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# SHORTLEAF PINE SEED PRODUCTION IN THE PIEDMONT[1]

Shortleaf pine occupies millions of acres of commercial forest land in the Southeastern United States and is one of the preferred pine species throughout much of its range. Natural regeneration of this species after harvest, however, is a major problem for forest managers. Adequate seed production is the first requirement of successful natural regeneration, and annual records are needed to provide information on the frequency and adequacy of seed crops--seed crops which, it must be remembered, take about 26 months to develop.

For the past 10 years annual seedfall of shortleaf pine has been sampled in the Piedmont. Two stands were sampled at each of the following locations: Morganton, N. C.; Clemson, S. C.; Union, S. C.; and Athens, Ga. Beginning in 1959 and continuing through 1963 (5 years), two additional stands were sampled at Buckingham, Va. All these shortleaf stands might be termed typical of the Piedmont, but they differed widely in their individual characteristics. Average diameter of the stands varied from 5.8 to 11.8 inches; average age from 37 to 80 years; average height from 52 to 86 feet; site index from 47 to 76; basal area of shortleaf pine per acre from 67 to 144 square feet; and the average number of trees per acre from 144 to 644.

Ten $\frac{1}{4}$-milacre seed traps were randomly placed in each stand and the trapped seed was collected weekly from October 15 to December 31 and then biweekly from January 1 to March 15. Soundness of the seed was determined by cutting tests.

Ten-year records of the seed production of the original eight stands and 5-year records of the Virginia stands are listed in table 1. Haney (1962) estimates that 100,000 sound seed per acre are required for adequate stocking of shortleaf pine seedlings on a scarified seedbed. On this basis, and excepting Virginia, 3 of the years, 1955, 1957, and 1961, could be considered adequate seed years in most of the sampled areas. In 1956 there was a widespread seed crop failure, apparently caused by heavy frost in the spring of 1955 (Haney 1957). The other years were of intermediate seed production, with large differences observed between the geographic locations.

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[1] The Department of Forestry of Clemson University cooperated at Clemson, S. C., and Duke Power Company cooperated at Morganton, N. C.

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Table 1.--Sound seed per acre produced by 10 shortleaf pine stands over a 10-year period

| Location of stand | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Thousand seed | | | | | | | | | |
| 1 Morganton, N. C. | 46.0 | 185.6 | 2.0 | 218.8 | 40.8 | 13.2 | 21.2 | 163.6 | -- | 30.4 |
| 2 Morganton, N. C. | 48.0 | 181.6 | 5.2 | 260.8 | 22.0 | 16.4 | 11.2 | 160.4 | -- | 9.2 |
| 3 Clemson, S. C. | 7.2 | 228.4 | 1.2 | 490.4 | 9.6 | 0.8 | 6.8 | 64.8 | 23.2 | 2.4 |
| 4 Clemson, S. C. | 1.2 | 63.2 | 0.4 | 351.6 | 1.6 | 0.4 | 4.0 | 9.6 | 15.6 | 2.0 |
| 5 Athens, Ga. | 33.2 | 154.4 | 0 | 1143.2 | 316.0 | 11.2 | 23.2 | 120.8 | 130.4 | 1.2 |
| 6 Athens, Ga. | 20.0 | 103.6 | 0 | 1060.8 | 236.8 | 7.6 | 41.2 | 166.4 | 53.6 | 4.4 |
| 7 Union, S. C. | 3.2 | 31.6 | 1.2 | 343.9 | 2.6 | 7.4 | 0.4 | 164.0 | 31.2 | 0 |
| 8 Union, S. C. | 0.5 | 22.6 | 0 | 233.3 | 4.2 | 24.8 | 0.4 | 174.4 | 66.8 | (1) |
| 9 Buckingham, Va. | -- | -- | -- | -- | -- | 6.0 | 22.4 | 20.4 | 4.0 | 86.4 |
| 10 Buckingham, Va. | -- | -- | -- | -- | -- | 6.4 | 24.4 | 19.2 | 8.0 | 34.8 |

[1] Stand destroyed by insects.

Buckingham, Va., in the northern portion of the shortleaf pine range, has not had a good seed crop during the 5-year measurement period, whereas at Athens, Ga., the most southerly location sampled, one stand has had good seed crops 50 percent of the time and the other 40 percent of the time over a 10-year period.

The possible relation of seed production to latitude was tested by linear regression analysis. Average annual sound seed production per acre was negatively correlated to the degrees of north latitude, which accounted for 51 percent of variation (fig. 1).

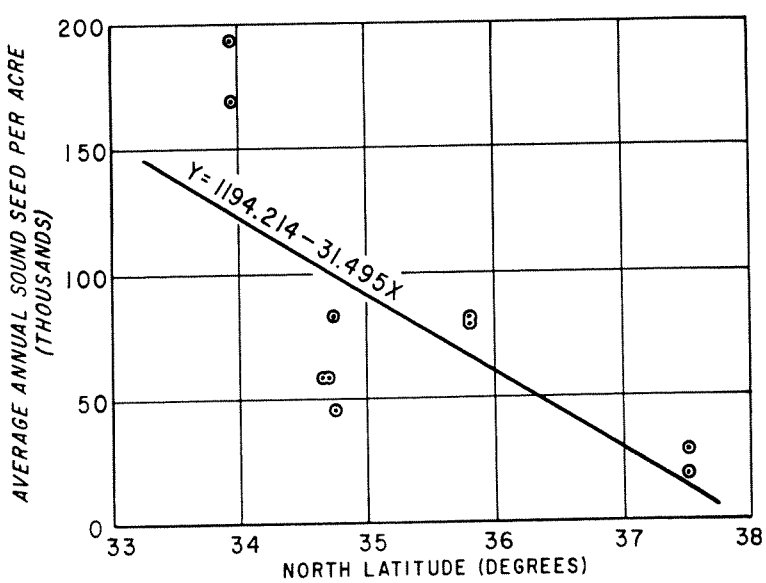


Figure 1.--The relationship of the degrees of north latitude to the average annual sound shortleaf pine seed produced per acre.

The study was originally designed to compare the influence of individual stand characteristics on seed production per acre. However, none of the stand characteristics measured, including average diameter, age, basal area, site index, or the number of trees per acre, was significantly correlated with sound seed production per acre.

The percent of total sound seed is an indication of the percentage of seed capable of germinating when the environmental conditions are favorable. The percentage of sound seed varied from 6 to 100, and the average for all stands during the 10-year period was 46 percent. The best seed years, 1955, 1957, and 1961, also had the highest proportion of sound seed, with an average of 57 percent for the 3 years, as compared to an average of 41 for the other 7 years.

Seedfall usually began the last week in October and continued through the middle of March. Sixty-two percent of the seedfall occurred by November 30, and 89 percent by December 31. This is typical of the seasonal pattern of southern pine seedfall distribution and points to the fact that seedbed preparation should be completed before November 1.

## SUMMARY AND CONCLUSIONS

The 10-year records of annual shortleaf pine seedfall throughout the southeastern Piedmont have shown that 3 good seed years occurred. In the Georgia Piedmont, seed crops were more frequent than in the northern portions. Reasons for the observed differences between geographical areas are not clear, but it is evident that both local and regional factors may influence seed production. A localized seed crop occurred in 1958 when Athens, Ga., had a good seed year but all of the other areas reported poor seed crops. Good seed years occurred throughout most of the area in 1955, 1957, and 1961, and also in East Texas for two of these years, 1955 and 1957 (Stephenson 1963). These data support the theory that climate as well as the physical soil-site environment influence seed production of trees. It is extremely difficult, however, to define how weather affects seed production. Development from flower initiation to mature seed spans a period of about 26 months in southern pines. At any time of the year 2, and in late summer 3, seed crops at different stages of development are present on the tree. The same weather may help one stage and hurt the other. Destructive agents, by reducing a good flower crop to a poor seed crop can obscure the weather effects. An experimental approach is needed, whereby all factors that affect seed production are studied one by one, before a clear picture of seed production can emerge.

Individual stand characteristics were not significantly correlated with average annual sound seed production during the 10-year period. It is possible, however, that more intensive sampling within a given geographic location would reveal a greater influence of site and stand characteristics on shortleaf pine seed production.

The percentage of sound seed is reported to be highest in years of high seed production (Lotti 1956; Pomeroy and Korstian 1949), as was also observed in this study. The 57 percent sound seed for the 3 best seed years compares closely to the 61 percent sound seed reported for seed crops in Texas (Stephenson 1963). The 10-year average of 46 percent sound seed is somewhat better than the 5-year average of 33 percent sound seed reported for shortleaf pine in Kentucky (Allen 1963).

The frequency of shortleaf pine seed crops is only the starting point in investigations aimed at a better understanding of natural regeneration. Further studies of climatic factors, destructive agents, pollen production, fertilization, and embryo development will undoubtedly prove important.

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