of white fir, Scotch pine, and Austrian pine were grown seven months under optimal greenhouse conditions in 30 cu in (76 cm^3) Spencer-Lemaire book planters. The seedlings were then allowed two months for hardening off under reduced photoperiod and nutrient levels (low nitrogen, high phosphorus and potassium.

When the seedlings were approximately nine months old and 20 cm tall, they were transplanted on November 3 to a plowed and roto-tilled experimental site. They were spaced on one foot (30.4 cm) centers within rows five feet (1.52 m) apart. The experimental design was a split plot with five replicates, 270 seedlings per replication. Main plots were tree species (three species, 90 seedlings per species) and sub-plots were the nine mulch treatments (10 seedlings per treatment) listed in table 1.

New sawdust and straw mulches were spread evenly to a width of 75 cm and a depth of 5 cm on plots containing seedlings. Four-mil black and clear polyethylene film 90 cm wide and 300 cm long was used for the plastic mulch treatments. Where a combination of organic and plastic mulch was used, the plastic was applied over the top of the sawdust and straw mulches.

Seedlings were flood irrigated approximately every 10 days throughout the experiment. No fertilizer was added and no insect or disease problems developed.

Field measurements included survival percentage, candle length of pines, and number of new branches originating from white fir lateral and apical buds (breaks). Three seedlings were harvested from each sub-plot for growth measurements. The seedlings were extracted without disturbing the root systems and transported to the laboratory, where the soil was carefully removed by gentle washing with tap water. Following fresh weight measurements, shoots and roots were dried in a mechanical convection oven at 77 °C for 24 hours, and dry weights were recorded.

Analysis of variance and Tukey's procedure (hsd) were used to determine significance of growth treatment effects. Differences between survival means were determined with a chi-square test in which a 9 × 2 contingency table was used.

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RESULTS AND DISCUSSION

All mulch treatments increased the percentage of survival of white fir except the combinations of black plastic and straw, clear plastic and straw, and clear plastic and sawdust. With black plastic or clear plastic alone, in 70 and 52 percent of the transplants survived, respectively; without mulch, 15 percent survived. Either plastic combined with straw reduced the survival percentage below the no-mulch treatment (2, 2 and 15 percent, see table 1).

The survival percentage of Austrian pine was lower with the combinations of black plastic and straw and clear plastic and sawdust than with the no-mulch treatment (52, 70 and 94 percent, respectively). The remaining treatments were equal to the no-mulch treatment (table 1).

The combinations of black plastic and straw and clear plastic and straw reduced percentage of survival of Scotch pine below that with no mulch, 73, 60 and 96 percent, respectively. Straw alone reduced survival by 20 percent. The remaining treatments did not differ and averaged 100 to 81 percent (table 1).

Growth responses of white fir as influenced by the different mulch treatments are given in table 2. Black plastic resulted in significantly greater shoot fresh weight. Shoot dry weight was not affected. The combinations of clear plastic and straw or sawdust significantly reduced the number of breaks originating from terminal and lateral buds. Treatments did not cause significant differences in root biomass.

Growth responses of Austrian pine are listed in table 3. Shoot fresh weight was significantly lower on seedlings mulched with straw than on those without mulch. Black plastic combined with straw markedly reduced shoot dry weight. Candle length and root weights were not significantly different among the treatments.

Scotch pine growth data is listed in table 4. All mulch treatments except straw significantly increased shoot fresh and dry weights of Scotch pine, compared with the no-mulch treatment. Candle length and root weights were not significantly different among treatments.

No species x treatment interactions were found for any of the growth parameters in the analysis of the pine data.

The greater percentage of survival of white fir under most mulch treatments, especially black plastic or clear plastic alone, may be related to favorable modification of soil moisture, soil temperature, soil nutrition and CO_2 levels. Improved plant growth under plastic mulch has been attributed to reduced movement and leaching of nitrates (1), moisture conservation (3), and elevation of microclimate CO_2 levels (6). The increased weight of the fresh shoots of the white fir with black plastic treatments maybe due primarily to increased moisture levels in the soil (4). Survival of Austrian pine and Scotch pine apparently is not benefited by the use of mulch, but survival can be reduced by certain mulch combinations.

The detrimental effect (reduced survival) on all three species of trees by black plastic combined with straw and the reduced survival percentage of white fir and Scotch pine by clear plastic combined with straw are difficult to explain. With the Austrian pine, straw alone reduced shoot fresh weight and black plastic combined with straw reduced shoot dry weight (table 3). It may be possible that plastics and straw combined caused a moisture stress that limited root development of Austrian pine. That did not occur with the white fir and Scotch pine; most treatments increased shoot fresh weights of these species (tables 2 and 4). The effects of mulches on soil temperature, soil moisture, soil nutrition, and microclimate CO_2 levels must be evaluated.

CONCLUSIONS

Clear or black plastic mulches alone may contribute substantially to survival of white fir. Plastic and organic mulches did not benefit Austrian or Scotch pine survival. All mulches except straw promoted shoot growth of Scotch pine. Straw mulches in combination with plastics must be carefully evaluated; they reduced survival of all tree species, and reduced the number of breaks of white fir. Black plastic with straw reduced weights of shoots of fresh and dry Austrian pine.

Table 1. Effects of mulch treatments on survival of white fir, Austrian pine and Scotch pine seedlings

Treatment	White Fir	Austrian Pine	Scotch Pine
	percent survival		
1. Black Plastic (B.P.)	70 a[1]	94 a	100 a
2. Clear Plastic (C.P.)	52 ab	72 a	90 bc
3. Straw	36 b	88 ab	76 cd
4. Sawdust	34 b	92 a	100 a
5. B. P. + Straw	2 d	52 c	73 cd
6. B. P. + Sawdust	36 b	78 ab	81 bc
7. C. P. + Straw	2 d	85 ab	60 d
8. C. P. + Sawdust	10 cd	70 b	89 bc
9. No Mulch	15 c	94 a	96 ab

[1] Means separated by chi-square test (9 x 2 contingency table per tree species), 5% level

Table 2. Effects of mulch treatments on number of breaks and shoot and root weights of white fir

Treatment	Breaks[1]	Shoot Weight		Root Weight	
		Fresh	Dry	Fresh	Dry
	number	*grams*			
Black Plastic (B.P.)	3.92 a[2]	7.09 a	3.04 a	11.49 a	2.37 a
Clear Plastic (C.P.)	2.18 a	2.54 b	1.50 a	10.46 a	1.16 a
Straw	4.51 a	3.55 ab	1.56 a	8.76 a	1.87 a
Sawdust	1.54 a	3.32 b	1.76 a	6.54 a	1.96 a
B.P. + Straw	.80 a	2.25 b	1.32 a	9.36 a	2.01 a
B.P. + Sawdust	2.36 a	1.68 b	.79 a	9.74 a	1.60 a
C.P. + Straw	.45 b	2.21 b	1.44 a	8.72 a	3.49 a
C.P. + Sawdust	.63 b	.30 b	1.81 a	7.54 a	2.46 a
No Mulch	.75 a	3.43 b	2.26 a	5.92 a	2.79 a

[1] New growth on shoots originating from terminal or lateral buds.
[2] Means separated by Tukey's w procedure, 5% level.

Table 3. Influence of mulch treatments on candle length, shoot and root weights of Austrian pine

Treatment	Candle Length[1]	Shoot Weight		Root Weight	
		Fresh	Dry	Fresh	Dry
	cm	*grams*			
Black Plastic (B.P.)	7.15 a[2]	21.77 a	6.50 a	15.25 a	4.14 a
Clear Plastic (C.P.)	5.20 a	21.78 a	5.08 a	14.31 a	4.36 a
Straw	4.82 a	12.07 b	4.85 a	15.83 a	3.65 a
Sawdust	6.46 a	15.37 a	6.29 a	18.48 a	2.62 a
B.P. + Straw	6.89 a	13.68 a	3.88 b	14.33 a	3.10 a
B.P. + Sawdust	5.82 a	19.98 a	6.75 a	21.13 a	4.38 a
C.P. + Straw	6.86 a	12.60 a	4.59 a	14.25 a	3.97 a
C.P. + Sawdust	4.62 a	16.72 a	6.71 a	14.36 a	4.77 a
No Mulch	6.96 a	18.46 a	6.16 a	15.02 a	3.84 a

[1] Current seasons growth from apical growing point.
[2] Means separated by Tukey's w procedure, 5% level.

Table 4. Influence of mulch treatments on candle length, shoot and root weights of Scotch pine

Treatment	Candle Length	Shoot Weight		Root Weight	
		Fresh	Dry	Fresh	Dry
	cm	*grams*			
Black Plastic (B.P.)	10.71 a[1]	16.29 a	5.59 a	19.66 a	4.14 a
Clear Plastic (C.P.)	10.94 a	19.19 a	6.01 a	14.90 a	3.93 a
Straw	7.09 a	12.44 b	4.51 b	15.67 a	3.89 a
Sawdust	8.96 a	13.29 a	4.75 a	13.73 a	3.04 a
B.P. + Straw	9.45 a	15.69 a	5.21 a	15.58 a	3.67 a
B.P. + Sawdust	10.71 a	13.07 a	5.01 a	13.23 a	2.63 a
C.P. + Straw	38.70 a	14.61 a	5.97 a	16.69 a	4.52 a
C.P. + Sawdust	13.13 a	20.09 a	6.77 a	16.85 a	3.98 a
No Mulch	6.96 a	11.34 b	4.03 b	13.32 a	3.92 a

[1] Means separated by Tukey's w procedure, 5% level.

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