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Herbicide and Fertilizer Combinations for Newly Planted Loblolly Pine Seedlings on a Flatwoods Site in Southeastern Arkansas: Year Three Results

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HERBICIDE AND FERTILIZER COMBINATIONS FOR NEWLY PLANTED LOBLOLLY PINE SEEDLINGS ON A FLATWOODS SITE IN SOUTHEASTERN ARKANSAS: YEAR THREE RESULTS'

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Abstract-Herbicide and fertilizer combinations were tested for enhanced loblolly pine (*Pinus taeda* L.) seedling performance on a chemically prepared, flatwoods site in southeastern AR. Fertilizer treatments were selected combinations of 40, 50, and 50 pounds per acre of elemental N, P, or K, respectively. Arsenal+Oust (4 ounces+2 ounces per treated acre) was applied for herbaceous weed control (HWC). One treatment of herbicide or herbicide+ fertilizer was applied per year; the same rate was used for years one (1996) and two (1997). After three growing seasons, the greatest seedling volume resulted from two treatments of HWC+NPK fertilizer. Two treatments of HWC alone provided 80 percent and one treatment of HWC achieved 67 percent of the best volume. Of plots receiving year one treatments only, HWC produced the greatest year-three seedling volume. Post-treatment herbaceous biomass was greatest on untreated checks and plots receiving NPK fertilizer.

INTRODUCTION

Public land management continues to emphasize non-timber values, shifting a greater proportion of society's demand for fiber to private lands. In response, managers seek refinement of old and development of new technologies to increase the productivity of timberlands. Vegetation management and fertilization are two technologies that potentially increase yields.

OBJECTIVE

The objective of this study was to control herbaceous weeds and fertilize newly planted loblolly pine (*Pinus taeda* L.) seedlings for one or two growing seasons after planting and record resultant growth of seedlings and returning herbs.

METHODS

A flatwoods site in southeastern AR (Bradley County) near Vick was selected for testing. The site was clearcut during the summer of 1995 and followed in August with a helicopter application' of Accord+Arsenal (2 quarts + 12 ounces) per acre. The site was burned approximately eight weeks after treatment and in February 1996 hand planted with bare-root loblolly pine seedlings on an 8-feet X IO-feet spacing. Analysis at study Initiation indicated the Myatt-Kalmia complex, a mound phase silty clay loam soil (Larance 1961), had a pH of 5.3 with 10 pounds and 50 pounds per acre of P and K, respectively.

Test treatments are as follows.

1. Check-no herbaceous weed control (HWC) or fertilizer.
2. HWC in year one. No fertilizer.
3. HWC in years one and two. No fertilizer.
4. HWC and 50 pounds per acre of elemental P-fertilizer in year one.
5. HWC and 50 pounds per acre of elemental P-fertilizer in years one and two.
6. HWC and 40 pounds and 50 pounds per acre of elemental - and P-fertilizer, respectively, in year one.
7. HWC and 40 and 50 pounds per acre of elemental - and P-fertilizer, respectively, in years one and two.
8. HWC and 40 pounds, 50 pounds, and 50 pounds per acre of elemental N-, P-, and K-fertilizer, respectively, in year one.
9. HWC and 40 pounds, 50 pounds, and'50 pounds per acre of elemental N-, P-, and K, fertilizer, respectively, in years one and two.

A herbicide mixture of Arsenal + Oust (4 ounces + 2 ounces per treated acre) was applied annually durlng year one (May 2, 1996) or years one and two (May 9, 1997) for control of herbaceous competitors. Herbicide was applied as an early post-emergent (< 2 Inches tall) treatment using a CO_2 backpack sprayer and hand-held ``T'' boom with four, 8002 nozzles. Herbicide was mixed with water until the total application volume was 10 GPA. Volunteer pines were cut from all plots and hardwood sprouts treated with a cut-surface application of concentrated Garlon 4.

Commercial fertilizer was manually applied annually during year one (May 8, 1996) or years one and two (May 13, 1997). Fertilizer was applied at 40, 50 and 50 pounds per acre of elemental N, P, and K, respectively. First-year herbicide and fertilizer were applied in bands six feet wide and centered over-the-top of seedlings. Second year herbicide and fertilizer applications were broadcast over the entire treatment plot. The same rate and elements were applied both years on plots receiving fertilizer.

Treatment plots were installed in April 1996 and consisted of seven rows with eight seedlings per row. Measurement plots were the internal five rows with six seedlings per row, leaving a single row surrounding each plot as the buffer. Only seedlings in measurement plots were used for analysis.

Herbaceous biomass response to treatments was monitored. Three, 2- X 2-feet wooden squares were randomly located within each measurement plot. Biomass was clipped in early July of the first, second, and third growing seasons. Samples were oven dried and dry weights converted to dry tons per acre. Because year one HWC was

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in bands, year one biomass samples were restricted to the treated bands only. Year two sampling occurred throughout the measurement plot.

All seedlings were measured in April 1996 for initial height and ground line diameter (GLD) and again in November after one, two, and three (DBH) growing seasons. Height measurements were recorded in centimeters and converted to inches (initial, age one and two) and to feet (age three). GLD at initial, and after one and two growing seasons plus DBH at age three were recorded in centimeters and converted to inches for this manuscript. Volume at ages one and two was computed as (total height)(total GLD)^2 and expressed in cubic inches (in^3). Age three volume, reported in cubic feet (ft^3), was computed as (total height)(0.005454 total DBH^2).

This is a 2 X 3 X 2 incomplete factorial experiment with two timings of application, three fertilizers, and two timings of HWC. Treatments were assigned according to a randomized complete block design with four blocks. Data were analyzed in an analysis of variance with means separated using Duncan's New Multiple Range test. All tests were conducted at the p=0.05 level.

RESULTS AND DISCUSSION

Rainfall following herbicide application and throughout the first growing season (summer 1996) was ideal for efficacious weed control and seedling growth. HWC provided 95 percent weed-free growing conditions until 90 days after treatment when asters, grasses, and sedges such as common ragweed *(Ambrosia artemisiifolia)*, tickseed sunflower (*Bidens aristosa*), fireweed (*Erechitites hieracifolia*), dogfennel (*Eupatorium spp.),* false boneset (*Kuhnia eupatorioides),* goldenrod *(Solidago* spp.), crabgrass (*Digitaria* spp.), panicums *(Panicum* spp.), paspalums (*Paspalum spp.)* and sedges (*Carex* spp. *Cyperus* spp.) re-invaded test plots. Legumes (partridge pea *(Cassia* spp.), beggar lice (*Desmodium* spp.), lespedeza *(Lespedeza* spp.), and wildbean (*Strophostyles* spp.) were tolerant to herbicides and increased in prevalence over the two growing seasons. Late in the season, species of groundcover *(Hype&urn* spp., *Rhexia* spp. and *Polypremum* spp.) commonly invaded plots. Differences in herbaceous vegetation on treatment plots were apparent the year following treatment (for both timings). Visually, there appeared to be an increased early-prevalence of sedges (Carex *spp.; Cyperus* spp.), followed by increased *Andropogon* spp. and a general increase in the quantity of herbaceous biomass. Rainfall during the summer of 1997 was below average for July, August, September, although average for the year.

Survival

Survival was excellent at 92 percent or higher for all treatments after three growing seasons (table 1). No statistical differences were detected.

FM-Year Growth

Best total height was achieved with HWC; check seedlings were numerically the shortest (table 1). Largest ground line diameters were recorded on plots receiving HWC alone or HWC plus P fertilizer. Greatest volume was observed for seedlings treated for HWC alone. All treatments provided more ground line diameter and volume than untreated checks. Plots scheduled for first- or first- and second-year treatments were in the same stage of treatment at this point, thus statistical differences between equivalent treatments are due to noise. For example, some noise does exist for height and GLD on plots receiving HWC during year one and HWC during years one and two. Elsewhere, noise is minimal with plots logically positioned for a meaningful interpretation of subsequent growth.

In July of 1996, herbaceous biomass on treated plots was approximately 10 percent that of the untreated check (table 2). Although significantly less than the untreated check, biomass was statistically greater on plots receiving HWC+N fertilizer than HWC+P alone. Data suggests residual herbs benefitted from the additional water and nutrients resulting from treatments. If residual herbs survived treatment due to herbicide tolerance, then fertilizer favors the development of a tolerant subpopulation. To avoid developing a tolerant subpopulation, the brand of herbicide should be rotated for successive treatments.

Second-Year Growth

Two years of HWC plus NPK was the only treatment providing largest seedling heights and ground line diameters (table 1). Best total volume resulted from herbicide and NPK applications during years one and two. This performance was more than 1,100 percent better than the untreated check, 47 percent better than one year of HWC and 24 percent better than two years of HWC. Intermediate volume occurred with two years of HWC alone or combined with two years of NP or P.

The best year-one treatment was HWC alone (table 1). One year of HWC provided more seedling volume than HWC plus one year of fertilizer. All treatments yielded more seedling volume than the untreated check.

Magnitudes of 1997 herbaceous biomass varied greatly as herbs were deliberately controlled on some plots and not others (table 2). Biomass levels on plots receiving a first-year HWC+NPK treatment, and now in the second growing season (July 1997), had returned to untreated check levels (table 2). The same was true for HWC+NP in July 1997 if p=0.10. Data suggests that nutrients were available during the post-treatment year to increase herbaceous competition over that of using HWC alone. Perhaps, fertilizer utilization by young seedlings would be better if an N-fertilizer treatment was also followed with HWC.

Third-Year Growth

The best height, diameter, and volume resulted from two years of, HWC plus NPK fertilizer. This treatment provided 750 percent more cubic feet per tree than checks (table 1). Please note that 131 of a possible 132 trees receiving two years of HWC plus NPK fertilizer reached 4.5 feet in height. In contrast, only 59 of 135 of the check trees had a DBH. Over time, the gap between check and treated trees is expected to increase as more short check trees exceed 4.5 feet in height and are used to compute volume. Two years of HWC provided 80 percent and one year of HWC provided 67 percent of the resultant volume from two years of HWC+NPK. Intermediate volume resulted from two years of HWC with two years of NP or P.

The best year-one treatment was HWC alone. All treatments yielded more seedling volume than the untreated check.

Table l-First- (1996). second= (1997), and third-year (1998), loblolly pine seedling responses (S = survival at ages 1, 2, and 3, Ht = total height at ages 1, 2, and 3, D = ground line diameter for ages 1 and 2, d.b.h. = diameter at breast height at age 3, V = total volume at ages 1, 2, and 3, n = volume sample size) to 1 or 2 years of herbicide[a] and fertilizer[b] treatments on a southeastern Arkansas (Bradley County) flatwoods site (treatment n = 144)

Treatment[c]	S1	s2	s3	Htl	Ht2	Ht3
	Percent			Inches		Feet
Initial	100			6.1		
HWC 1,2 + NPK 1,2	94a	92a	92a	21.5bc	60.9a	8.7a
HWC 1,2 + NP 1,2	97a	97a	97a	20.1cd	57.4b	8.2bc
HWC 1,2 + P 1,2	96a	96a	96a	22.0b	60.1ab	8.4b
HWC 1,2	96a	96a	96a	22.0b	57.7ab	8.4b
HWC 1	96a	94a	94a	24.2a	58.4b	8.0c
HWC 1 + P 1	94a	94a	94a	22.3b	53.9c	7.5d
HWC 1 + NP 1	97a	95a	94a	21.8b	51.8c	7.4de
HWC 1 + NPK 1	96a	96a	94a	21.1bc	51.9c	7.16
Untreated check	95a	94a	94a	19.0d	35.1d	5.97f

Treatment[c]	D1	D2	DBH3	VI	v2	v3	n
	--Inches---			$Inch^3$		Ft^3	
Initial	.17			.18			
HWC 1,2 + NPK 1,2	.66bc	1.9a	1.5a	11 .Obc	232.7a	.15a	131
HWC 1,2 + NP 1,2	.63c	1.8b	1.3bc	9.5c	207.6b	.IIbc	137
HWC 1,2 + P 1,2	.68ab	1.7b	1.3b	11.8b	196.5b	.12b	132
HWC 1,2	.64c	1.7b	1.3b	10.5bc	188.0b	.12b	135
HWC 1	.71a	1.5c	1.2c	14.2a	158.1c	.10c	130
HWC 1 + P 1	.69ab	1.5d	1 .0d	12.1b	125.4d	.06d	133
HWC 1 + NP 1	.63c	1.30	1 .0d	10.8bc	109.5d	.06d	124
HWC 1 + NPK 1	.62c	1.4e	1.Od	9.5c	106.5d	.06d	129
Untreated check	.37d	.7f	.6e	3.3d	20.66	.02e	59

[a] A single application of Arsenal+Oust (4 oz+2 oz) was used for first- and second-year herbaceous weed control (HWC) for all plots.
[b] Fertilizer was applied at 40, 50, and 50 pounds/acre of elemental N, P, or K, respectively. The same rate and elements were used for years one and two.
'Treatment means in a column and sharing a common letter are not significantly different (Duncan's New Multiple Range test p = 0.05).

Table P-First- (July 1996), second- (July 1997), and third- (July 1998) year herbaceous biomass following 1 or 2 years of herbicide[a] and fertilize? treatments on a chemically prepared flatwoods site in southeastern (Bradley County) AR

Treatment[c]	Herbaceous biomass		
	July 1996	July 1997	July 1998
Herbaceous weed control year 1 + NPK year 1	0.36bc	1.40ab	1.36a
Herbaceous weed control year 1 + NP year 1	.30bc	1.23bc	I.IIabc
Untreated check	1.85a	1.58a	1.32ab
Herbaceous weed control year 1 only	.13d	1.13bc	.98bc
Herbaceous weed control years 1,2 + P years 1,2	.13d	.13d	.88c
Herbaceous weed control years 1,2 + NPK years 1,2	.25cd	.23d	.96abc
Herbaceous weed control year 1 + P year 1	.IId	1.07c	.90c
Herbaceous weed control years 1,2 only	.IId	.33d	.80c
Herbaceous weed control years 1,2 + NP years 1,2	.41b	.27d	1.15abc

[a] A single application of Arsenal+Oust (4 oz+2 oz) was used for first- and second-year herbaceous weed control (HWC) for all plots.
[b] Fertilizer was applied at 40, 50 and 50 pounds/acre of elemental N, P, or K, respectively. The same rate and elements were used for years one and two.
'Treatment means in a column and sharing a common letter are not significantly different (Duncan's New Multiple Range test p = 0.05).

Several treatments exhibited 1998 herbaceous biomass levels that were statistically similar to the untreated check (table 2). Among those similar were four treatments containing N fertilizer (HWC 1 year+NPK 1 year, HWC 1 year+NP 1 year, HWC 1,2 years+NP 1,2 years, and HWC 1,2 years+NPK 1,2 years). Biomass recovery in the post-treatment year reached untreated check levels on the HWC+NPK plots receiving treatment for both one or one and two years.

REFERENCES

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