Georgia Forestry Commission

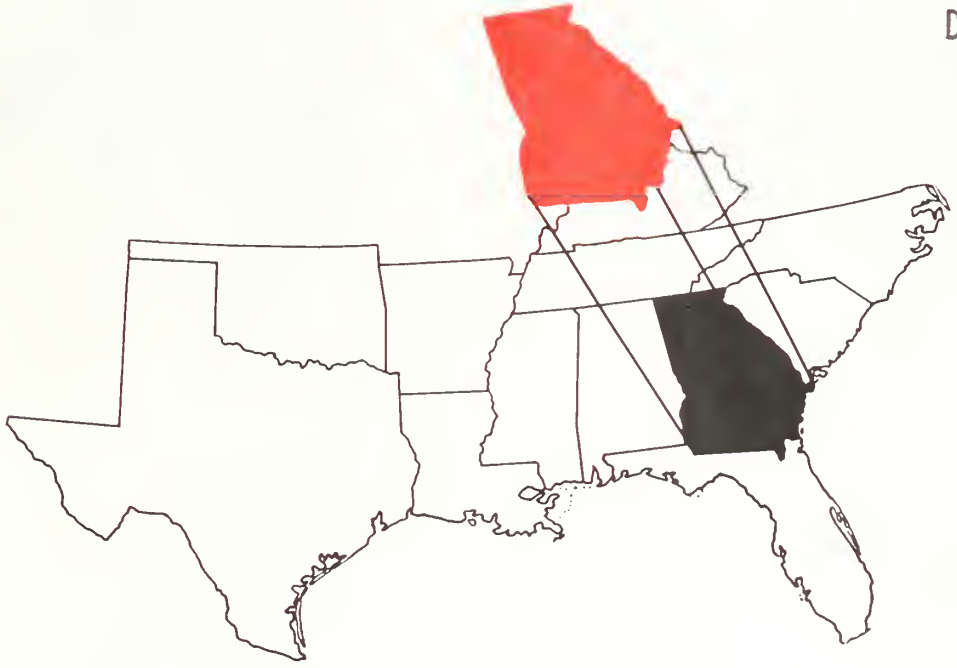
Research
REPORT

No. 7

September, 1990

A FIELD INVESTIGATION OF THE FACTORS WHICH CONTROL GERMINATION AND ESTABLISHMENT OF LOBLOLLY PINE SEEDS.

By P. M. Dougherty



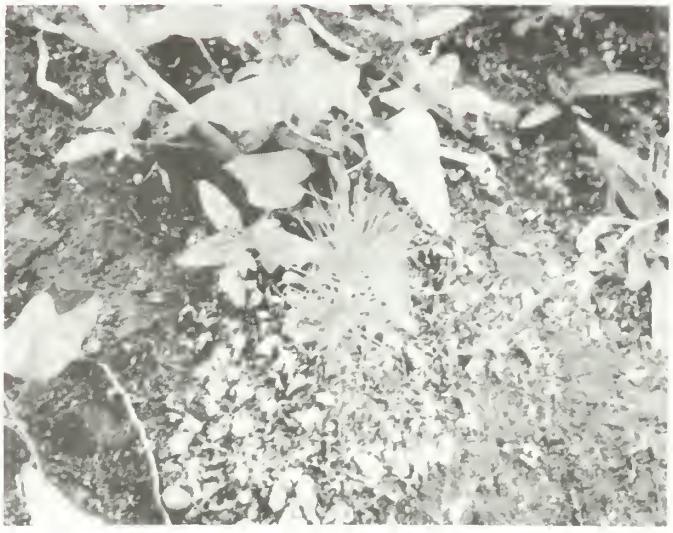
AUTHOR

Phillip M. Dougherty, Ph. D
Assistant Professor - Silviculture
University of Georgia
School of Forest Resources

ABSTRACT: Eight methods of direct seeding were tested on a Piedmont soil near Covington, GA. The results of this study suggested that sowing with stratified seed and applying mulch over the seed was the most effective treatment for promoting seed germination and establishment in a dry year like 1986. The success of the mulch treatment implies that creating a microsite for the seed in which moisture remains high and constant is the most important factor in insuring success with direct seeding.

A FIELD INVESTIGATION OF THE FACTORS WHICH CONTROL GERMINATION AND ESTABLISHMENT OF LOBLOLLY PINE SEEDS.

By P. M. Dougherty



The key to converting a single pine seed, as shown in the upper photo, to an established seedling, is to prevent seed desication.

INTRODUCTION:

Direct seeding is an attractive method for regeneration because it is low in cost and provides an opportunity to improve the genetics of the stand. To prevent the problem of overdense stands that may result from broadcast sowing and to use genetically improved seed efficiently, it will be desirable to spot or row sow. However, initial attempts to do this in north Georgia have not been successful (personal communication, Georgia Forestry Commission). Several site factors can result in failure of a seed to germinate and become established. Factors reported to be important in establishment are: contact with mineral soil, seed movement, getting buried too deep, lack of moisture, and loss of seeds to birds and rodents. The objective of this study was to determine what microsite condition would need to be established to insure seed germination and establishment.

MATERIAL AND METHODS

Study Site Description:

The study was established on a cutover site in Newton County. The site had been harvested in 1985, and burned in January 1986. The soil on this site is a Hiawasee sandy loam. The site has less than five percent slope.

Biological Material:

The seeds used in this study were obtained from the Georgia Forestry Commission and were a mixture of improved north Georgia families. Lab tests showed the seeds to have a 98% germination rate. One fourth of the seeds were stratified for 30 days (February planting) and one fourth for 65 days (March planting). The other half was not stratified. Seeds were not treated with repellent before sowing.

SOWING TREATMENTS AND STUDY DESIGN:

Study Design:

The study design was a randomized complete block design with four blocks. Plots within blocks were single rows with 20 seeding spots per row. Each planting spot was flagged and a single seed placed 1 inch from the base of each pin flag so seeds could be relocated. All seeds were planted by pressing the seed into the soil with the planter's thumb.

Sow Treatments:

The study consisted of eight treatments:

1. Scrape to mineral soil with a fire plow and place a 12X12-inch square netting over the stratified seed which was sown in mid-February.
2. Scrape to mineral soil with a fire plow, sow the stratified seed and then mulch with ¼-½ inch of cottonseed hulls (mid-February sow date).
3. Scuff to mineral soil with the side of the planter's boot, sow with nonstratified seed and mulch with cottonseed hulls (mid-February sow date).
4. Same as treatment 3 but sown with stratified seed.
5. Scuff to mineral soil with the side of the planter's boot, sow with stratified seed and mulch with cottonseed hulls (mid-March sow date).
6. Scuff to mineral soil with the side of the planter's boot, sow with stratified seed (mid-February sow date).
7. Scuff to mineral soil with the side of the planter's boot, sow with stratified seed (mid-March sow date).
8. Scuff to mineral soil with the side of the planter's boot, sow with stratified seed and pull local debris over the seed for a mulch (mid-March sow date).

Measurements:

Seedling emergence and survival were assessed on year day numbers 87, 105, 120, 133, 149, 171, 196, and 306. These observations were expressed on a percent of the number originally sown. Arcsin transformations were made before tests for significant differences in treatment means were made using the Duncan's multiple range test.

RESULTS AND DISCUSSION

Trends in Environmental Conditions:

The rainfall and temperature reported at Covington, Georgia, are shown in Table 1. Rainfall for the period between February and July was only 50 percent of the average expected for this area and temperatures were above normal. Both the low spring rainfall and above average temperature created conditions unfavorable for seed germination and establishment.

Trends in Seedling Emergence and Survival:

The trends in percent established seedlings observed during the 1986 season are shown in Figure 1. Stratified seeds sown in February that were mulched had the highest germination. Peak emergence averaged 56 percent for the February scrape and mulch treatment and 50 percent for the February scuff and mulch treatment. In both cases, due to the long hot summer drought, surviving seedlings had dropped to below 30% by day 306. The same scuff and mulch treatments applied in mid-March had much lower emergence and final survival than did the February sow date. Using local debris as a mulch instead of cottonseed hulls was just as effective as the cottonseed hulls (Fig. 1) In dry springs like 1986, it is likely that the main factor limiting emergence and establishment is the rapid wetting and drying during the germination phase. Mulching will reduce rapid wetting and drying; however, mulching also serves to keep the seeds in place and prevents them from being covered with excess soil. In wet years, mulching might not be an advantage if it promoted pathogen problems. Sowing treatments which place the seed just below a light litter layer should be tested.

Using nonstratified seeds in February and March was less successful than using stratified seeds. Nonstratified seeds should not be used in February or March sowings.

Analysis of Variance:

An analysis of variance test was conducted using Arcsin transformation and the Duncan's multiple range test to determine significant treatment differences on each of the assessment dates (Table 2). In the period when maximum emergence had occurred, treatment 2 (scrape, mulch, stratified seed, February) was significantly better than all the other treatments except treatment 4 (scuff, mulch, stratified seed, February). This clearly indicates that in dry years that February planting and mulching is the desirable method for promoting emergence. At the final assessment, (Day 306), most of the mulch treatments and February plant date treatments were no longer significantly different (Table 2).

Other Observations:

Several observations were made during the study that were not quantified but are worth mentioning.

1. In this study there was almost no loss of seeds to birds or rodents. The site was clean and high rodent populations would not be expected as might occur in an old field or a site that had advanced regrowth.
2. Seed movement after a rain was a problem. Even though the seeds were pushed partially into the soil with the planter's thumb, after a light rain seeds did move from their original placement.
3. Seed movement to low areas and getting buried too deep by sediment may be a problem.

These observations need to be considered in future studies.

CONCLUSIONS

From this study it would apear that the major factor controlling seed germination and emergence in a year with a dry spring is rapid wetting and drying. This was the same conclusions reached by Thomas and Wein (1988) for jack pine, white pine, black spruce and balsam fir. Mulching with cottonseed hulls did increase emergence. Mulching improved moisture relations and also reduced seed movement and deep coverage by sediments. One could mulch each spot at a low cost because very little mulch/spot is needed and it is light to carry. However, on sites where a forest floor of needles is left in place, the success of treatment 8, (using local debris as mulch), suggests that local needles could be used as a mulch source. Hardwood foliage might cause a problem in seedling emergence. Mechanizing a planter to drop seeds just between the litter layer and forest floor should be considered. This would require not burning the site.

In a dry year like 1986, February appeared to be a better month to sow than March. On the average this may not be true. For instance, at the Griffin Experiment Station, Spalding, Co., the average rainfall is 4.63 inches in February and 6.08 inches in March (Kinard and Tippins, 1982). Evaporative demand (drying potential) will be greater in March than February due to the higher temperatures in March. Jones, 1971, reported that for slash pine in the middle and upper coastal plains of Georgia that February and March were the best months for direct seeding. Early emergence in February and possible frost kill might be a concern in February. However, the average date when minimum temperatures fall to 24°F or less is February 23 at the Griffin Station (Kinard and Tippins, 1982). In an ongoing study at the University of Georgia, we have found that young seedlings can tolerate temperatures down to approximately 25°F. Seeds planted in early February would not be expected to emerge until late February. In most years, direct freeze damage to young seedlings will probably not be a problem.

In a dry year like 1986, final seedling survival was only about 20% in the best treatments. This could mean that to insure success in dry years one might need to put 4 - 5 seeds per spot. However, it would probably be more reasonable to target for more average years and put 2 - 3 seeds per spot.

This research suggests that there is hope for direct seeding. More controlled work needs to be done to further optimize germination and establishment. This should include seed treatments to accelerate germination and ways to mechanize seed placement between the litter layer and mineral soil.

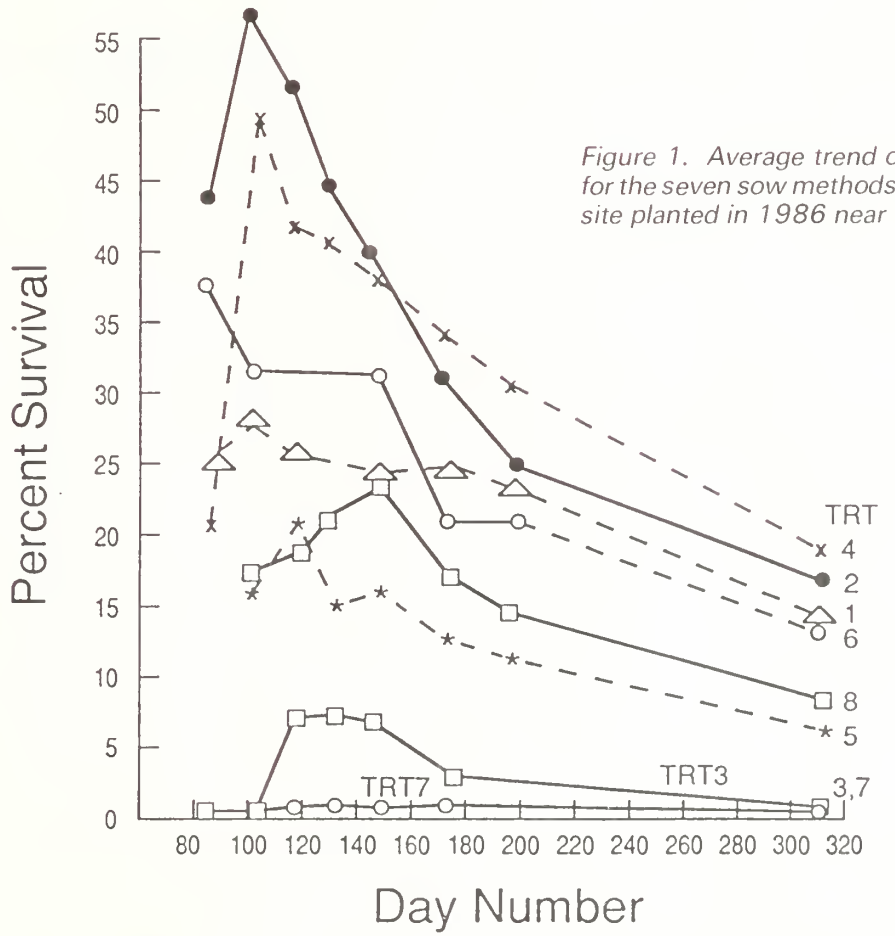


Figure 1. Average trend of percent surviving seedlings for the seven sow methods treatments (TRT) applied on a site planted in 1986 near Covington, Georgia.

Table 1: Monthly rainfall, average temperature and the minimum temperature observed at the Covington, Ga. weather station in 1986. The departures from the long-term normals are also given for rainfall and average temperature (NOAA, 1986).

Month	Total Rainfall (inches) (inches)	Rainfall Departure (inches)	Average Temperature (°F)	Temperature Departure	Minimum Temperature
Jan	1.87	--	43.1	-0.1	7°
Feb	2.28	-2.14	51.3	5.1	20°
March	2.78	-3.12	55.2	1.7	22°
April	1.18	-2.70	63.2	0.8	31°
May	2.59	-1.68	71.4	1.8	45°
June	2.33	-1.38	79.6	3.8	64°
July	2.19	-2.51	83.6	4.9	65°
Aug	5.47	2.20	77.6	-0.6	55°
Sept	4.05	0.87	74.6	1.8	57°
Oct	4.57	1.77	63.5	1.4	40°
Nov	6.75	3.65	57.9	5/5	27°
Dec	4.93	0.73	44.9	-0.4	26°

Table 2: Test of significant differences in Arcsin transformed means using the Duncan's multiple range test and a significance level of .05. All treatments in a column with different letters are significantly different.

			Day Number						
Treatment	TRT	87	105	120	133	149	171	196	306
S. Scrape-net Feb.	1	.52	.56^{c}	.53^{bc}	.52^{abc}	.51^{abc}	.51^{ab}	.50^{ab}	.38^{ab}
S. Scrape, mulch, Feb.	2	.72	.86^{a}	.80^{a}	.74^{a}	.68^{a}	.59^{a}	.52^{ab}	.43^{a}
Scuff, N S, mulch	3	.0	.0	.25^{d}	.25^{d}	.25^{c}	.11^{cd}	.06^{cd}	.0^{c}
F Scuff, S, mulch	4	.47	.56^{c}	.71^{ab}	.70^{ab}	.67^{a}	.63^{a}	.59^{a}	.46^{a}
Scuff S, mulch, Mar.	5	--	.40^{c}	.39^{cd}	.33^{cd}	.34^{bc}	.30^{bc}	.28^{bc}	.18^{bc}
Scuff, S, Feb.	6	.66	.59^{bc}	.53^{bc}	.55^{abc}	.59^{ab}	.42^{ab}	.42^{ab}	.33^{ab}
Scuff S, Mar.	7	--	.0^{d}	.0^{e}	.06^{e}	.0^{d}	.0^{d}	.0^{d}	.0^{c}
Scuff S, S mulch, Mar.	8	--	.41^{c}	.44^{cd}	.48^{bcd}	.5^{abc}	.42^{ab}	.39^{ab}	.29^{ab}

LITERATURE CITED

Jones, E. P. 1971. Season for direct seeding slash pine in the middle and upper coastal plains of Georgia. USDA Forest Service Report Note SE-151, 7pp.

Kinard, D. J. and H. H. Tippins. 1982. Weather data summary for the Georgia Experiment Station 1926-1981. University of Georgia College of Agriculture Experiment Stations, Research Report 406, 51pp.

Thomas, P. A. and R. W. Wein. 1985. Water availability and the comparative emergence of four conifer species. Can. J. Bot. 63:1740-1746.

John W. Mixon
Director

Approximate Cost Of
Press Time and Paper Only
COST: $966 QTY 3M