FAST GROWING TREES

DISTRIBUIÇÃO, VARIAÇÃO E USOS DOS RECURSOS GENÉTICOS DE ARAUCÁRIAS NO SUL DO BRASIL

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Resumo

Araucária angustifolia (Bert.) O. Ktze é a única espécie do seu gênero que ocorre no Brasil, sendo as maiores populações concentradas no estado do Sul e a grandes altitudes onde predominam temperaturas baixas e chuvas abundantes e bem distribuídas.

Reservas naturais tem sido drasticamente reduzidas pela derrubada de árvores há mais de 1 século, tanto para exploração de madeira como p/ uso da terra para agricultura.

Estudos genéticos tem revelado um padrão discontinuo de variação através da area natural de distribuição. As raças geográficas mais promissoras em termos de crescimento em regiões específicos, tem sido identificados através de testes de procedência. Os mais recentes esforços para preservar o valor genético das araucarias esta sendo tentado através da formação de populações base de procedência as quais conterão de variabilidade genetica original representativa de cada raça geográfica.

DISTRIBUTION, VARIATION AND USES OF ARAUCARIA GENE RESOURCES IN SOUTHERN BRAZIL

Summary

Araucaria angustifolia (Bert.) O.Ktze is the only species of its genus to occur in Brazil. The major populations are concentrated in the southern States, on the highlands where cool temperatures and abundant and well distributed rainfall predominate.

Natural stands have been drasticaly reduced in extension due to continuous fellings for over a century for timber exploration as well as to make room for agricultural crops.

Genecological studies have revealed a discontinuous pattern of variation through the natural distribution range. Geographic races of most promissing growth for specific regions have been identified through a number of provenance tests.

The most recent effort to preserve the valuable genetic resources is aimed at the formation of provenance base populations, which will hopefully contain the original genetic variability, representative of each geographic race.

Introduction

Known by other names such as "pinheiro brasileiro" (Brazilian pine), "pinheiro-do-paraná" (Paraná pine)or just araucaria, Araucaria angustifolia (Bert.) O. Ktze is the only Araucaria species to occur in Brazil. It has played an extremely important role in the country's economy. Straight trees with almost cylindric boles, reaching 30 to 50 m in height and 2 m in diameter at breast height were commonplace in the Southern States.

The species provides high quality timber for general construction, frame work, furniture, veneer, pulp and many other uses.

Araucaria wood in form of sawn timber and veneer was, for a long period, one of the most important items of Brazilian exportation.

The original araucaria forests covered an estimated area of 200 000 km^2 (GOLFARI, 1971) of which, part is in the province of Misiones in Argentina. The major formations are in the States of Paraná and Santa Catarina, where intensive logging continues to present days. Extensive areas of natural araucaria forests were turned into endless fields of coffee, wheat, soya beans and other crops, as a result of the timber exploration and the expansion of agriculture. Thus, many of its valuable geographyc races are believed to be extermined.

The need to preserve this valuable gene resource has led many Brazilian forest research institutions into a joint pro - gramme on gene conservation.

Natural Distribution

Araucaria angustifolia occurs naturally through the southern and southeastern Brazil, extending from the latitudes of 19°30'S to 31°30'S and longitudes of 41°30'W to 54°30'W, including also part of the province of Misiones in Argentina (GOLFARI, 1971). The species thrives on deep fertile soils within the climatic types classified, according to the Köppen's system, as "Cfa" and "Cfb"(humid sub-tropical without dry season and mild to hot summer).

Such climatic types are predominant through the southern highlands where araucaria forests are concentrated. Within the given range of latitudes, these types of climate are found from lower altitudes in the south and progressing to higher altitudes to the north. Following a similar pattern, natural stands of araucaria are found as a general rule, from 500 m above sea level in the south to over 2000 m as the populations extend northward to the States of São Paulo, Rio de Janeiro and Minas Gerais. Exceptions to these altitudinal limits are also found, especially in the south, where the species occurs at altitudes of about 300 m in São Martinho and Tenente Portela (MATTOS,1972) and as low as 250 m (PITCHER, 1975) and 198 m (GURGEL FILHO & PISANI, 1975) in Lauro Müller, near the coast of Santa Catarina. As mentioned by MAACK (1968), A. angustifolia extends to altitudes lower than 500 m only where cool air flows from the highlands towards the valleys.

Normal mean temperatures in the araucaria region are 20 to 21°C in the Summer and 10 to 11°C in the Winter (OLIVEIRA,1948).

Not only cool to mild temperatures but also plenty of rainfall through the year is required by the species. Annual rainfall figures ranging from 1270 to 2494 mm (GOLFARI, 1971)are usual but not less than 1000 mm (HUECK, 1972). A.angustifolia is intolerant to water deficit and this is the main reason for its restriction to altitudes above 800 m in the northern section of its distribution range (GOLFARI, 1971), where they occur in small spots scattered along the more humid portions of the mountain ranges.

The distribution pattern of A. angustifolia is well illustrated by HUECK (1972)(Fig. 1). The extensive forests, concentrated on the southern highlands, are frequently interrupted by spots of natural grasslands. As explained by KLEIN (1960), they are remnants of a vegetation type which predominated during a dryer period, previous to the formation of araucaria forests.

Variation

Although not very noticeable at first sight, A. angustifolia

presents some morphological variation which might be, to some extent, associated to the environmental conditions. Trees growing on high and cold flatlands in Santa Catarina, on shallow lithosol near São Joaquim, were reported by GOLFARI (1971) as being larger in diameter and disproportionately shorter (around 10 m in height) than the trees on warmer sites with deeper soil, where they reach over 30 m in height.

The size of the seeds also varies remarkably. CASTRO (1959)

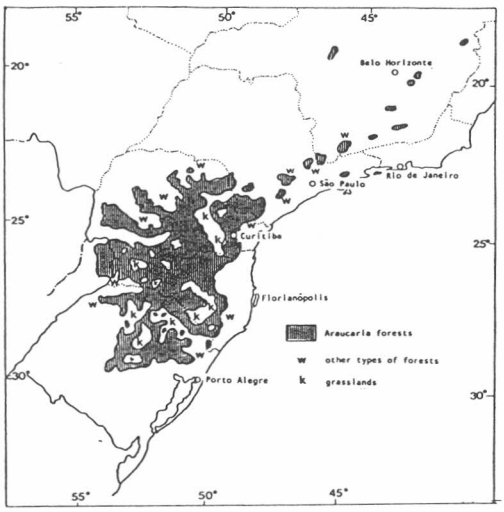

Fig. 1. Natural distribution areas of Araucaria angustifolia (from HUECK, 1972).

has shown that, seed size, when measured by its length, is associated to the altitude of its source between 500 and 1580 m. Smaller seeds were produced by stands from higher altitudes. On the other hand, the latitude of the seed source was shown by BANDEL (1966), to be more important than altitude to the variation of the seed weight. In his study, seed weight increased with increase in the latitude of the sources.

Other types of variation exist whose pattern of distribution or the association to specific environment is not yet clear. REITZ & KLEIN (1966) described them as 9 varieties and one form of the species as follow:

a) A. angustifolia var. elegans (Hort.) Reitz & Klein.
(Branches slender and numerous; needles smaller and closely inserted).

b) A. angustifolia var. sancti josephi Reitz & Klein.
(Kernels ripe in February and March)

c) A. angustifolia var. caiova Reitz & Klein.
(Kernels ripe in June and July)

d) A. angustifolia var. Indehiscens Mattos.
(Kernels smaller, ripe from September to January but do not fall by themselves off the cone).

e) A. angustifolia var. angustifolia
(Kernels red, ripe in April and May)

f) A. angustifolia var. nigra Reitz & Klein
(Kernels dark-red almost black before drying)

g) A. angustifolia var. striata Reitz & Klein
(Kernels red with darker longitudinal stripes)

h) A. angustifolia var. semi-alba Reitz & Klein
(Kernels with white tip before drying)

i) A. angustifolia var. alba Reitz & Klein
(Kernels white or yellowish before drying)

j) A. angustifolia for. monoica
(Strobili male and female on the same tree)

Of all these variants, the type variety seems to be by far the most frequent. For practical purposes, A. angustifolia is expected to mature between March and May.

Several experiments for the study of the species racial variation have been established in Brazil and Argentina. A test planted in Santa Rita do Passa Quatro, SP, (GURGEL & GURGEL FILHO, 1973) showed remarkable differences between 3 widely distributed seed sources. At 12.5 years of age, volume production of Capão Bonito provenance was 49% and 68% greater than Campos do Jordão and Lages provenances respectively. In a larger experiment involving 23 provenances planted in Tres Barras, SC (GURGEL & GURGEL FILHO, 1968), better growth was obtained with seeds from São Paulo and southern Minas Gerais than from Paraná, Santa Catarina and Rio Grande do Sul. Campos do Jordão provenance produced larger number of branches and was more susceptible to frost, while Irati provenance showed a peculiar yellowish-green needles.

Growth differences among provenances have been quite discontinuous through the sampled area. Correlations of this character with the environmental factors at the seed sources have not been consistent. Growth was significantly correlated with longitude and annual mean temperature but not with annual rainfall, altitude or latitude, in a test planted in Puerto Libertad, Argentina (FAHLER & DI LUCCA, 1979), while in southern São Paulo, Brazil (SHIMIZU & HIGA, 1979), only the latitude at seed source was correlated to height growth up to six years of age. This experiment showed further that growth differences among provenances and the correlation of height growth with latitude of seed source tend to decrease with age.

Only in some cases (BALDANZI et al., 1973; FAHLER & DI LUCCA, 1979) have the local provenances performed as well as the best in the group; in others (GURGEL & GURGEL FILHO, 1968; SHIMIZU & HIGA, 1979; MONTEIRO & SPELTZ, 1979) they have not shown outstanding growth. Thus, the optimality of the local race for early growth can not be generalized for the species.

Negative correlations between altitude at seed source and growth at 3.5 years (KAGEYAMA & JACOB, 1979) and at 2 years of age (SHIMIZU & HIGA, 1979) were statistically significant. However, it is likely to reflect mostly the effect of seed size on early growth; low altitude sources having larger seeds (CASTRO, 1959), would grow more than those from higher altitudes. The effect of seed size on the growth rate of A. angustifolia was shown by GLASER & OLIVEIRA (1972). Seeds larger than 6 cm in lenght resulted in plants growing 18% more than those derived from seeds smaller than 3.9 cm in length and 16% more than those derived from the mixture of all sized seeds, at the fourth year after planting.

Uses of Araucaria angustifolia Gene Resources

Araucaria forests have been the main source of high quality timber for construction, frame work, furniture, veneer, pulp and other uses.

Sawn timber and veneer have been exported to several countries for a long period; at times they were rated second only to coffee in exported value.

The araucaria reserves in the State of São Paulo were exhausted in the period between 1930 and 1940 (KRUG, 1964). As estimated by MAACK (1968), 7.4 million hectars of natural araucaria forest existed in the State of Paranã, of which only 34% was left by 1950 and 28% by 1960. The remnants in the State were further reduced to 433 580 ha (MACHADO, 1975) in 1967 and 316 620 ha (FUPEF/IBDF, 1978) in 1977, the latter being only 4.3% of the original area.

Araucaria timber production in all States increased from 1.5 million cubic metres in 1945 to 3.3 million in 1950. From that year to 1966, the output was steady around 2.8 million cubic metres a year. Then until 1972, it decreased to an annual

output of 1.8 million cubic metres (PARANÁ, 1976).

Reforestation with araucaria was done at first by a few companies as well as by the federal government. Close to 90 000 ha had been planted by 1979, according to the estimates from several sources.

A. angustifolia is not considered a fast growth species in Brazil. Volume increments in mature natural stands were estimated to a maximum of 2.11 m^3/ha/year (MUNIZ, 1966), while in planted stands, it varied greatly depending on the site quality. Inside bark volume increment in planted stands varied from 2.56 m^3/ha/year in the poorest sites to 14.48 in the best sites in a survey by HOOGH (1978). The same variable compared in different sites by SPELTZ (1973) revealed growth increment varying from 1.1 m^3/ha/year on grassland area to 10.8 m^3/ha/year on forest soil.

Due to such growth behaviour, plantation rates declined sharply in the last years to not more than 300 ha a year, giving place to the introduced Pinus elliottii, P. taeda and Eucalyptus which are less site demanding and have higher growth rates.

Population Improvement

As investments in reforestation with A. angustifolia has become less attractive due to its slower growth rate as compared to Pinus and Eucalyptus species, efforts for population genetic improvement of the species have been insipient.

A few planted or natural stands have been maintained for seed production areas by the Brazilian Institute for Forestry Development (IBDF) and some companies as well.

Further experiments for the study of provenance and progeny variations are under way, in connection to the formation of genetic base populations for improvement work, under the coordination of the Brazilian Working Group on Forest Tree Improvement. These will hopefully lead to a more precise mapping of the seed zones, if important differences among provenances are maintained through the rotation age. Also other important facts on population structure and patterns of variation at different levels may be known.

Seed collections from natural stands have been organized through joint effort by the main forest research institutions in the araucaria region.

Seed procurement, their sources and storage problems

Procurement of araucaria seed has become harder in the last years, due to continuous fellings of mature, seed bearing natural stands. Moreover, bumper seed crops occur at times only in limited areas. Much of the seed fallen off the trees are eaten by wild and domestic animals and people as well.

Large scale production of planting stock has, therefore, frequently depended on supplies from distant natural stands.

Seed supply from a bumper crop to be sown in the following years has not been feasible due to storage problems. Seed viability declines sharply from 100% to almost 0% in 3 to 4 months if adequate storage facility were not available. By keeping the seeds in plastic bags at low temperatures (0 to 5°C), viability was maintained between 70 and 90% after 4 month storage (PRANGE, 1964).

Vegetative propagation

Several methods of vegetative propagation have been tried with A. angustifolia. Neither air-layering nor rooting of hormon treated cuttings, tried by BANDEL (1966), did lead to any promissing result. Certainly, a number of factors must be taken into account and carefully controlled.. Rooting sucesses of 25 to 26% was reported by TESDORFF (1969) with cuttings taken from 12 year-old trees and treated with 0.5%, 1.0% and 2.0% solutions of indol-butyric-acid.

Among several grafting methods tested by GURGEL & GURGEL FILHO (1967), the best result (27%) was obtained with veneer side graft.

Similarly to the growth habit of other Araucaria species, grafting of lateral shoots of A. angustifolia results in plagiotropic growth and, if straight growth were desired, orthotropic shoots must be grafted.

The serious limitation of most grafting methods is the small number of orthotropic shoots that each tree usually produces.

The "patch graft" method, as described by NIKLES (1973), was applied sucesfully to A. angustifolia by KAGEYAMA & FERREIRA (1975). The main advantage of this method is that many buds can be obtained from each apical shoot and therefore, the number of grafts per tree can be greatly increased.

Constraints on Progress in Population Genetic Improvement

The main difficulties in promoting genetic improvement in this species arises when breeding is considered. The trees usually produce seed only after 15 or 20 years of age (BANDEL & GURGEL, 1967).

Controlled pollination work on the trees is almost impossible due to the height and large span of the crown. The reproductive organs are produced at the tips of the branches, in the midst of densely packed tufts of prickly needles.

Large amounts of seed is annually lost to cone and seed insects whose behaviour and control methods should be better understood.

Vegetative propagation techniques must be further studied and directed toward a more efficient method.

Very rarely has A. angustifolia been planted in large scale in recent years. Being a very site demanding species, it is rapiddly loosing ground to the introduced Pinus and Eucalyptus species which have higher growth rates. Extensive areas in the araucaria region have also been turned into endless fields of coffee, wheat, soya bean and other crops.

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