EFFECTS OF FERTILIZER TREATMENT APPLIED TO A YELLOW-POPLAR "SEED ORCHARD"

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Abstract.--Height, diameter, and seed head production were analyzed after six years of biannual fertilizer, lime, and herbicide applications on a yellow-poplar seed orchard.

Thinning was found to increase diameter growth, live crown length, and seed head production. Trees in unthinned areas showed greater height growth, probably due to less wind damage on these plots. Herbicide application increased height and diameter growth. And the application of nitrogen at 150 and 300 # per acre resulted in increased seed head production. Inconsistency in seed head production shows that genetic potential for productivity will have as much or more effect than environmental manipulation.

It is recommended that wide spacing and the application of nitrogen fertilizers be used to establish trees with good seed production.

Additional Key Words: Seed production.

Several orchards for the production of superior yellow poplar seed have been established and others are in the planning and establishment stages (anonymous 1971). Normal seed bearing age for yellow poplar has been reported to be as young as 9 years (Schopmeyer, 1974). Where orchards are established by grafting mature yellow poplar clones, early seed production should result. However when seedling seed orchards are established, some technique is needed to stimulate early seed production. Further, techniques are needed to achieve and maintain full seed production as a part of seed orchard management. There is little or no information covering management procedures for yellow poplar seed orchards.

This study was designed to investigate the effect of thinning and fertilizer application on seed production and growth of yellow poplar of sapling size at a final spacing of approximately 36 by 36 feet.

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The study was established on a 7 acre portion of a 9 year old plantation owned by the Kaiser Aluminum and Chemical Corporation near Ravenswood, West Virginia2/. The area had been machine planted on a 6 by 6 foot spacing. Survival had been excellent and a full stand was established. Trees averaged 21.7 feet in height and 3.5 inches dbh.

Soils are of the Muskingham Upshur series, well drained with an approximate site index of 55 to 64 for oak (Anonymous 1961).

In 1966 the plantation was thinned to an approximate 12 by 12 foot spacing, removing, wherever possible the poorest trees. One year later a second thinning was made to approximate a 36 by 36 foot spacing; this being the projected spacing for a yellow poplar seed orchard. In spite of the fact that severe winds are often encountered in this area, there was no wind-throw after either thinning. Control trees were selected in the unthinned stand on the periphery of the area and all trees were permanently numbered. Soil samples were taken around each tree and bulked by treatment for analysis. Treatments to be applied were high (300# per acre), medium (150# per acre) and low (0# per acre) of N, P and K in a factorial design using all possible combinations of these elements. Three additional treatments were included as special controls: 1. Thinning only, 2. Thinning plus lime and 3. Thinning plus herbicide. Treatments were applied to two tree plots as a measurement unit. Prior to the application of the fertilizer, all treatment plots except as previously noted were sprayed with Amizine at the rate of 10# per acre in an area of 8 foot radius around each tree. The average pH of the area was approximately 6.4 and lime was applied to all trees except as noted previously at the rate of three tons per acre (20# per tree) in an area with an 8 foot radius around each tree.

Treatments were assigned in a completely randomized design with five replications and fertilizer applied three weeks after the lime application, in late May.

Based on soils analyses, fertilizer and lime amendments and herbicide applications have been made biannually after the initial treatment.

After six years, the average height of the trees is 39.5 feet and average dbh is 9.98 inches. The average number of seed heads produced per tree is 337. Height variation is from 46.0 for the untreated control to 36.7 for treatment 29 (thin only). The largest average diameter

2/ The authors wish to thank the Kaiser Aluminum Corporation for the use of the plantation and their continued cooperation in carrying out the study.

is 11.0 inches dbh in treatment 12 (medium N, low P, high K), while the smallest average diameter is 6.52" for trees in the unthinned control. Greatest seed head production is from treatment 11 trees (medium N, low P, and medium K), an average of 615 per tree while the smallest production is from the unthinned control, an average of four seed heads per tree (See Table I).

The analysis of variance with all treatments using only growth from 1972-73 showed no significance for height, very high significance for diameter growth and no significance for seed head production.

Treatment-control comparisons show that differences due to "thinning alone" are significant at the 5% level for all three variables; for "lime alone" the [y] are significant at the 5% level for height. Differences due to "herbicide alone" are significant at the 5% level for height and diameter; and for all fertilizer treatments combined, they are significant at the 5% level for diameter and seed head number (See Table II).

The number of trees producing seed has increased from 9 (2.8%) to 293 (94.2%) since the first treatment. Of the 17 non producing trees, 10 are in the unfertilized controls, 6 in the low N treatments and one in the medium level for N, P and K. One fourth of the unfertilized trees are not bearing seed at this time.

DISCUSSION

Although the thinning operation was planned mainly to approximate seed orchard spacing, control trees in the unthinned area were selected to establish a base for treatment response. Of interest is the fact that the greatest response in both diameter growth and seed head production was associated with thinning.

The tree crowns **in** the thinned area have increased in diameter and live crown length, most of the trees having live branches to within four or five feet of the ground.

Yellow-poplar is apparently a species which responds well to thinning even at an advanced age. Beck and Della-Bianca (1975) showed that stands up to 70 years of age responded well to heavy thinning. Our results would certainly support the fact that thinning at early ages can also be beneficial.

Height growth in the unthinned area was better than in thinned areas regardless of treatment. This is confounded by the fact that there has been continued branch breakage in the thinned area. Exactly how much this has affected the current height measurement in problematical, but there is no doubt that a bias has

been introduced because of this fact. There is evidence that more breakage occurs on trees in the heavier fertilizer treatment (Cech et. al. 1975).

The Amizine application was designed to minimize fertilizer uptake of herbaceous competition in the fertilized areas. Fitzgerald and Seldon (1975) reported an increase in height growth of yellow-poplar, three years after transplanting. The results of our study support this fact and also show an increase in diameter growth with repeated application of herbicide. Though statistically nonsignificant, there is also marked increase in seed head production in plots which were thinned and herbicided over those which were thinned only.

The addition of Nitrogen at either level resulted in an increase in diameter growth which was not statistically significant, and an increase in the number of seed heads which was statistically significant at the 5% level. There was no significant effect from P and K for the 1974 seed crop.

One of the problems in analysis is the inconsistancy of seed production within treatments. In one case one of two pairs of trees had 2,304 seed heads while the paired tree (with the same treatment) had 14 seed heads. Several trees bore over 1,000 seed heads. Often one very productive tree offsets the low production of the other trees in the treatment. Apparently the genetic potential for productivity will have as much or more effect on seed production at the early age of 15 than the environmental manipulation tried in this study.

At this point, the only clear evidence, is that for thinning, and the beneficial effect of nitrogen application on diameter growth and seed head production.

Apparently wide spacing in seed orchards and application of nitrogen fertilizers will be sufficient treatment to establish trees with good seed production.

Table 1. Average height, diameter, and number of seed heads six years after initial treatment.

Treatment	N	P	K	1974 Height(Ft.)	1974 Diameter(In.)	1974 Number of Seed Heads
1	L	L	L	40.50	10.41	391
2	L	L	M	35.11	8.80	190
3	L	L	H	36.89	8.79	316
4	L	M	L	38.60	9.67	179
5	L	M	M	39.78	9.68	296
6	L	M	H	39.90	9.95	411
7	L	H	L	38.40	9.26	344
8	L	H	M	38.90	9.27	205
9	L	H	H	36.90	9.71	195
10	M	L	L	40.30	10.69	615
11	M	L	M	39.90	9.58	253
12	M	L	H	39.90	11.06	358
13	M	M	L	38.30	9.60	437
14	M	M	M	38.70	10.54	545
15	M	M	H	39.90	10.78	327
16	M	H	L	38.90	10.27	455
17	M	H	M	40.00	10.74	380
18	M	H	H	40.33	10.97	498
19	H	L	L	40.60	10.83	372
20	H	L	M	41.33	10.78	385
21	H	L	H	39.25	10.25	298
22	H	M	L	41.10	10.59	437
23	H	M	M	41.10	10.44	451
24	H	M	H	39.90	10.23	420
25	H	H	L	38.90	10.02	410
26	H	H	M	38.40	10.22	314
27	H	H	H	37.60	10.29	197
28	Herbicide only			40.20	10.45	352
29	Thin only			36.70	9.42	204
30	Lime only			41.60	9.48	220
31	Control			46.60	6.58	4
	Average			39.51	9.98	337

L - Low
M - Medium
H - High

Table 2. Treatment-control Comparison.

A. Modified LSD

Effect	Treatments Compared	Ht.	LSD	Significance	Diam.	LSD	Sign.	Number of seed heads	LSD	Sign.
	Thin	36.70	2.248	*	9.42	0.783	*	204	165	*
Thinning	No Thin	46.60			6.58			4		
	Thin	36.70	2.248	*	9.42	0.783		204		
Lime	Lime	41.60			9.48			220		
	Herbicide	40.20	2.248	*	10.45	0.783	*	352		
Herbicide	Thin	36.70			9.42			204		

B. Tukey Test

Effect	Treatments Compared	Ht.	LSD	Significance	Diam.	LSD	Sign.	Number of seed heads	LSD	Sign.
	Fertilized	39.24	3.173		10.13	1.105		358	232	
Fertilizer	Thin	36.70			9.42			204		
Fertilizer	Fertilized	39.24	3.173		10.13	1.105		358	232	
X Herb	Herbicide	40.20			10.45			352		
Fertilizer	Fertilized	39.24	3.173		10.13	1.105		358	232	
X Lime	Lime	41.60			9.48			220		
	Fertilized	39.24	3.173		10.13	1.105	*	358	232	*
Treatment	Control	46.60			6.58			4		

*Significant at the 5% level.

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