Mulching Effects of Plant Fiber and Plant Fiber–Polyester Mats Combined With Fertilizer on Loblolly Pine Seedlings

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*In this preliminary study, several mattings, combined with and without fertilizer application, were tested around newly planted loblolly pine (*Pinus taeda *L.) seedlings. After 9 months in the field, jute-polyester and jute mats had similar survival rates relative to controls, but hemlock-polyester mats had depressed survival when used in combination with fertilizer. All types of mats had similar durability—85 to 90% of them remained intact and stayed in place throughout the study. Fertilization generally increased seedling development but did not affect mat durability. Mats in combination with fertilizer did not affect seedling development. The mats provided 100% weed control.* Tree Planters' Notes 42(3):32-35; 1991.

Mulching newly planted seedlings may be a practical weed-control measure on southern pine sites and pastures being converted to pines, especially when herbicides cannot be used (Bengston 1969, Bilan 1960, Koch and McKenzie 1977, Shekour et al. 1987, Wolters 1972). Forest litter and logging debris can be shredded on site to form a mulch or mulch can be transported from another site. Such natural mulch provides several benefits, including weed control, improved water retention in the soil, and reduced moisture stress for seedlings (Walker and McLaughlin 1989). Natural mulch should also reduce erosion by wind and water, decrease sedimentation, lessen energy inputs for weed control, and alleviate nonpoint source pollution (Dao 1987). It also restores the soil–air interface, which is often needed if cultural practices result in litter destruction, soil displacement, or compaction.

Another mulching strategy is to use manufactured matting that provides the benefits of natural mulch. Additionally, controlled-release fertilizers, animal repellents, insecticides, and herbicides might be selectively incorporated into the matting as needed. The combination of mulch and pesticides in agronomic crops has been promising (Banks and Robinson 1984, Crutchfield et al. 1985, Ghadiri et al. 1984), and the addition of such chemicals might be based on silvicultural prescriptions to ensure seedling survival and early development on sites where nutritional deficiencies, animal damage, and insect and weed problems are expected to be especially severe. Also, the primary materials used in such mats are plant fibers, and therefore mats do not pose an environmental hazard as they decompose.

In this preliminary work, we studied plant fiber and plant fiber-polyester mats placed around the root collar of newly planted loblolly pine (*Pinus taeda* L.) seedlings and over a mowed cover of grasses (mostly *Andropogon* spp. and *Schizachyrium* spp.), forbs, and blackberries (*Rubus* spp.) Only a small quantity of the kinds of mattings tested were available, and we knew it would be difficult to detect positive growth responses among tree seedlings because of the small sample size. However, any negative effects from using the mats would probably be detected.

The objectives were to determine if

1. the mats remain intact and in place under field conditions (durability)
2. the mats benefit survival and development of planted loblolly pine seedlings
3. the mats control weeds
4. the combination of fertilizer and mats is especially beneficial

Methods

Fiber mat production. The mats were produced at the USDA Forest Service's Forest Products Laboratory in Madison, Wisconsin. The materials used were derived from jute (*Corchorus* spp.), western hemlock [*Tsuga heterophylla* (Raf.) Sarg.], and polyester. The jute was a bast fiber 3 to 4 inches long taken from the somewhat woody outer layer of the stem. The western hemlock was produced from 100% pulp-grade chips. The polyester fibers were 5.5 denier, 9.7 inches long, and crimped.

The fibers of jute, jute and polyester, or western hemlock and polyester were introduced into a turbulent air stream, transferred via this air stream to a moving support bed, and subsequently formed into a continuous, low-density mat of intertwined fibers that contained no adhesives. The weight per unit area of the mats was 0.030, 0.079, and 0.161 pounds per square foot for the 95% jute/5% polyester, 100% jute, and the 95% western hemlock/5% polyester mats, respectively. No adhesives were used. Further details are generally available upon request.

Study site. The site is gently sloping Beauregard silt loam (Plinthaquic Paleudults, fine-silty, siliceous, thermic) at the Palustris Experimental Forest, Rapides Parish, LA. Vegetation consists of established grasses, forbs, and blackberries. The plant cover was rotary mowed several days before the plots were installed, and weather data were available from a continuously recording electronic weather station located a quarter mile from the site.

Study design and analysis. In May 1989, four mat treatments and two fertilizer treatments were laid out in a 4 × 2 factorial experiment arranged in a randomized complete block design with 10 blocks serving as replications. A single loblolly pine seedling formed each of the 8 plots per block. The seedlings were grown in containers before planting. The blocks were planted by hand on May 25, 1989, with one of four half-sib families of 28-week-old pine seedlings that had been grown in containers. The total sample population was therefore 80 pine seedlings for the entire study.

In July 1989, seedling heights and groundline diameters were measured just before the mats and fertilizer treatments were applied. The mat treatments were (1) jute-polyester, (2) jute, (3) hemlock-polyester, and (4) controls (no mats). The fertilizer treatment consisted of a broadcast application of a commercial formulation of 13-13-13 N-P-K at 300 pounds per acre (39 pounds N, 17 pounds P, and 40 pounds K per acre) after the mats were placed around the pine seedlings. Controls received no fertilizer.

The matting was cut in 18- by 18-inch squares before being installed. Small mats were used because the amount of available hemlock-polyester material was limited. The mats were cut from one side to the middle so they could be fitted around the root collar of the pine seedlings. No hole had to be punched to make room for the seedling. Fertilizer was spread by hand over the matting on appropriate plots.

In April 1990, 1 year after outplanting, the final groundline diameter and height data for the loblolly seedlings were taken and the durability (ability to stay intact and in place) of the mats was visually evaluated: excellent, good, poor, or none remaining.

Analyses of variance ($P<0.05$) were used for seedling diameter and height comparisons. Mean differences, if present, were determined with Duncan's multiple range test ($P<0.05$). The durability results were arranged in contingency tables and analyzed by chi-square tests for independence ($P<0.05$). Seedling survival was evaluated by binomial distribution tests where the expected survival was 70% and the critical region was ±20% for each type of matting based on check results ($P<0.05$). In April 1990, competing vegetation was visually examined under each remaining mat.

Results and Discussion

Loblolly response and weed control. Loblolly pine survival was 80% or less for both nonmatted and matted seedlings, even though rainfall was above normal in May (the seedlings were planted on May 25, 1989) and the weather was cooler and wetter than normal for 2 months after planting (tables 1 and 2).

The jute and jute-polyester mats did not influence survival relative to the controls (table 2). There was droughty weather in August and September 1989, and the mats were expected to improve survival over the checks by conserving water through weed control and reduced surface evaporation (table 1). However, the cool-wet weather in June and July 1989 probably allowed all surviving seedlings to establish themselves before the drought developed.

Table 1—*Monthly temperature and rainfall averages over the past 31 years, compared with average monthly ambient temperature and rainfall for the study period (from weather data collected at the Palustris Experimental Forest, Rapides Parish, LA)*

Months and activities	31-year averages: Ambient temp. (°F)	31-year averages: Total precip. (inches)	Averages during the study: Ambient temp. (°F)	Averages during the study: Total precip. (inches)
April	67	4.56	65	1.82
May	73	5.59	74	9.33
Planted seedlings 5/25/89				
June	80	3.62	76	13.75
July	82	3.97	79	6.35
Mats installed 7/31/89				
August	82	3.79	78	1.14
September	77	3.66	77	0.80
End of first growing season				
October	67	3.13	67	0.56
November	57	4.79	59	2.41
December	51	5.57	43	3.38
January	48	4.41	52	14.60
February	51	4.27	56	4.23
Beginning of second growing season				
March	59	3.95	61	6.41
April	67	4.56	66	3.27
Final measurements 4/25/90				

Table 2—*Mean loblolly pine seedling survival, groundline diameter (GLD), and height response to mulching with plant fiber and plant fiber-polyester mats, with and without broadcast fertilizer*

	At planting		Final measurement		
Type of mat	GLD (mm)	Height (cm)	Survival* (%)	GLD (mm)	Height (cm)
No fertilizer					
Jute-polyester	3 a	31 a	50 b	4 d	43 b
Jute	3 a	32 a	60 b	5 cd	42 b
Hemlock-polyester	3 a	31 a	60 b	5 cd	38 b
None	3 a	32 a	60 b	4 d	41 b
Fertilizer†					
Jute-polyester	3 a	32 a	80 b	7 b	45 ab
Jute	3 a	31 a	70 b	7 b	45 ab
Hemlock-polyester	3 a	32 a	20 a	8 ab	52 a
None	3 a	32 a	80 b	6 cb	46 ab

Pine diameter and height mean values in columns followed by the same letter do not differ significantly based on analyses of variance and Duncan's multiple range tests ($p < 0.05$).

*Results for seedling survival are based on binomial distribution tests where the expected survival was 70% and the critical region was ± 20% for each type of matting based on check results ($p < 0.05$).

†The fertilizer used was a commercial formulation of 13-13-13 N-P-K at 300 pounds per acre (39 pounds N, 17 pounds P, and 40 pounds K per acre).

Hemlock-polyester mats reduced survival to 2 seedlings on the fertilized plots, but the surviving pines were the largest in the study (table 2). Reduced survival when fertilizer was used with the hemlock-polyester matting probably resulted from phytotoxicity associated with the mats rather than drought (table 1). Evidently, only larger than average seedlings will likely survive when the combination of fertilizer and hemlock-polyester matting is used.

No interactions of fertilizer and mat affected seedling development, possibly because the small sample size masked the interactive effects. This may be the case, for Bengston (1969) found that the combination of plastic mulch with fertilizer was especially beneficial over a 4-year period. Fertilization alone generally increased seedling development, as it normally does on this type of soil (table 2) (Shoulders and Tiarks 1983) The groundline diameters and heights of fertilized pine seedlings averaged 3 mm larger and 6 cm taller than those of unfertilized seedlings, respectively.

The mats had smothered the competing plants present at the time of installation, and no new weed growth or seed germination occurred under the mats. Although the mats were cut when they were placed around the pine seedlings, none of the grasses, forbs, or blackberries grew through the cut edge. Therefore weed control under the mats was 100%. Weed control is often correlated to increased growth, but height and diameter of checks was very similar to the matted treatments in the summer of their first growing season (table 2).

Mat durability. The three types of mats remained largely intact for the 9-month study period, and 85 to 90% remained in good-to-excellent condition (table 3). Therefore, excluding adhesives during manufacturing did not result in a loss of mat integrity, even though rainfall was above normal from October 1989 through April 1990 (table 1). The mat material was easily cut from the side to fit around the seedling root collar. Not having to punch a hole to make room for the seedling was a clear advantage over stiff materials that are difficult to puncture.

Animals, probably deer, disturbed some of the mats, apparently destroying 3 and damaging 5. However, there were no significant differences among mat types in terms of durability, and fertilizer did not significantly affect durability (table 3).

Table 3—*Evaluations of mat durability 9 months after placement around the root collar of loblolly pine seedlings using χ^2 tests of their heterogeneity**

	No. of mats			
Variables	None	Poor	Good	Excellent
Mat type (n = 20 mats per type)				
Jute-polyester	1	2	7	10
Jute	1	2	7	10
Hemlock-polyester	1	1	0	18
χ = 10.77††				
Fertilizer treatment (n = 30 mats per treatment)†				
None	3	3	8	16
300 lb. per acre	0	2	6	22
χ = 4.43††				

*Control results were excluded from these analyses because observations would be counted only in the none-durability class.

†The fertilizer used was a commercial formulation of 13-13-13 N-P-K at 300 pounds per acre (39 pounds N, 17 pounds P, and 40 pounds K per acre).

††The critical values ($p < 0.05$) of the mat and fertilizer comparisons are 12.59 and 7.82, respectively.

Conclusions

As outlined in our objectives, we reached several conclusions: (1) the mats were durable enough in the field to warrant more extensive testing, (2) the presence of the mats did not reduce loblolly pine seedlings survival, with the exception of the hemlock-polyester mat used in combination with fertilizer, (3) 100% weed control was maintained, and (4) the combination of fertilizer and mats was not generally better than fertilizer alone in this short-term study. Clearly, the negative effects of mats were minimal. A longer term study is needed to better assess the positive effects of mats on tree growth.

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