gen, daß Konkurrenzeffekte eine entscheidende Ursache für das Aufrechterhalten der Heterozygotie in Pflanzenbeständen sein können.

Auf diese Zusammenhänge wird unter allgemeineren Voraussetzungen (Dominanz, beliebige Umwelteinflüsse) in einer folgenden Arbeit ausführlich eingegangen werden (TAG 1972, in Vorbereitung).


### Summary

Title of the paper: Studies on competition between *various* genotypes in plant *stands.* V. Phenotypic selection *and* competition.

Based on a simple linear model of competition (no dominance, no environmental variance except competitive effects) and under phenotypic selection (with constant selection intensity) in each generation the existence of equilibrium points $\Delta p = 0$ is shown. The relation of these results to the gain of phenotypic selection as well as the importance of these equilibria points in explaining the maintenance of allelic polymorphisms in plant populations is pointed out and discussed.


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# Cultivating and Fertiiizing Stimulate Precocious Flowering in Loblolly Pines


By RONALD C. SCHMIDTLING


Any practical technique for stimulating early flowering of seedlings would be valuable in tree-improvement programs. The study described here tested the effects of cultivation and fertilization on early flowering of loblolly pine (Pinus taeda L.) in a plantation established on the Harrison Experimental Forest in southern Mississippi in 1960.

### Materials and Methods

The study area, about 20 miles north of the Gulf of Mexico, had been stocked with second-growth longleaf pines before it was clearcut in 1958—59. Slope is less than 5 percent on the gently rolling land. The soils are upland fine sandy loams in the Bowie and Shubuta agricultural series and are low in nitrogen, phosphorus, and potassium. Soil samples taken at depths of 4 to 6 inches averaged 0.027 percent N, 2.23 ppm $P_2O_5$, and 0.043 meq K/100 g of soil.

The plantation consisted of twenty 200-tree plots, each surrounded by two rows of border trees. The spacing was 10 ft by 10 ft. Five treatments were each replicated four times in a randomized block design.

The treatments were:

- Check, no cultivation or fertilizer
- Cultivation but no fertilizer
- Cultivation and a single application of 100 lb N (as ammonium nitrate), 50 lb $P_2O_5$ (as superphosphate), and 50 lb $K_2O$ (as muriate of potash) per acre
- Cultivation and a single application of 200 lb N, 100 lb $P_2O_5$, and 100 lb $K_2O$ per acre
- Cultivation and a single application of 400 lb N, 200 lb $P_2O_5$, and 200 lb $K_2O$ per acre.

The fertilizer was applied in May of the second year in the field; cultivating was done three or four times a year for the first 3 years. Seedlings that died soon after planting were replaced.

Trees were examined to determine the numbers of male flowers and cones after 1, 2, 3, and 4 years in the field; cones after 5, 6, and 9 years; and female flowers after 1, 2, 3, 4, and 7 years. Survival after 9 years in the field was uniformly high, varying only from 94.5 to 97.8 percent within treatments. The results of individual treatments, therefore, are based on the reactions of at least 756 trees. Differences due to treatment were statistically analyzed at the 0.05 level.

### Results and Discussion

Male flowering. — One tree bore male flowers 3 years after planting; it had been cultivated and fertilized. The next year, 67 trees had male flowers. None were on control plots, and all but one were on fertilized plots (Figure 1).

GIERTYCH and FORWARD (1966) found that fertilizing with nitrogen caused a shift from male flowering to female flowering in a study involving 20 mature P. resinosa Ait. SWEET and WILL (1965) associated a deficiency in nitrogen with an increase in male flowering of rooted cuttings from several reproductively mature P. radiata D. DON. VAN BUIJTENEN (1966) found that fertilization decreased male flowering of P. taeda, and BARNES and BENGTSON (1968) found no effect on flowering of P. elliottii ENGELM.

These studies differed from the present study in that they measured flowering in mature trees or in vegetatively propagated material from mature trees. The material of the present study was juvenile, and no flowering had occurred before the study was initiated. Fertilization may decrease male flowering in mature loblolly pines, but it also promotes precocious flowering.

Female flowering. — After 3 years in the field, 12 trees bore female flowers; all were on fertilized plots. The effects of treatment were also apparent in subsequent years. Cultivation alone doubled the number of trees flowering in both the fourth and seventh years after planting (Figure


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Grateful acknowledgment is made to the late Dr. LLOYD F. SMITH, who provided some of the data.

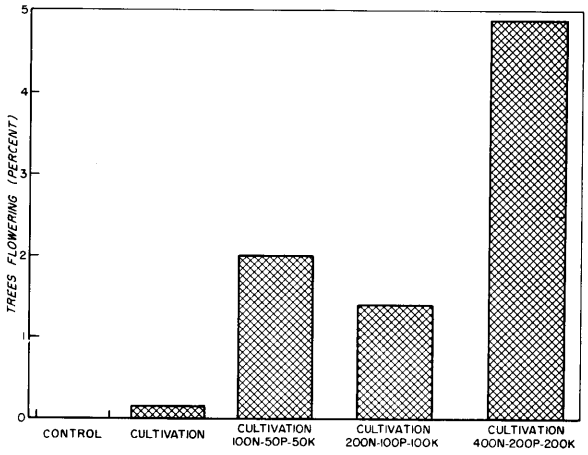


*Figure 1.* — Male flowering in loblolly pines, by treatment, 4 years after planting.

2). Fertilization in combination with cultivation had even greater impact.

In spite of the large differences between fertilized and unfertilized plots, varying the amount of fertilizer did not affect the number of trees flowering per plot. There was a statistically significant effect on the number of cones produced per cone-bearing tree, however (*Figure 3*).

Several recent reports have shown that fertilization has a positive effect on female flower and cone production in mature pines or clonal propagules from mature trees (Van Buijtenen 1966, Giertych and Forward 1966, Shoulders 1967, Barnes and Bengtson 1968). If we assume that there is a difference between the induction of precocious flowering and the induction of flowering in mature trees, the apparent conflict between the data in *Figures 2 and 3* is resolved. The lowest level of fertilization was enough to induce precocious flowering. This effect very closely paralleled growth rates in the plantation (Smith and Schmidtling, in press). Increasing the amount of fertilizer increased the cone production of those trees which were flowering (*Figure 3*).

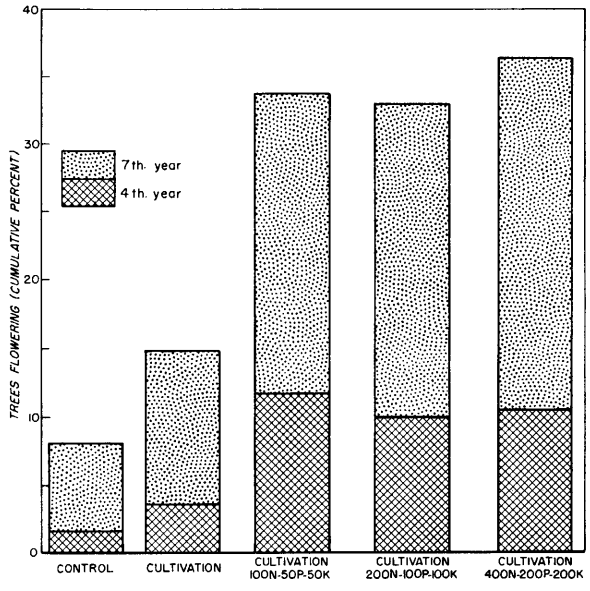


*Figure 2.* — Female flowering in loblolly pines, by treatment, 4 and 7 years after planting.

## Summary

Fertilization and cultivation substantially increased the likelihood of both male and female flowering by 4- to 7-year-old *Pinus taeda* L. Applying more than 100 lb/acre of N, 50 lb of $P_2O_5$, and 50 lb of $K_2O$ did not increase the likelihood of flowering, but it did increase the number of cones produced on those trees which were flowering.

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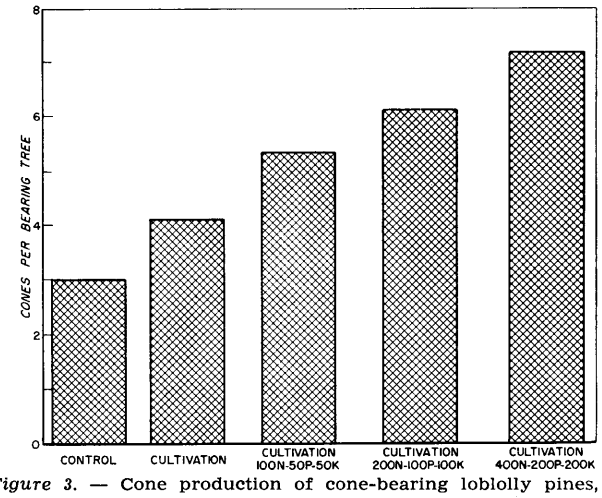


*Figure 3.* — Cone production of cone-bearing loblolly pines, by treatment, 9 years after planting.