

occurring, high sca cross. In this study, all 17 tested parents displayed equal sca variance (Table 5). If this holds for other populations of loblolly pine, it would not be possible to increase the probability of producing good specific combinations by favoring one parent over another.

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Atypical Seedlings of *Populus L.*: Their Genetic Significance and Value in Breeding

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Summary

The incidence of abnormal, albino and chlorophyll-deficient seedlings, pleiocotyly and polyembryony is reported in *Populus L.* With the exception of chlorophyll-deficient seedlings, this may be the first record of these occurrences in this genus. The possible use and significance of these atypical phenomena in *Populus* breeding are briefly discussed.

Key words: *Populus L.*, controlled crosses, progenies, genetics, breeding, unusual seedlings.

Zusammenfassung

Es wird über das Vorkommen von abnormalen, albino und chlorophyll-defizienten Sämlingen, Pleiokotylye und Polyembryonie bei *Populus L.* berichtet. Mit Ausnahme der chlorophyll-defizienten Sämlinge, könnte dies der erste Bericht über solche Vorkommen in dieser Gattung sein. Der mögliche Gebrauch dieser atypischen Formen in der Pappezüchtung wird kurz diskutiert.

Introduction

Seedling morphology has been widely used in applied genetics and plant breeding to permit early screening and selection from large populations within a limited space (HASKELL 1961). The genetic significance and value of unusual seedlings for early screening in *Eucalyptus* breeding

was discussed by VENKATESH and SHARMA (1974). The unusual *Populus L.* seedlings which are described in this report were observed when hybrid seed was germinated. Their possible genetic significance and value in breeding are also discussed.

Hybrid seed resulted from a series of intra- and inter-specific crosses of *Populus deltoides* MARSH., *Populus nigra* L. and *Populus maximowiczii* HENRY made in 1982 and repeated in 1983. The seeds were germinated in Petri dishes on sterilized silica sand in the laboratory in both years. Seedlings were then transplanted into polystyrene Leach tubes (super cell containers of 164 cm³, Ray Leach Container Nursery, Canby, Oregon, U.S.A.) filled with Pro-mix (a mixture of 60% peat moss, 20% perlite and 20% vermiculite). The seedlings were grown in a greenhouse for about three months in both years. The surviving seedlings were then moved into a shade house for over wintering.

The different atypical seedlings recovered from the progenies of various crosses were broadly classified into four types, namely (1) abnormal seedlings, (2) albinos and chlorophyll-deficient seedlings, (3) pleiocotylyous seedlings, and (4) twins.

Observations

Abnormal Seedlings

These were characterized by malformation or total atrophy of root or hypocotyl. The frequency range of ab-

normal seedlings was from 1.9% to 8.4% in different families. The rootless type lacked a primary root. The hypocotyl-less type lacked hypocotyl but had well-developed cotyledons and roots. In one instance, a hypocotyl-less seedling with one cotyledon, and in another instance a hypocotyl-less seedling with three cotyledons, were also observed. None of these abnormal seedlings survived. Analysis showed no significant differences in the occurrence of abnormal seedlings which could be attributed to mother trees (*P. deltoides*) and pollinators (*P. deltoides*, *P. maximowiczii*, and *P. nigra*).

These seedlings resemble abnormalities induced by irradiation (KEDHARNATH 1972) which are also lethal. Presumably, at least some of them represent deleterious and lethal natural mutations of long standing that have survived in the population in the heterozygous condition concealed as recessives. Crossing between two such heterozygous carriers might have brought these natural mutations into homozygous condition. It is also possible, especially in interspecific hybrids, that the abnormal seedlings resulted from deleterious alleles for which there was no corresponding allele in one of the parent species.

Albinos

Six albino seedlings were observed totally lacking in chlorophyll. They died within two to five days of germination, when the cotyledonary food reserve was presumably exhausted. All the albino seedlings appeared only in the progenies of one female clone (*P. deltoides*), when crossed with three male clones (*P. deltoides* Cl. D476, D477 and *P. nigra* Cl. N166) out of 35 successful controlled crosses.

One chlorophyll-deficient seedling was also detected. This was pale yellow in colour, unlike the total albinos described above, and survived for seven days after germination.

Albinos and chlorophyll-deficient seedlings have been reported in conifers (SQUILLACE and KRAUS 1963; VENKATESH and THAPLIYAL 1977; MITTON *et al.* 1981) and in a few broad-leaf species (MCKAY 1954; MOFFETT 1956; VENKATESH and EMMANUEL 1976; VENKATESH *et al.* 1978; RAJORA and RAWAT 1982). LESTER (1960) reported chlorophyll-deficient seedlings in *Populus tremuloides* MICHX. when seeds from hermaphrodite catkins were germinated. However, this is the first report of true albino seedlings in the genus *Populus*.

Pleiocotylous Seedlings

Seedlings with one cotyledon (monocotylous), three cotyledons (tricotylous) and a seedling with four cotyledons (tetracotylous) were observed. The monocotylous seedlings were observed in the interspecific *P. deltoides* × *P. maximowiczii* cross. The tricotylous seedlings were observed also in the intraspecific *P. deltoides* cross. No pleiocotylous seedling appeared in the *P. deltoides* × *P. nigra* crosses. This gives an indication that the paternal clones of latter species may not be carrying the genes for pleiocotyly.

The tricotylous seedlings produced their first leaves in a whorl of three leaves, and not in alternate pairs as is usual for *Populus* seedlings. They then tended to change from the whorled to the normal alternate arrangement. The leaves which developed in the first whorl were equal in size and alternated with three cotyledons. The tricotylous seedlings were almost of the same height but had more branches and thicker stems than dicotyledonous seedlings and were also harder in winter.

The monocotylous seedlings had a much larger cotyledon than any of the cotyledons of dicotyledonous seedlings. The cotyledon of monocotylous seedlings had two fused apical

lobes of equal size. This suggests that they must have originated by the fusion of two cotyledons which is a case of syncotyly. The first leaves of monocotylous seedlings were unequal in size and appeared in the usual alternate pairs. They grew more slowly than dicotyledonous and tricotylous seedlings.

The only tetracotylous seedling observed had cotyledons of unequal size which were not uniformly placed in a whorl. From the size and placement of cotyledons, it appears that they were formed by the splitting of usual cotyledonary rudiments. The seedling grew more slowly than the usual seedlings and immediately bifurcated; one fork being less vigorous than the other.

The phenomenon of pleiocotyly has been recorded in the literature (review by HASKELL 1954). Monocotyly has been studied in great detail in horticultural and agricultural crops. The condition found was an inherited one (e.g. in *Mimulus* (BROZEK 1926), in *Brassica* (HOLTORP (1944), among others). In forest tree species, VENKATESH and SHARMA (1974) found tricotily an inherited condition in *Eucalyptus*. Our interpretation of the phenomenon as an inherited character in *Populus* is based on the same criteria. It is hard to determine at this stage the nature of its inheritance. According to STRAUB (1948) and HASKELL (1949, 1954, 1961), pleiocotyly is polygenically controlled.

Selection for pleiocotyly, as an early criterion of tree growth, has a large potential in breeding. GRIFFITH (1953) found that tetracotylous and tricotylous seedlings of *Cupressus lusitanica* MILL. showed significantly greater one-year heights than dicotyledonous seedlings. Recently, VENKATESH and SHARMA (1974) found tricotylous *Eucalyptus* seedlings more vigorous than dicotylous seedlings.

Twin Seedling

One pair of twin seedling was observed in pollen-mix cross *P. deltoides* × (*P. maximowiczii* + *P. nigra*). They were independent twins and one seedling of this pair was weaker than its mate. The two, however, were free and unattached to each other.

These seedlings must have formed from twin embryos in the seed. It is likely that they resulted from polyembryony which, to date, has not been recorded in the *Salicaceae* family. Twin seedlings are known in many genera (MUNTZING 1937, 1938) and have been used on several occasions as indicators of diverse types of chromosome numbers, including haploids, various polyploids and aneuploids. In the pair of twins observed, one of the seedlings tended to be poorer in growth than its partner. Generally, with twins showing differences in seedling vigour, most of the weaker seedlings (about 75%) of the twin pair have chromosome numbers deviating from the normal (HASKELL 1961). If the observed twin turns out to be a haploid-diploid pair, then the haploid seedling sporophyte (STETTLER 1966; STETTLER and BAWA 1971) could be of great value because by inducing chromosome doubling, a diploid homozygous plant could be produced at one step.

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Detailed information on the frequencies of atypical seedlings in various crosses and on statistical analysis is available upon request from the authors.

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Short Note: Morphological Variation in Chestnut Fruits (*Castanea sativa* Mill.) in Tuscany (Italy)

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Abstract

Based on the analysis of eight fruit traits a three year variation study was performed on twenty trees from seven chestnut stands (*Castanea sativa* MILL.) in Tuscany (Italy).

A hierarchical univariate analysis of variance (within each year) showed that localities account for little of the total variation for all considered traits. Most of the variability appeared to be due to within tree differences. Differences between years (probably due to differences in weather) were also significant. In spite of the large within tree variability statistically significant classification of the material in cultivars has been obtained using discriminant analysis. This seems to validate gene conservation efforts aimed to maintaining these cultivars. No answer emerged as to the origin of the cultivars.

Key words: *Castanea*; Morphological variation, Multivariate analysis.

Zusammenfassung

In sieben Edelkastanien-Beständen (*Castanea sativa* MILL.) der Toskana (Italien) wurde über drei Jahre hinweg eine Variations-Studie durchgeführt, die auf der Analyse von 8 Frucht-Merkmalen beruhte. Eine in jedem Jahr durchgeführte univariate hierarchische Varianzanalyse zeigte, daß für die Gesamtvariation der beobachteten Merkmale die Standorte nur wenig verantwortlich sind. Der größte Teil der Variabilität war auf die Unterschiede innerhalb der Einzelbäume zurückzuführen. Die Analyse zeigt signifi-

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kante Unterschiede zwischen den Jahren, vermutlich in Abhängigkeit von den unterschiedlichen klimatischen Bedingungen. Trotz der großen Variabilität innerhalb der Einzelbäume wurde durch die Diskriminanzanalyse eine statistisch bedeutsame Klassifizierung des Untersuchungsmaterials in Kultivare erreicht. Diese Ergebnisse unterstreichen den Wert von Gen-Erhaltungsmaßnahmen zur Erhaltung dieser Kultivare. Eine Antwort über die Abstammung der Kultivare wird nicht gegeben.

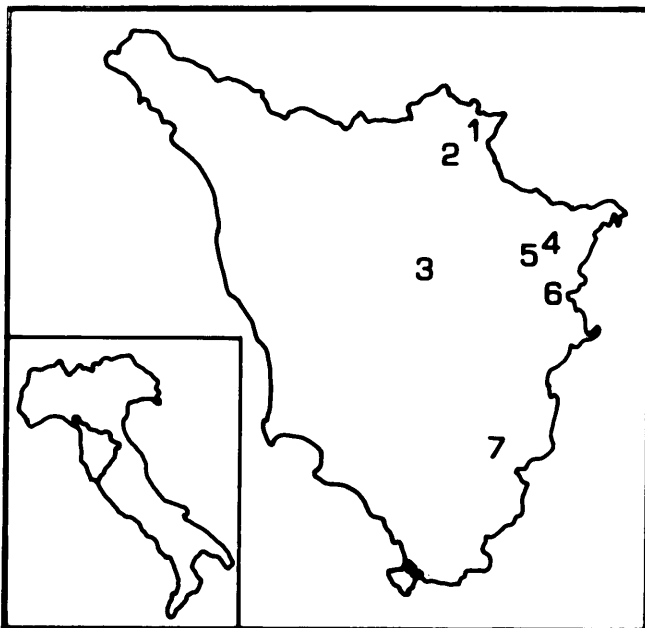


Figure 1. — Geographic location of considered chestnut stands. See Table 1 for locality identification.