COLD HARDINESS IN INTRA-SPECIFIC HYBRIDS OF TULIP POPLAR

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INTRODUCTION

The large range of most forest tree species has provided, inter alia, opportunity for considerable racial differentiation. One generality often encountered in relation to environmental differences is that southern races are faster growing but less cold hardy than northern races. Another is that local seed sources are usually best adapted to their particular environment regime. Thus a fundamental problem presented to the forest geneticist is to determine the validity of such generalities; i.e. to determine the effectiveness of natural selection in bringing a population to full ecological optimum. It is in this relationship that classical seed source studies have their greatest potential and have served to guide the movement of genotypes to areas of maximum productivity. Although complete information concerning genetic variation is lacking for most tree species, present evidence suggests that local populations are not always at adaptive peaks and that the suitable selection of non-local seed sources can sometimes provide significant genetic improvement. Nevertheless, the useful genetic gain obtainable by seed source selection may be less than the total species potential for a given region. it is at this point that intra-specific hybridization becomes desirable as one means of providing additional genetic variation.

The study herein reported presents preliminary data from a continuing investigation of intra-specific hybridization in tulip poplar (*Liriodendron tulipifera* L.). A fundamental question in the study is the inheritance of cold-hardiness, particularly in crosses involving northern and southern populations. The natural range of tulip poplar extends from central New York (Lat. 43 N), south to southern Louisiana and Mississippi, and into northern Florida (Lat. 30° N); thus providing experimental material with a large north-south differentiation. In addition to providing interesting material for a study of cold hardiness, tulip poplar is a species with a well-known commercial value (e.g. McCarthy, 1933; Auten 1937 a, b; Holcomb and Bickford, 1952; Holsoe, 1950; and Querengasser, 1961). Previous studies of geographic variation have been reported by Vaartaja (1961) and by Limstrom and Finn (1956). Breeding techniques have been developed by Taft (1962) and were discussed in a previous report by Stairs and Wilcox (1966).

MATERIAL AND METHODS

Two populations were chosen from the extreme north and south parts of the species range. Three male trees were selected from a natural stand in Mississippi for crossing to each of three female trees growing in a natural stand in central New York. Seed obtained from the nine experimental crosses will be referred to as hybrid seed. At the time of hybrid-seed collection, open-pollinated seed was collected from the Mississippi and New York trees to serve as population controls. The seed was then sown in a 3:1:1 mixture of sand, soil, and peat moss for germination studies. After completion of the germination studies the seedlings were transplanted into nursery beds at the New York College of Forestry Experimental Station. Observations on cold damage were made each June following two successive winter exposures. Seedlings evaluated as undamaged in the previous fall were scored as either damaged or killed by cold during the subsequent winter.

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RESULTS AND DISCUSSION

The cold-hardiness of the hybrid seedlings as compared to parent populations is shown in table 1. At the completion of one winter in the field an average of 84 percent of the Mississippi seedlings were killed. Following the second winter the surviving Mississippi seedlings showed severe winter damage, but none were killed. Growth from the less than 16 percent surviving was limited to the lower buds and sprouting. Among the New York seedlings only a slight amount of cold damage was observed and no death was attributed to cold effects at the end of one winter. At the completion of the second winter no additional cold-injury was recorded. Cold damage among the hybrid seedlings ranged from a high of 71.4 percent for one cross (NY X M 2) to a low of 5.3 percent (NY 2 X M 1) for another. A trend for greater cold-sensitivity appeared to develop in crosses utilizing M 2 as the male parent, although this was greatly accentuated by the high amount of injury in the cross NY 3 X M 2. The relatively few individuals in that particular cross render it unreliable as an indicator, and its deletion would leave an average of 14.3 percent cold-damage following the first winter and 9.6 percent after the second winter for the hybrid population. None of the hybrid seedlings were killed by cold injury during the first two winters.

Table 1.--Seedlings damaged or killed by cold*

Population	Total no. trees (1966)	Percent damaged 1966	Percent damaged 1967	Percent killed 1966
New York				
N Y (O.P.) #1	14	12.5	0.0	0.0
N Y (O.P.) #2	2	0.0	0.0	0.0
N Y (O.P.) #3	19	0.0	0.0	0.0
Hybrid				
N Y 1 x M 1	155	5.7	8.9	0.0
N Y 2 x M 1	113	5.3	12.7	0.0
N Y 3 x M 1	49	12.2	13.7	0.0
N Y 1 x M 2	67	17.9	8.3	0.0
N Y 2 x M 2	111	34.2	8.6	0.0
N Y 3 x M 2	7	71.4	0.0	0.0
N Y 1 x M 3	124	14.5	5.9	0.0
N Y 2 x M 3	90	10.1	8.9	0.0
N Y 3 x M 3	(Cross failed to yield viable seed)			
Mississippi				
M (O.P.) #1	43	11.7	100.0	83.7
M (O.P.) #2	7	14.3	100.0	71.4
M (O.P.) #3	24	4.2	100.0	95.8

* N Y = New York trees; M = Mississippi trees; O.P. = open pollinated seedlings. Results on the two dates are based on the number of living seedlings during the previous fall. No additional seedlings were killed during the 1967 winter.

The unequal frequencies in each seedling-group limit direct comparison. Nevertheless, it is clear that a substantial difference in cold-hardiness exists between the New York and Mississippi populations. This observation is hardly unexpected; however, the relative cold-hardiness of the hybrid seedlings is encouraging. Early height growth of the hybrid seedlings following transplanting to the nursery were superior to the New York open-pollinated trees. If the superior vegetative vigor of the hybrid population continues, cold-hardiness may be the most significant factor in making use of the growth rate potential of southern genotypes. It is important to note that the species in central New York is at its northern limit in terms of commercial range and the use of intra-specific hybridization may have greater usefulness at more southerly locations.

In summary three points may be noted: (1) the superior growth rate of the hybrid population should be considered as preliminary data only, a similar report of between stand crosses showing superior vigor has been made between tulip poplar stands growing only a few miles apart (Carpenter and Guard, 1950); (2) the apparent cold hardiness of the hybrid population will not be completely confirmed until several years after field planting; and (3) present evidence is encouraging and adds emphasis to the need for cooperative intra-species hybridization studies in this and other forest tree species.

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