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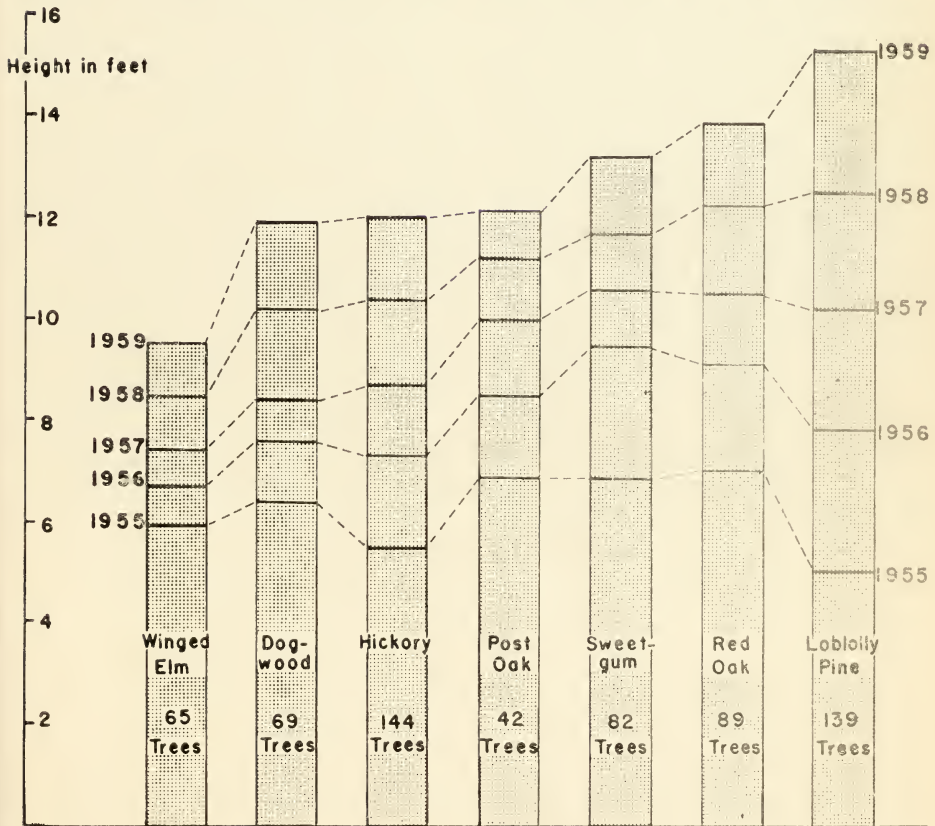
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A Progress Report on

The Ability Of Small Pines To Compete With Hardwood Sprouts



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Conclusions

From this study the following conclusions are made:

1. Hardwood competition is the major cause for differential growth of planted seedling and sapling loblolly pines in erst-while hardwood stands.

2. Results show the mean height of pines after three growing seasons in the field to be less than that of competing hardwood sprouts simply because of subjective selection of competitors.

3. This subjective selection of hardwood competitors on the basis of comparative height has been justified to an extent by the fact that pines have shown greater height growth persistence in the last four years than have hardwoods so that pines at a slight height disadvantage at three years in the field will have overcome that disadvantage, on the average, by the end of seven years in the field.

4. Taller pines are more persistent in height growth than shorter pines with the result that taller pines outstrip com-

petitors to a greater extent than do shorter pines.

5. Since there are more hardwoods taller than short pines than there are taller than tall pines, this may explain why tall pines continue to grow more rapidly than do small ones. There is simply less tall competition.

6. A higher percentage of the total competition is close to short pines while, apparently, up to three seasons in the field, taller hardwoods are offering little competition to either tall or short pines if they are $5\frac{1}{2}$ feet or farther away.

We may conclude then, that the planted pines which were shorter after three years in the field were so because of much close-in-competition. They have grown relatively slowly since then for the same reason. Had competition been reduced at that time to a situation comparable to that of the taller pines, they might have attained about the same height growth rate of the taller pines.

Figure 1. Showing rate of height growth of the average loblolly pine and of the average hardwood for the more common species competing with the pines.

A PROGRESS REPORT ON THE ABILITY OF SMALL PINES TO COMPETE WITH HARDWOOD SPROUTS

By E. G. ROBERTS

As a preface to this report it is well to point out that, with the progress being made in the foliar application of herbicides in pine-hardwood stands, stemwise treatment of hardwood competitors may not be necessary in the future. The study, nevertheless, illustrates a method of attacking the analysis of the competition to which a tree is subjected. The method of approaching the problem could be the same in, let us say, a mixed hardwood stand where we do not envision the use of a selective herbicide.

When planted pines are growing in competition with hardwood sprouts on what seems to be a reasonably uniform site and the pines and hardwoods are of seedling and sapling size, why do some pines thrive, in early years, and others die? If the pine planting stock is presumably uniform in seed source, seedling size, and the like, then four causes for differential growth and survival come to mind: (1) genetic differences, (2) differences in effectiveness of planting, (2) microsite differences, and (4) differing degrees of competition between pines and hardwoods.

In comparing the survival of pines and the uniformity of their growth in plantations on old fields devoid of woody plants with plantations where natural stands of hardwoods are being converted to pines, there seems to be much greater variation in survival and growth in these erstwhile hardwood areas. If this is true, the major factor influencing the success of the pines is the degree of competition with hardwood sprouts.

Pines exist in competitive situations. How can we measure such a situation and how can we evaluate the impact of the situation on a pine? Certainly some of the following elements enter into a competitive situation:

(1) size of pine, (2) size of hardwoods,

(3) hardwood species, (4) distance to hardwoods, and (5) direction to hardwoods.

If we know the combination of situational elements which results in various pine survival and growth responses, we know how to alter situations to achieve our desired ends. Altering situations is another way of saying conducting cleanings. Cleanings are laborious at best; for this work it is desirable to get by with the least possible expenditure which will achieve the desired results.

The work described and discussed here was undertaken to provide information on pine response to competitive situations and then, by extension, to develop cleaning prescriptions.

The small pines and hardwood sprouts considered are on a branch of the Mississippi Agricultural Experiment Station near Pontotoc in north Mississippi. The site is on quite flat Flatwoods upland which is characterized by its impervious clay soil.

In the summer of 1952, all hardwoods 6 inches d. b. h. and larger were notch girdled, those from 3 inches to 6 inches d. b. h. were single-hack girdled, and those under 3 inches d. b. h. were felled with an axe or ditch-bank tool.

Loblolly pine seedlings were planted in late December 1952 and early January 1953. Spacing of pine seedlings probably more nearly approximated 5 by 5 ft. than it did the intended 6 by 6 ft. The area has received no treatment since planting. It has been free of fire and grazing.

An inspection of the plot at the end of the 1955 growing season showed profuse sprouting and every conceivable degree of competition between hardwoods and pines. It seemed likely that many pines would win out and that many others would not.

One hundred-fifty competitive situations were staked, numbered, measured,

Table 1. Stand prior to treatment in 1952.

D.b.h.	Sou. red oaks	Other ¹ red oaks	Willow oak	Black-jack oak	White oak	Post oak	Sweet-gum	Black-gum	Sh. pine	Red-cedar	Hickory	Other ²	Plot total	Total per acre
Under	1719	1250	117	---	39	1797	1562	3125	273	117	4414	8339	22752	4550.3
3' high to 1.5" d.b.h.	625	195	156	---	39	780	430	859	39	39	1289	2812	7263	1452.6
2	35	30	20	---	15	125	40	40	30	---	115	85	535	107
3	35	15	5	---	5	50	20	25	25	---	30	55	265	53
4	30	5	20	---	10	65	30	5	15	---	70	40	290	58
5	8	7	5	1	2	27	18	11	7	---	28	22	136	27.2
6	9	10	---	1	3	26	9	6	4	---	14	13	95	19
7	12	7	---	---	---	23	9	4	4	---	19	4	82	16.4
8	11	4	---	---	3	29	9	2	4	---	19	3	84	16.8
9	8	5	1	---	---	9	9	2	1	---	17	4	56	11.2
10	6	4	1	---	1	18	2	1	1	---	8	1	43	8.6
11	9	5	1	---	1	13	1	1	1	---	2	1	35	7
12	6	1	---	---	1	7	6	---	---	---	---	2	23	4.6
13	1	4	---	---	---	5	---	---	---	---	---	---	10	2
14	2	---	---	---	---	---	---	---	---	---	---	---	2	0.4
15	1	---	---	---	---	---	---	---	---	---	---	---	1	0.2
16	---	---	---	---	---	---	---	1	---	---	---	---	1	0.2
17	---	---	---	---	---	---	---	---	---	---	1	---	1	0.2
18	---	---	---	---	1	---	---	---	---	---	1	---	2	0.4
19	1	---	---	---	---	---	---	---	---	---	---	---	1	0.2
20	---	1	---	---	---	---	---	---	---	---	---	---	1	0.2
24	---	---	---	---	---	1	---	---	---	---	---	---	1	0.2
Plot total	2518	1543	326	2	120	2975	2145	4082	404	156	6027	11391	31679	
Total per acre	503.6	308.6	65.2	0.4	24	595	429	816.4	80.8	31.2	1205.4	2278.1		6335.8

¹Largely cherrybark oak. ²Winged elm most common; also persimmon and dogwood were abundant.

and recorded. These situations covered a range of competition in regard to the pine in question from apparently hopeless conditions to ones where the pine was definitely in the clear.

For each situation, the following were recorded: (1) height of the pine, (2) direction and (3) distance to its competitors, (4) species, (5) stump diameter of the hardwoods cut, (6) number of sprouts per clump and (7) height of competitors (of the tallest member, in the case of sprout clumps). For the most part, trees shorter than the pine in question and those over six feet away were considered to be offering it little competition.

At the end of the 1955 growing season, few hardwoods over six feet away from the pines in question seemed to be in competition with them. Since competitive conditions have changed with time, in the 1959-60 winter an enlarged situation was measured and recorded where it seemed necessary in order to carry the study on for a few more years.

The seven conditions recorded at each competitive situation may all affect the

survival and growth of the pines in question — as, indeed, may many conditions not considered. Brief mention should be made of those conditions which are not included in the material which follows. **Direction** from the pine in question to a possible competitor may affect the pine but it is not apparent from a cursory analysis of the data. Between the time of cutting in the summer of 1952 and the time this study was installed at the end of the 1955 growing season, so many of the little stumps had rotted and disappeared that **stump diameter** as a factor in determining sprout size yielded no useful information. **Number of sprouts per clump** may have a considerable effect on some competitive situations, but consideration of numbers per clump increases the complexity of the problem out of all reason.

Attention is directed now to the growth rates and patterns of various elements of the competitive situations. In Table 2, the unequal number of trees taken by species in the shortest and tallest groupings results in nearly equal percent-

Table 2. Growth patterns of planted loblolly pines and of hardwood sprouts.

	Mean ht. in ft. at end of 3 yrs.	Mean annual ht. growth in ft. during 1st 3 yrs.	Mean ht. in ft. end of 7 yrs.	Mean annual ht. growth in ft. during last 4 yrs.	Growth per- sistence in % $\frac{\text{Col. 1}}{\text{Col. 2}} \times 100$
	(1)	(2)	(3)	(4)	(5)
20 shortest ¹ loblolly pines	2.9	0.98	8.3	1.34	137.85
All (139) loblolly pines	5.0	1.68	15.3	2.56	152.41
20 tallest loblolly pines	7.2	2.39	20.7	3.38	141.35
12 shortest sweetgums	4.6	1.54	7.5	0.73	47.30
All (82) sweetgums	6.9	2.30	13.2	1.57	68.37
11 tallest sweetgums	12.9	4.29	20.3	1.85	43.20
11 shortest red oaks	3.7	1.24	8.0	1.06	85.06
All (89) red oaks	7.0	2.33	13.8	1.71	73.67
12 tallest red oaks	11.3	3.76	20.3	2.24	59.50
20 shortest hickories	3.2	1.08	7.8	1.14	105.58
All (144) hickories	5.5	1.83	12.0	1.62	88.73
19 tallest hickories	8.2	2.72	16.4	2.07	75.96
65 winged elms	5.9	1.97	9.5	0.88	44.71
69 dogwoods	6.4	2.14	11.9	1.38	64.48
42 post oaks	6.9	2.31	12.1	1.29	55.57
20 ashes	6.4	2.13	11.1	1.17	55.01
19 blackgums	5.6	1.88	9.7	1.01	53.97
23 red maples	6.9	2.31	13.5	1.25	54.07
17 white oaks	7.1	2.35	14.0	1.74	74.08

¹In each case of shortest and tallest groupings, reference is to heights in 1955.

ages of the total number of trees in each species; they range from 12.4% to 14.4%. In the case of the shortest and tallest pines, the data are for the 20 shortest and 20 tallest in 1955 for which the competitive situation has not changed through death or deformation of competing hardwoods.

The data in Column 1 of Table 2 show that the mean height of loblolly pines was less in 1955 than the mean heights of all species of hardwoods reported. One cannot conclude from these data that during the first three years hardwoods grow more rapidly than pines. Many small hardwoods were not recorded as being competitive because they were considerably smaller than the pines. Column 5, Growth Persistence, shows whether the annual growth rate is accelerating or declining. The data indicate that the average planted pines which are at a slight height disadvantage in relation to hardwood sprouts after three years in the field will overcome that disadvantage by the seventh year in the field. The data confirm what might be expected: taller trees continue to grow more rapidly in height than do shorter trees. Growth in height is more persistent for loblolly pines than it is for hardwood sprouts. For the three most abundant hardwoods, ranking in persistence of height growth is

from most to least persistent hickory, red oak, sweetgum. (see Table 3). The growth patterns for the more abundant species are depicted in Figure 1.

Table 4 presents the expected fact that there are more hardwoods which are taller than short pines than there are those taller than tall pines while Table 2 shows that, presumably as a result of this condition, the tall pines continue to grow more rapidly than the short pines. Table 4 shows, further, that of the total competition as defined, about the pines a higher percentage is closer to short pines than is the case with tall pines (columns 5 and 9).

Column 10 in Table 4 shows that the number of hardwood competitors at a certain distance from the tall pines is a small percentage of the number at the same distance from the short pines up to distances 5 feet from the pines. This is reasonable and to be expected. At 5½ feet an unreasonable situation prevails—there are more taller hardwoods (more competition) about the tall pines than about the short ones. At 6 feet competition is equal. Since this is contrary to reason, we may fairly conclude that taller hardwoods at 5½ feet and more distance do not offer pines much competition under these conditions. This conclusion is strengthened by the observation that in column 9 over 50% of the competition, as defined, is within 5 feet of the pines and in column 5 within 3 feet.

Column 11 may be interpreted as follows: at 2 feet and closer, there is only 3.57% as much hardwood competition taller than the tallest pines as there is hardwood competition taller than the shortest pines; at 2½ feet and closer, there is 6.15% as much; at 3 feet and closer, 7.14%; etc. Column 11 fortifies the conclusion that, with the shortest pines, there is a higher percentage of the total competition close in to the pine.

A table was developed similar to Table

Table 3. Ranking of all pines and hardwood from most to least in amount and persistence of height growth.

Mean annual ht. growth during last 4 years	Growth persistence
Loblolly pine	Loblolly pine
White oak*	Hickory
Red oak	White oak*
Hickory	Red oak
Sweetgum	Sweetgum
Dogwood	Dogwood
Post oak	Post oak
Red maple*	Ash*
Ash*	Red maple*
Blackgum*	Blackgum*
Winged elm	Winged elm

*Small samples—17 to 23 trees.

4 for all trees at least one foot taller than the pines, another for all at least one and one-half feet taller, etc. As these compilations add little to the picture, they are not presented here.

Table 5 shows what could already be deduced — that the pines which were larger after three growing seasons in the field have outstripped competitors at the end of seven growing seasons to a far greater extent than have the less favored pines.

Recommendations

On the basis of the data presented here,

the following recommendations are made for cleaning planted loblolly pines at ages of about three to eight years in the field.

(1) No hardwood taller than the pine should be left within two feet of the pine.

(2) Not more than two hardwoods taller than the pine should be left within five feet of the pine.

(3) No hardwood more than three feet taller than the pine should be left within five feet of the pine.

Table 4. Trees which were taller than the pines at the end of the 1955 growing season and which are at the indicated distance from the pines.

For the 20 pines shortest in 1955 ¹					For the 20 pines tallest in 1955 ¹					
Dist. from pine	No. for all pines	No. per pine	Accum. no. per pine	Accum. % of total	No. for all pines	No. per pine	Accum. no. per pine	Accum. % of total	$\frac{(7)}{(3)} \times 100$	$\frac{(8)}{(4)} \times 100$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	5	0.25	0.25	3.10	---	---	---	---	---	---
1	15	0.75	1.00	12.42	---	---	---	---	---	---
1½	10	0.50	1.50	18.63	---	---	---	---	---	---
2	26	1.30	2.80	34.78	2	0.10	0.10	5.56	7.69	3.57
2½	9	0.45	3.25	40.37	2	0.10	0.20	11.11	22.22	6.15
3	19	0.95	4.20	52.17	2	0.10	0.30	16.67	10.53	7.14
3½	14	0.70	4.90	60.09	3	0.15	0.45	25.00	21.43	9.18
4	26	1.30	6.20	77.02	4	0.20	0.65	36.11	15.38	10.48
4½	12	0.60	6.80	84.47	4	0.20	0.85	47.22	33.33	12.50
5	13	0.65	7.45	92.55	2	0.10	0.95	52.78	15.38	12.75
5½	1	0.05	7.50	93.17	8	0.40	1.35	75.00	800.00	18.00
6	8	0.40	7.90	98.14	8	0.40	1.75	97.22	100.00	22.15
6	3	0.15	8.05	100.00	1	0.05	1.80	100.00	33.33	22.36
Total	161	8.05	---	---	36	1.80	---	---	---	---

¹Basis for selection: These are the shortest (or tallest) in 1955 of those in situations where the situation has not been altered through death of competitors or through a change in a competitor through being broken or pinned down by falling, girdled hardwoods. Where some but not all of a 1955 pine height class (one-half foot height classes) had to be taken to get 20 situations, the situations were arranged in numerical order and taken in that order.

Table 5. Change in numbers of competitors with time.

Ht. of pines in 1955	No. of pines	No. of Hard- woods per pine taller than pine	No. pine living in 1959	No. of hardwoods per pine taller than pine in 1959
1½	2	12.0	1	8.0
2	10	6.3	7	5.0
2½	2	6.5	2	6.5
3	11	8.2	11	6.7
3½	8	7.2	7	5.7
4	13	5.7	13	2.7
4½	18	6.6	17	2.9
5	22	4.8	22	1.6
5½	17	4.1	17	1.2
6	16	2.6	15	0.6
6½	10	2.1	10	0.4
7	15	1.9	14	0.4
7½	0	0	0	0
8	2	0.5	2	0
8½	1	3.0	1	0
9	3	1.7	3	0
Total or average	150	4.9	142	2.8