Heterosis in the flowering precocity of Eucalyptus hybrids

By C. S. VENKATESH and V. K. SHARMA

Forest Genetics branch, Forest Research Institute,
Dehra Dun, India

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Introduction

Precocious flowering, whether natural or induced, confers a definite advantage in forest tree breeding if such reproductive precocity does not adversely affect timber and wood production of forest trees. Such early flowering helps shorten the normally long breeding cycles of trees, a major drawback of forest genetics research. Especially in fast growing, quick yielding and short rotation forest trees such as eucalypts in the tropics and birch (LEPISTO, 1973) in temperate countries, precocious flowering can lead to rapid improvements through accelerated breeding. Described here is the heterotic effect and certain other correlations that we observed in regard to earliness of flowering of certain artificial F_1 hybrids of Eucalyptus tereticornis SM. and E. camaldulensis DEHN. two widely introduced species of this large predominantly Australian genus.

Material

During the monsoon rains in July-August, 1972, an experimental field trial consisting of three replicated rows had been planted at Dehra Dun using year old F_1 hybrids of a one-way controlled interspecific cross E. tereticornis X E. camaldulensis (FRI-4-1970) as the test material and open pollinated progenies of the two parental trees as the controls. The present observations are based on this material.

Observations

The hybrids expressed heterosis in growth rate at about two years of age, during 1973, when they surpassed the better camaldulensis parent, in both height and diameter growth, the two major parameters of stem volume yield of forest trees. Hence they are of potential commercial importance.

Only stray flowering was noticed in the hybrid and the tereticornis progenies during 1974. However, by May 1975, at about 4 years of age, more than one third of the F_1 hybrids, lecs than one sixth of the tereticornis but none of the camaldulensis progenies initiated their first flush of flowers as indicated in Table 1.

Table 1. — Data on first flowering in 1975

Identity of progeny	No. of trees scored	% of trees initiating fl. buds May	June	Total % initiating fl. buds in May & June	Heterosis % over Mid-parent	Better parent
Tereticornis	35	14.28	31.42	45.70	—	—
F_1 Hybrid	35	34.28	14.28	48.56	25.71	2.86
Camaldulensis	35	00.00	00.00	00.00	—	—

From a eomparison of the figures in Table 1 it will be evident that of the parental species, E. tereticornis is precocious flowering but not *E.* camaldulensis. As for the hybrid, it surpassed the mid-parent by 25.71% and the better parent by 2.86% in the total number of progenies that first flowered during May and June of 1975, and by an even wider margin in May of the same year. There is clear evidence therefore, of heterosis in the hybrid both as regards preeocity of first flowering as well as in the earliness of flower bud initiation within the same season. Whether such heterotic effect will subsequently express itself in various other features of reproduction, remains to be seen and studied in due course.

Further, within the hybrid population as well as in that of the tereticornis parental progenies, there was indication of a positive association between average height and diameter on the one hand and earliness of flowering on the other. In other words, the taller and thicker stemmed individual generally tended to be precocious in comparison with the relatively shorter and thinner stemmed individuals within the same population. This is a fortunate situation because it implies that the use of such precocious flowering habit for the aecelerated breeding of these eucalypts will not impair their vegetative growth and thus their wood volume production as would have been the case if flowering precocity and vegetative development had been negatively correlated with each other as is true in some species of Pinus and Betula.

Discussion

Precocious flowering can be used as a very important tool in forest tree breeding work. According to HEIMBURGER (1962) precocious types often appear after interspecific hybridization indicating combined action of complementary genes influencing age at first flowering. This apparently seems to be the case in the present instance where the heterotic F_1 interspecific hybrids of Eucalyptus excelled their parents in their readiness to flower as they in fact did in regard to their vegetative growth i.e. in height and diameter increment.

The early onset of flowering maturity reported in this article is being currently taken advantage of in advancing to the F_2 hybrid and backcross generations. From the immediate practical aspect also such precocious flowering is an advantage as it will facilitate quick mass production of seed of improved varieties of eucalypts for commercial planting of man made forests in tropical and subtropical countries. It may be recalled in this connection that, as in Douglas fir, in eucalypts also (NEL, 1965), delayed scion-stock incompatibility necessitates the establishment of seedling seed orchards (ELDRIDGE, 1971) in preference to the grafted clonal type generally used for other forest trees.

In this context then, flowering precocity acquires added importance in eucalypts.

Summary

Heterotic effect in regard to flowering precocity is reported in a controlled *Eucalyptus tereticornis* × *E. camaldulensis* cross. The implications of such precocious flowering in eucalypt improvement by selective breeding and hybridization is indicated.

Key words: Eucalyptus hybrids, Early flowering.

Zusammenfassung

Bei F_1 Hybriden aus der Kreuzung von *Eucalyptus tereticornis* Sm. mit *E. camaldulensis* Dehn. waren im Alter von 4 Jahren mehr blühende Individuen festzustellen als bei gleichaltrigen Individuen der reinen Elternarten, d. h *E. camaldulensis* blühte bis dahin überhaupt noch nicht. Die Eigenschaft des Frühblühens wird dem Hybridcharakter zugeschrieben.

Literature Cited

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Inbreeding in Neighboring Trees in Two White Spruce Populations

By J. F. Coles and D. P. Fowler[1])

Department of the Environment
Canadian Forestry Service
Maritimes Forest Research Centre
P.O. Box 4000, Fredericton, New Brunswick, Canada

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Introduction

White spruce [*Picea glauca* (Moench) Voss] has a transcontinental distribution, is one of the most important conifers in Canada, and is a genetically variable species (Nienstaedt and Teich, 1971). These factors combine to make it an excellent candidate for tree improvement work (Carlisle and Teich, 1970).

A temporal or spatial relationship among individuals in a population permits interbreeding and gene exchange between these individuals and therefore they may resemble each other more than they resemble members of different populations (Stebbins, 1949). Intuitively, there must be a tendency for close neighbors to mate, and proximity in time or space increases the probability that these neighbors will be related. If the trees growing near one another are related, then crossing these related individuals will result in inbreeding. In most naturally outbreeding plants, inbreeding reduces the mean phenotypic value shown by characters such as seed set, germination percent, and vigor. Franklin (1970) summarized much of the literature on inbreeding, particularly selfing, and the resulting reduction in seed yield, seed germination, survival, and early growth of seedlings for many Pinaceae species.

The amount of inbreeding in natural stands is determined largely by the distance and rate at which genes migrate within or between populations. As conifer seeds are seldom distributed more than 200 m (Fowells, 1965), pollen movement must account for most gene migration. If gene flow is extensive as a result of considerable long-distance pollen movement, natural inbreeding will be limited. If, however, effective pollen flow is limited, and gene exchange between neighboring trees is common, a significant amount of natural inbreeding may occur.

The genetic structure of natural populations has only recently received attention. The family group structure of trees has not been well documented although such relationships are generally accepted (Bannister, 1965; Koski, 1973; Sorensen, 1973; Ledig, 1974; Tigerstedt, 1974). Studies in Japan in natural forests of both *Cryptomeria japonica* and *Thujopsis dolabrata* have indicated relatedness of trees within groups (Sakai *et al.* 1970; Sakai and Miyazoki, 1972). Loblolly pines (*Pinus taeda* L.) growing within 100 m of each other in a small stand are probably related since the progenies from controlled crosses had depressed survival, green weight, and three-year height (Snyder, E. B., USDA Forest Service, Southern Forest Experiment Station, Gulfport, Miss., pers. comm. 1973). However, Tigerstedt (1973) found no gene clustering for trees in either of two stands of Norway spruce (*Picea abies* (L.) Karst.) in Finland. Spatial mapping of enzyme alleles in these populations indicated complete randomness of gene distribution.

The objective of this study was to determine the relationship among white spruce trees in groups within stands and to obtain estimates of the amount of inbreeding occurring under natural conditions.

Materials and Methods

Study Areas

Two central New Brunswick white spruce stands, separated by approximately 32 km, were chosen at study areas. One is a natural upland stand of mixed conifers at the Acadia Forest Experiment Station (AFES) and the other is a pure stand which has colonized abandoned farmland in the Tay River Valley (Tay). Based solely on an adequate number of male and female strobili, 17 trees at AFES and 9 at Tay were chosen for controlled pollination studies.

[1]) The authors are respectively, Forest Officer and Research Scientist, Canadian Forestry Service, Fredericton, New Brunswick. This paper is based on a thesis submitted in partial fulfillment of the requirements for the degree MS in Forestry, University of New Brunswick.