WEED CONTROL AND FERTILIZATION AID SWEETGUM PLANTATION ESTABLISHMENT[1]

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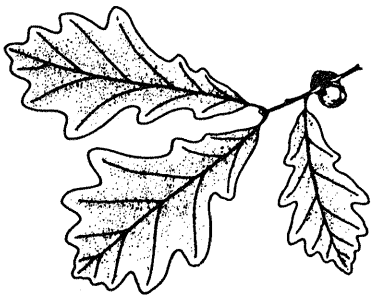

ABSTRACT.--This study examined the use of fertilization with N or NPK and the complete control of weeds rather than just operational disking during the first year in a sweetgum plantation as a means of producing increased growth. Hoeing around the seedlings twice during the treatment year significantly increased height growth during the treatment year and during the following year when no treatment took place. Survival after 2 years averaged 95% on hoed plots versus 76% on unhoed. Weed control during the first year in the field clearly was the most significant factor in stimulating sweetgum growth in this study. The effect of weed control on tree height and DBH has remained significant after 6 years of growth.

INTRODUCTION

Sweetgum (Liquidambar styraciflua L.) has been an important species in Westvaco's plantation program due to its adaptability to a wide range of sites. One major problem with plantation establishment is getting the seedlings above the weed competition. Operational disking is currently used to control vegetation in the rows between seedlings, but it leaves the area immediately surrounding the seedling undisturbed. For the disking to be effective, the tractor operator must be able to see the seedlings to avoid inadvertently damaging them. Any practice which increases the visibility and size of the seedlings would, therefore, be helpful.

Weed control and fertilization are two cultural practices which often can be beneficial to establishment of hardwood plantations, especially sweetgum. Hunt and Cleveland (1978) showed that disking increased the volume growth of several species, including sweetgum, when measured at age 5. Heights were also 1 1/2 to 4 times greater than undisked plots. Heavy mortality occurred in the hardwood species that did not receive the additional care of disking. Kennedy (1984) presented similar information for several hardwood species at age 4 on productive bottomland sites. Disking of the plantation resulted in significant gains in height, diameter, and survival of sweetgum when compared to mowing or no cultivation.

Ku et al. (1980) examined the response of a sweetgum plantation to fertilizer treatments. Their results showed a 50% biomass increase due to nitrogen or nitrogen plus phosphorus treatments in comparison to unfertilized plots at age 5.

The current study was designed to test the effects on growth of a sweetgum plantation of nitrogen fertilizer alone, or NPK mix, or unfertilized checks in both the presence or absence of weeds normally left by operational disking.

METHODS AND MATERIALS

The test was located on a low ridge in the Cache River Bottom, Massac Co., Illinois. The site was formerly wooded and had been prepared during 1978 for planting. Preparation included shearing, disking, row marking, and slitting. The soil is typed by the SCS as Alvin fine sandy loam which has developed on stream terraces of the Ohio River and its tributaries. The soil is described as well drained, strongly acid, with the A horizon 10 inches thick over a fine sandy loam B horizon and is classified as Typic Hapludalfs.

[1]A paper presented at the Fifth Central Hardwood Forest Conference held at the University of Illinois, Urbana, Illinois, on April 15-17, 1985.

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The 1-0 sweetgum seedlings were raised at the Westvaco nursery in South Carolina and hand planted in April 1979. Spacing in the plantation was 11 feet by 11 feet. Initial survival was 98% overall in the test.

The test design was a 2 x 3 factorial replicated 5 times with 15-tree measurement plots. Treatments were the removal of weeds by operational cross-disking and hoeing versus by operational cross-disking only, and fertilizer applications of NPK, N, and none.

Fertilizer treatments were applied by hand in a circular area of 2-foot radius around each tree. Ammonium nitrate was used for N alone and applied at a rate within the fertilized radius of 100 lbs/ac N. A combination of ammonium nitrate and 6-12-12 was used for the NPK treatment and applied at a rate of 100 lbs/ac N, 50 lbs/ac P, and 95 lbs/ac K. The fertilizer treatments were applied on May 25, 1979. Hoeing on the appropriate plots was done on May 24 and 25, 1979, and they were again hoed in Mid-July 1979 to maintain weed control.

Weed competition on the site the first year was mainly annual broadleaved species, predominately giant ragweed (Ambrosia trifida L.) and horseweed (Erigeron canadensis L.). Weed cover was typically 5 to 7 feet tall. A wide variety of other species was also present and included mustard (Brassica sp.), goldenrod (Solidago sp.), and pokeweed (Phytolacca americana L.). Some foxtail grass (Setaria sp.) was present on the site as were numerous hardwood sprouts of sassafras, hickory, and persimmon.

Operational cross-disking in 1979 and 1980 effectively controlled weeds in the plantation except in the approximately 20-inch square of ground around each planted seedling. The two hoeings reduced weeds in the undisked squares during the first year, though some weeds returned late the first season. Because no special effort was made to control weeds near the seedling during the second year, few differences in weed competition were then apparent due to the square having been hoed the previous year. When cultivation was stopped, weed growth throughout the test showed little difference due to prior intensity of cultivation.

Initial tree heights were measured on the study and were remeasured one, two, and six years after treatment. Seedlings which were damaged by disking were not included in the averages. At age 6 the DBH of each tree was also recorded. Analysis of variance showed no significant difference among the plots prior to treatment.

RESULTS AND DISCUSSION

It was anticipated that complete weed elimination would stimulate growth of seedlings. Hoeing around seedlings increased average height growth of the seedlings 71% over operationally disked plots during the first year. The effect of hoeing persisted the following year, even though no additional treatment took place, and increased growth 104% over plots which had not been hoed the year before. This carryover of the hoeing effect into the second year was undoubtedly due to the better seedling establishment and growth the previous year when weeds had been reduced.

The average height growth of the individual treatments at the various ages are shown in Table 1. Significant differences were present after one growing season. All the hoed plots had significantly more growth than the unhoed plots. After the second growing season, all hoed treatments had again produced significantly greater growth increments than unhoed. At age 6, the same significance of hoed plots over unhoed remained, and there were no significant differences in either total growth or average yearly growth among the hoed plots.

TABLE 1. Average height growth increments (feet) of sweetgum seedlings after 1, 2, and 6 years.

TREATMENT	First Year	Second Year	3 to 6 Yr Ave	6 Year Total
Check	0.6 a	0.9 a	2.1 a	10.0 a
N Alone	0.7 a	0.8 a	1.9 a	9.2 a
NPK	0.8 a	0.7 a	2.1 a	9.8 a
Hoe Check	1.1 b	1.6 b	2.9 b	14.1 b
Hoe N	1.2 b	1.7 b	2.8 b	14.1 b
Hoe NPK	1.3 b	1.6 b	2.9 b	14.3 b

Values in the same column followed by the same letter do not differ significantly ($p = 0.05$) by Duncan's multiple range test.

The effects of the treatments on DBH at age 6 were similar to effects on height growth. Unhoed plots averaged 1.3 inches and hoed plots averaged 2.2 inches. All hoed plots were significantly larger than unhoed, and there was no significance among the fertilizer treatments of the hoed plots. Thus, 6 years after the first-year treatment, hoeing around seedlings produced trees which were an average of 4.5 feet taller and 0.9 inches larger in diameter as compared to those which received only operational disking.

Analysis of variance showed the effect of hoeing to be very significant after the first year of growth. This significance was even more prounounced after the second season of growth. Throughout the study, the effect of hoeing has been the predominant factor in all analyses. Over the six year period of the study, trees in plots which included hoeing as part of the treatment averaged 47% greater height growth than their counterparts. In hardwood plantations, this magnitude of growth increase can be quite important. Studies on other types of sites have also shown the great important of vegetation control on establishment and growth of sweetgum seedlings (Kaszkurewicz and Keister, 1975; Kennedy, 1984).

Analysis of variance of individual factors showed no significant effect of fertilization at any point. The lack of significant response to the fertilizer treatments may have been due to the fairly fertile nature of the soils in the study area. This study in no way eliminates the potential gains to be expected by fertilizing sweetgum, particularly on less fertile soils and at later stages of development, possibly nearer the time of stand closure. Studies by others (Gilmore et al., 1971; Ku et al., 1980) certainly indicate this to be the case.

In addition to the effect on height growth, hoeing as a treatment on the sweetgum test also reduced disking damage to the seedlings. Less than 1% of seedlings in plots which were hoed were damaged by disking, whereas more than 13% of seedlings were damaged in unhoed plots. The poorest plots were those which received N application and no hoeing; there 19% of the seedlings showed disk damage. Damaged trees were noted on the tally sheets and not used in computing plot averages. Seedlings which were cut by the disk but resprouted were about 40% smaller than other seedlings in the same plot and the sprouts were generally not large-stemmed or vigorous. On the age six tally of the study, many individual trees which had received disk damage during the initial years had died. Clearly, the the stress imposed by the additional damage to the seedlings made them less competitive and resulted in lower survival potential. Hoeing, therefore, not only allowed significantly greater height growth but also reduced the probability of disk damage.

TABLE 2. Average age 2 survival (%) of sweetgum seedlings by treatment.

TREATMENT	SURVIVAL
Check	74.7 a
N Alone	74.7 a
NPK	80.0 a
Hoe Check	98.7 b
Hoe N	94.7 b
Hoe NPK	90.7 b

Values followed by the same letter do not differ significantly (p=0.05) by Duncan's multiple range test.

Survival after 2 years was greater on hoed plots and averaged 95% versus 76% for unhoed plots (Table 2). At age 6 the survivals were 88% and 67% respectively. In intensive plantation management, 67% survival at age 6 might be considered a problem. The increased survival on hoed plots was due in part to reduced weed competition and in part to reduced losses to disking. The height advantage gained by hoeing in the first year helped the tractor operator to easily see the tree in the second year of disking. While the majority of disk damage was recorded after the first year, some did also occur during the second year.

CONCLUSIONS

Weed control around sweetgum during the first year in the field can significantly increase first year height growth. The effect carried over into the second year where the growth of the seedlings was even more significantly related to having been hoed the year before. The height and diameter differences remain significant after 6 years.

Fertilization did not significantly increase growth of sweetgum in this study. The study site was relatively fertile and further work needs to be carried out to determine which sites might benefit from fertilization. Studies to determine the response to fertilization at later ages may also be helpful.

Removal of competing vegetation greatly reduced seedling damage due to operational disking. This was probably a result of increased visibility where weeds were hoed.

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