Table of Contents

WEST AUSTRALIAN NUTGROWING SOCIETY · YEARBOOK – 1 – 1975

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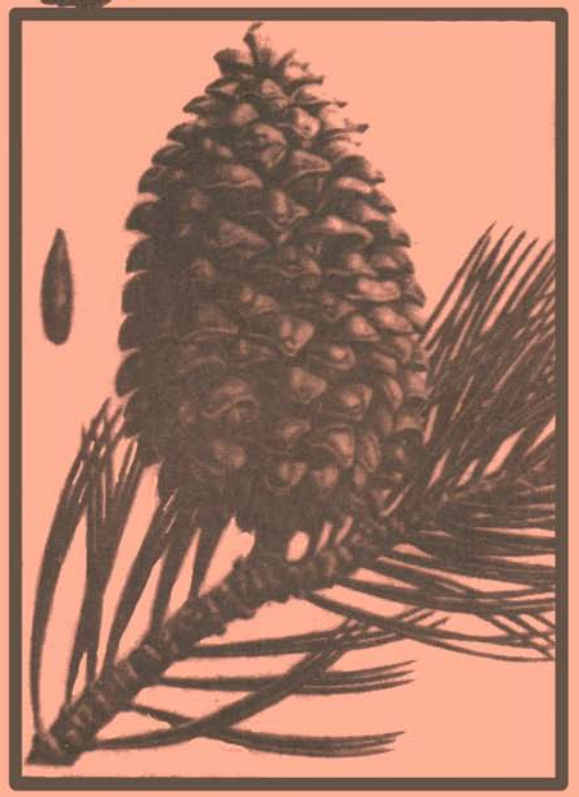

WEST AUSTRALIAN NUTGROWING SOCIETY

YEARBOOK

Vol. 1
1975

West Australian Nutgrowing Society

This Yearbook published 1976 by the West Australian Nutgrowing Society, P.O. Box 27, Subiaco, W.A. 6008, Australia.

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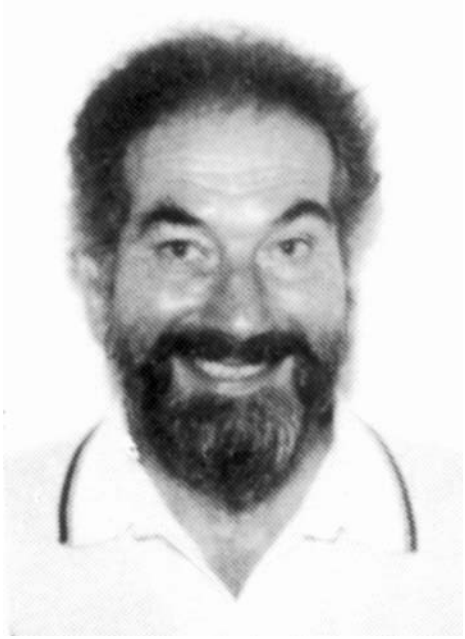
The Society publishes an informal regular newsletter, 'QUANDONG', and its annual YEARBOOK. Intending members may join at any time of the year, and receive all publications for the year of subscription. Membership is open to individuals, organizations, and nominated persons such as 'The Librarian' of an organization.

The current subscription rate is $5.00 per year.

Table of Contents

Editorial



David Noël,
Founder of the West Autralian Nutgrowing Society

The Editor is proud to present this, the first Yearbook to be issued by the West Australian Nutgrowing Society. Its appearance is a reflection of the growing strength of the Society, which itself reflects the increasing and widespread interest in the growing of nut crops.

One year ago, WANS consisted of a small band of 16 people who had each taken the trouble to reply to a tentative proposal mentioned in a local gardening magazine. In the year 1975 just completed, membership leapt to more than 10 times the original figure, and now we have members all over our own vast State, in every State of Australia, and even one in Canada.

This enormous response can leave no doubt that the formation of WANS is filling a long-felt need. Appreciation of the benefits of nut growing (including high-quality food production, beautification of garden and landscape, timber production, control of soil erosion, general ecological improvement, and the satisfaction of creating something for the future in one of the most fascinating areas of horticulture) is spreading through the land.

This development is especially appropriate for our State of Western Australia. W.A. has many special factors favouring the production of food from crop trees in general, and nut trees in particular. It is an enormous area (12 average American States could be packed within it), with climates ranging from cool temperature to tropical, from wet to extremely dry. It contains one of the few tropical areas forming part of a technologically-advanced Western-style nation. Its rainfall is markedly seasonal and it has extensive arid areas. While almost any type of nut plant can be grown somewhere within W.A., for many areas of the State a nut crop is the most favourable prospect of any type of agriculture activity.

Nut trees from the basis of what has been called ‘Permaculture’ or permanent agriculture, the creation of a permanent food-producing environment which avoids the need to strip off the entire plant cover of an area once or more each year. Trees can grow under low, irregular rainfall where no annual crop would be feasible, and where few animals could survive; it makes sense to choose trees which give an output of food or other useful product in such situations.

Of the 1000 or so nut-producing plants of the world, some 99% are hardly exploited or cultivated anywhere. While WANS will continue to promote the traditional and commercial nut crops, it will have a special interest in this unexploited 99%, which includes some amazing species of potentially world-wide importance but which are currently almost unknown. This issue of the Yearbook includes authoritative articles on the jojoba nut, from the deserts of Arizona and California; on the chilghoza pine nut, a native of the Himalayas, and on the pistachio nut, which originated in the arid areas of Central Asia. All have considerable potential in Western Australia.

The Jojoba Nut

PAUL H. THOMSON*

The Jojoba (pronounced HOHOBAH), *Simmondsia californica* Nuttall (synonym *S. chinensis* (Link) Schneider), is a plant of the *Buxaceae* or Boxwood family and is sometimes called the Desert Box. It is native to the Sonoran desert of southern California and southern Arizona in the United States, and in the northern 2/3 of the state of Sonora and throughout the length of Baja California in Mexico, stretching from latitude 34° in the northern portion of its range to 23° at the tip of the Baja California peninsula. It is not known to be found in the state of New Mexico. It is found on several of the larger islands in the Gulf of California. It grows from sea level in southern California and northern Baja California to an altitude of nearly 5,000 feet in southern Arizona. In California and Baja California it occurs in a Mediterranean climate of predominantly winter rainfall from November to March, while in Arizona and Sonora the rains are almost equally divided between winter and summer. Formerly abundant in the San Diego River valley, it is now becoming scarce due to urban sprawl in much of southwestern San Diego County.

Distribution of *Simmondsia chinensis* in the Southwestern United States and Northwestern Mexico. (Map supplied by the Office of Arid Lands Studies, University of Arizona).

* California Rare Fruit Growers, Star Route, Box P, Bonsall, California, 92003

This Desert Box is a very drought resistant plant and may be found growing in some areas of only 4 to 5 inches of annual rainfall where it may go for as long as two years with no rain at all. Under these conditions it is a small shrub, dying back to its main stems in periods of drought and sprouting vigorously when the rains return. It is at its best in areas of 14 to 18 inches of winter rainfall where it will attain a size of 15 feet and even 18 feet in the largest specimens, though these are very rare. It is a long lived plant with one specimen having 240 annual growth rings when cut just above ground level. The trunk on this old patriarch was over 6 inches in diameter. Smaller shrubs are often over 100 years of age but are seldom found with a single trunk.

The natural distribution varies from only a few plants to the acre to where it is the dominant vegetation with 150 to 200 plants per acre. It occurs in several different types of plant associations but is often conspicuously absent in areas that appear to be admirably suited. It is found growing in coastal sand where wind erosion has exposed as much as 10 feet of the root system, to river valleys where water erosion has exposed 3 or 4 feet of roots. It is rarely found on heavy clay soils but seems to prefer coarse gravelly alluvial fans where water is most often available. These broad valleys are colder than the surrounding slopes above them making the plant tolerant of rather low temperatures. Hardier mature individuals can stand a low of 15^0F in the northern portion of its range and at higher elevations while the southern forms, originating where temperatures seldom fall much below freezing, are much less cold resistant being severely injured or killed outright at 20 to 22^0F. These southern forms have proved to be unsuitable for planting in southern California where temperatures will drop to lows of 15° during the colder winters. Although these less hardy plants may have desirable characteristics that might be used in a breeding program, for general planting purposes seed sources should be selected from areas having low temperatures and even snow in some winters thus giving a margin of safety in the colder locations.

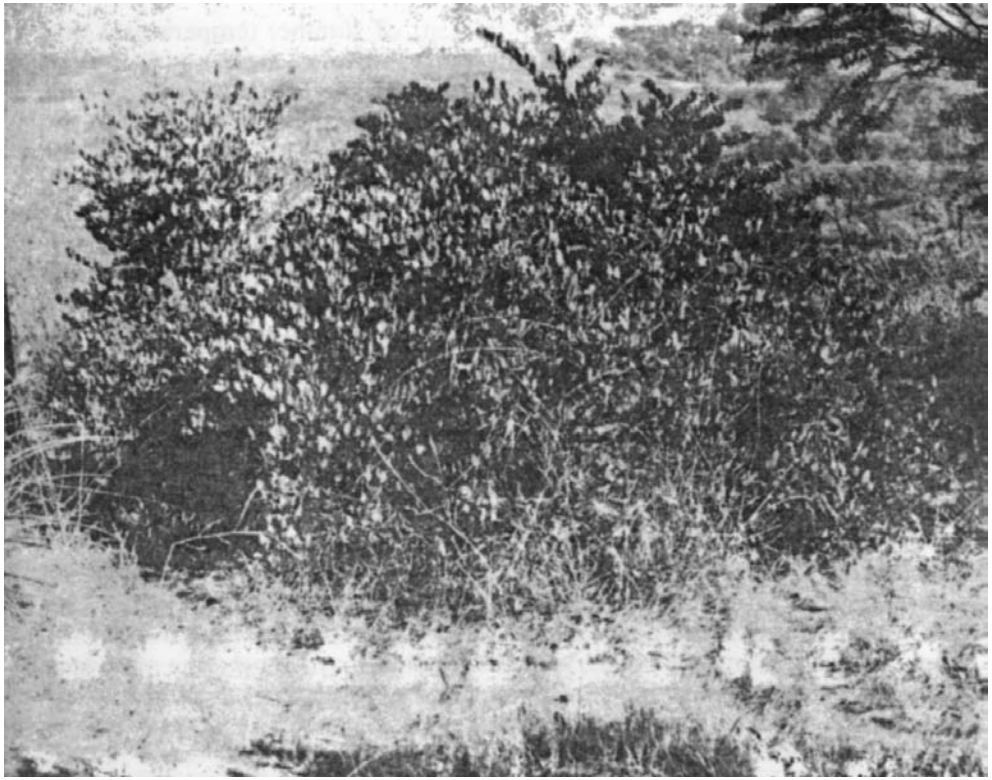
At the other extreme, Jojoba is very tolerant of summer temperatures that often reach 110 to 115°F throughout its range. Under these conditions of extreme summer drought it is capable of setting and maturing its crop of fruit which may ripen as early as the end of May at the tip of Baja California to the end of September, or even as late as the end of November in some years, at the northern portion of its range and at higher altitudes. Therefore seed setting and harvest time are dependent on the climatic variations for that particular year. Generally speaking earlier harvests occur during hot summers and later during cool years. In years when there is a heavy seed crop, ripening may extend for 2 or 3 months, but if a light crop, it is over in 3 weeks or a month. There is also considerable variation among plants as some ripen their crop all at once while others over an extended period. Selection should be made for early ripening and a short harvest season due to the high labour costs for harvesting the crop several times.

The Joboba is dioecious with male and female flowers found on separate plants. A very few monoecious plants have been observed, at least one of which has proved to be self fertile maturing seeds that when planted germinated normally, but this is a great rarity. Since the plant is wind pollinated males should be planted up wind from the females so the prevailing winds at pollen shedding time will carry the pollen to the females. The time of flowering varies with individuals and some females bear light crops because they do not bloom at the same time as the surrounding males, so it is advisable to propagate the male near a heavy bearing female to assure continuing good crops. However, pollen is carried a long way with female plants as far as 1/2 mile from the nearest male often maturing a few seeds thus making it difficult to determine which is the successful pollinator when several are present. In a planned planting the males should be so arranged as to have the pollen directly shed on the female plants or with no more than one intervening row.

Male flowers occur in small clusters of 1/4 to 3/4 inch in diameter and when dehiscing pollen are a yellowish colour. Female flowers are relatively inconspicuous being 1/16 to 1/8 inch wide and 1/4 to 3/8 inch long and of the same pale green colour as the new leaves and stem. Flowers form in the axil of the leaves and most often on new growth of the past season. In Arizona flowering is generally at alternate nodes while in California every node flowers. Plants are often found that show both styles of flowering with one or more limbs differing from the typical portion. Usually a single flower is found at each node, but some plants have a cluster or fascicle of flowers at the node, and even much more rarely a loose raceme of flowers. These types can carry potentially greater crops than single flowered types but unless sufficient moisture is available during the growing season most of the capsules will abort and only mature one or sometimes two.

Leaves vary in size and shape and some being somewhat oval while others are long and narrow. Length may vary from 3% to rarely 3 inches long and width from 3/8 to seldom 1% wide with a good average being 11/2 inches long and 5/8 to 3/4 inches wide. The leaves persist for about 3 years and continue to grow a little each year turning colour from the normal bluish-green to yellow-green to light brown as they age. Some bushes appear to be solid green while others, whose leaves have a glaucous tomentum on them, give a bluish appearance to the observer. When leaves are small and thin the plant usually has many leaves and short internodes; with large, thick, fleshy leaves they are fewer and the nodes farther apart.

The Jojoba is an intricately branched shrub or small tree, usually with several to many stems arising from near the base of the plant and giving it a round headed appearance. In

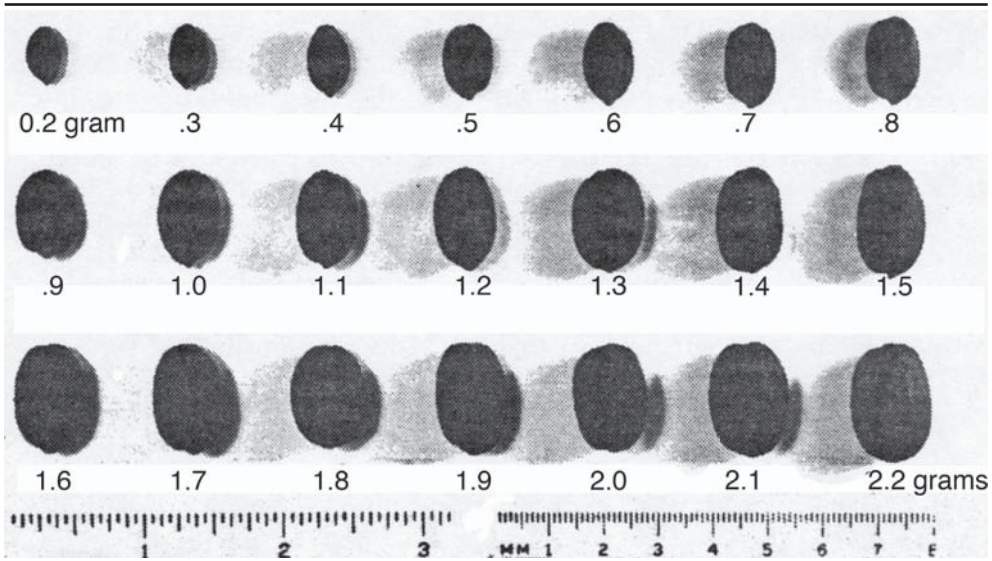


Eighteen-year-old bush about 5 feet high and an 8 foot spread. (Photo -Paul H. Thomson)

windy locations the shrub is almost prostrate; in dry locations it is often leafless part of the year and stunted in appearance. Some types will have 2 to 4 stems, while rarely bushes are found with a slender, upright form and a single stem. The bark on new growth is pale green or bluish-green, the same colour as the new growth of leaves. In the second year the bark is quite thin even on old stems. The wood is very brittle and smaller branches are easily broken with larger branches splitting or snapping off at their juncture with the main stem. The wood is hard, heavy, fine textured, close grained, without taste or odour and of a pale yellow to lemon yellow colour. When in contact with the ground it is not resistant to decay. It is occasionally used for firewood.

Close up showing dense structure of the bush. Group of severeal capsules are at top, just left of centre. (Photo - Paul H. Thomson)

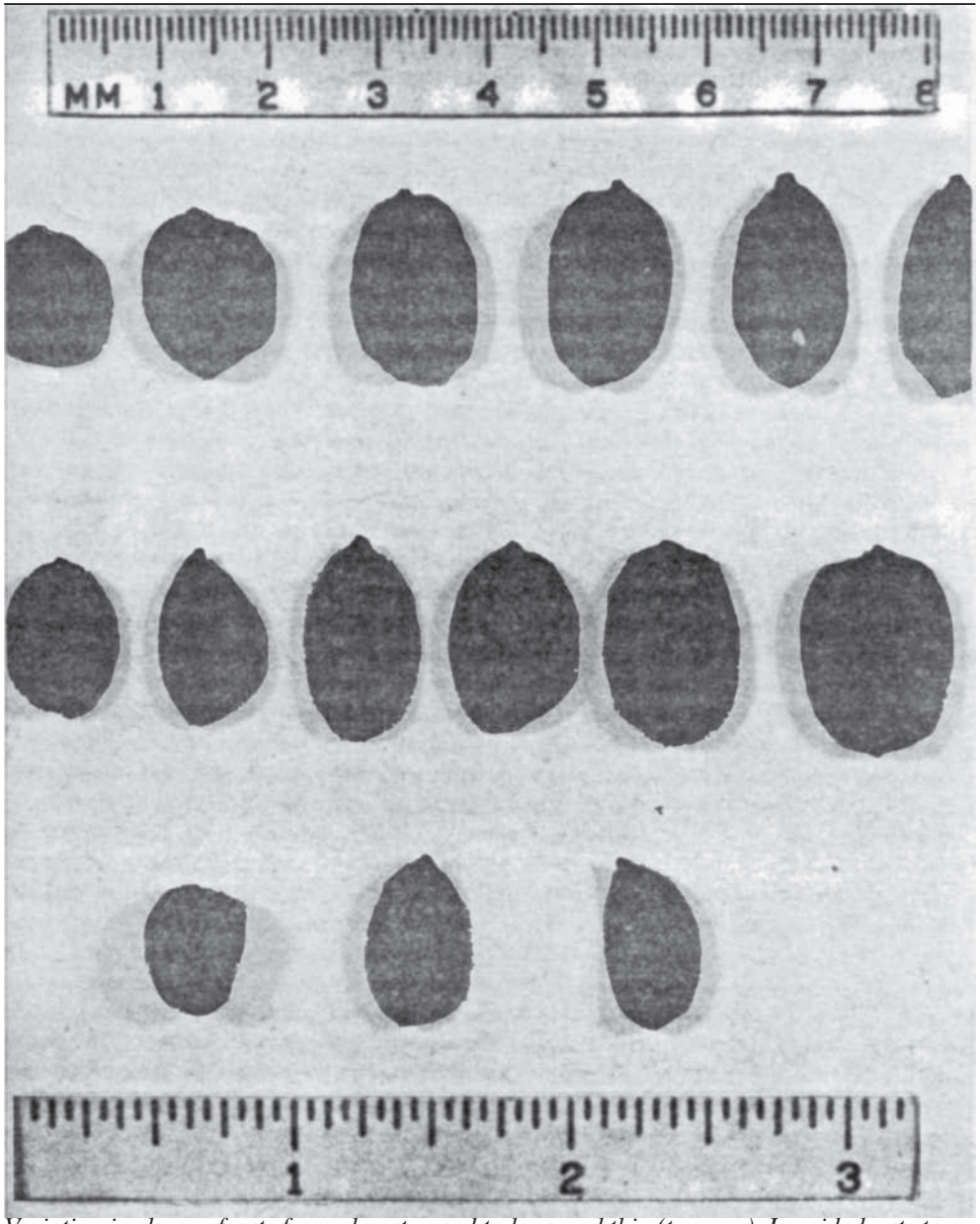
The seed is formed on short stems in a 3 valved capsule somewhat resembling an acorn. After pollination the capsule grows rapidly to full size in 6 or 7 weeks but the seed or fertilized ovule grows from the blossom end upwards towards the stem to completely fill the capsule in 6 or 7 months. All three ovules may mature, but as a rule two will abort leaving a single ovule to mature. Whether one or more ovules mature seems to be a genetic characteristic as some bushes will have a high percentage of twins with some capsules maturing all three ovules. Some have nuts of equal sized halves but others may have one large nut filling 3/4 to 9/10 of the capsule and the second nut of small size merely leaving an indentation in the end of the larger nut. When mature, the capsule splits into 3 parts and the seeds are often found hanging from the capsule by their thin, thread-like placenta before being dislodged by wind and falling to the ground.



Nuts of the 'Vista' clone, at present the only one named, varying in size from 0.2 of a gram to 2.2 grams, the largest ever found by the writer. The small nuts were harvested in 1964, a poor year, and the large nuts in 1972, a good year. (Photo - W.T. Borden)

The mature nuts vary greatly in size, shape, colour and wax content. Size may be as tiny as 0.2 of a gram and over 2,000 to a pound, or as big as the largest one found by the writer, which weighed 2.2 grams. An average size would be in the range of 1/2 gram and any bush which would average 1 gram for the whole crop would be very large. Sizes are not constant but vary on the same bush from year to year as there is more or less moisture to mature a crop. Shape may be almost round to long and thin, a length of 1 inch having been found, but all nuts have a beak-like point on the tip end the stem end being rounded. Most nuts will have a silvery pubescence on the rounded end but on some it is lacking. Some are well filled and almost smooth while the majority have broad grooves running the length of the nuts. Occasional nuts are found with a series of fine lines all over the surface. In colour they vary from a light tan to a deep chocolate brown, while rarely a bush will produce nuts with a maroon-purple cast which appears black at first glance. Usually bushes from a given locality will have nuts of a similar size, shape and colour. Wax content may be as low as 35% to as high as 61% of the weight of the seed. As large size and high wax content seem to be somewhat correlated, seed should be selected from large seeded bushes when a new planting is anticipated. Unfortunately large size and heavy production are not always correlated. On some bushes the dried capsules adhere tightly to the seed instead of permitting it to drop free of the capsule, thereby necessitating an additional hulling operation to remove the capsule. Obviously this is not a desirable feature, and bushes should be selected that always drop their nuts free of the capsule. Nuts of a more rounded shape weigh more than long nuts, and smooth nuts generally have a higher wax content than those with deep indentations. Nuts with a high wax content lose much less weight in drying than do those with a low wax content, which have to lose a greater amount of water causing them to become more wrinkled.

Several methods of determining the wax content can be used. The simplest and least accurate is to drop the seeds in water; if they float they usually have over 50% and if they sink under 50% wax. This is at best a very crude method since different seeds have different densities and one which may barely float may have a much higher wax content. About 96% of the



Variation in shape of nuts from almost round to long and thin (top row). Lopsided nuts to a large massive shape (second row). End view of nut showing silvery pubescence (left), and two halves of a twin nut (right). (Photo - W.T. Borden)

wax can be extracted by pressing it mechanically. Solvent extraction may give as high as 99% using heptane or hexane. An accurate non-destructive method is the use of nuclear magnetic resonance (NMR) techniques. This can be used on individual seeds to select those having the highest wax content for planting, but since there can be considerable variation between seeds from the same bush an average of 10 seeds would be better for selection purposes.

Propagation

The easiest and most used method is by planting seeds. The percentage of germination is usually high when fresh seed is used, often 95 to 99%, and seed stored for 4 or 5 years may still give as high as 90%. Gentry (2) reports 38% germination on seed stored for 11 years in an open shed in California.

The writer has had good results using 50% sandy loam soil, 25% redwood shavings and 25% sewage sludge as a potting mix in which to plant the seed. Any good mix that is well drained can be used that has a neutral to slightly alkaline (7.0 to 8.0) pH. Seed should be planted 1 to 11/2 inches deep and be kept moist all times but not wet. Germination is hypogeous with the radicle emerging first and extending downward into the soil for several inches before growth shows above ground. Growth may appear in as little as 5 or 6 days in the greenhouse to as long as 2 or 3 months outside. Seeds planted in the fall when days are cool and nights cold may not germinate until spring when the weather warms. Often fall planted seed will fail to germinate due to decay from fungus or cold. To insure germination in the fall and winter artificial heat sources must be used to hold the temperature at 80°F during the day and very little lower during the night. Optimum temperatures for germination and good early growth are 80° to 85°. Below 75° germination is much slower, but on the other hand, if temperatures of 100° to 110° are attained during the day, little or no germination takes place and most of the seed dies. As the plant gets older higher temperatures will promote rapid growth but these are not recommended for successful germination of seed.

Seed may be planted in gallon pots, but a better container is made by using a band of medium weight tar paper and making an open ended cylinder 4 to 5 inches in diameter and 15 to 18 inches deep. This bottomless container permits good drainage, which is essential for good germination, and allows to deep tap root to penetrate sufficiently deep for strong anchorage. A word of caution; bottomless containers should never be placed directly on a plastic sheet as this obstructs the drainage, waterlogging the soil and rotting the seed in short order. Direct seeding in the field is successful when the seed is planted at the beginning of summer and the soil kept moist with regular irrigations during the first two years to establish the plant. Fall planting is not as satisfactory since germination is spasmodic and the winter rains may or may not be sufficient to carry the plant through the year without supplemental watering. Rodents can be a problem when they dig up the newly planted seed and should be controlled. Germination is hastened for summer planting when the seed is soaked over night in water. Soaking it longer is not recommended and will inhibit germination instead of helping it.

Grafting can be done using the splice or whip graft during early spring from mid-March to mid-April. Scion wood of 1 or 2 year old wood may be used that has bark which has turned grayish-brown. Immature green wood has given poor results and is usually quite small, the best results being had when 1/4 to 1/2 inch mature wood is used. It is necessary to regularly remove all new growth below the graft starting two weeks after the grafting in order to force the scion to grow. Results have been variable with some bushes refusing to take a graft and others taking 100%. Certain scions seem to take more readily than others also. Grafting should be done fairly low to the ground if it is expected to establish a new top on the plant as it will branch vigorously below the graft at best. Higher grafts might be useful if a male branch were to be grafted onto a female plant to try and eliminate the need for separate pollinator males.

Cuttings of new terminal growth having two or three nodes can be rooted by dipping the base in a commercial rooting hormone preparation and setting them in 3 inch deep nursery flats which are placed under intermittent mist and held at 75° to 80°F. Rooting takes place in 4 to 8 weeks depending on the clone. The rooted cuttings are potted in individual pots or gallon cans and held for a year before planting them in permanent locations in the field. Cuttings

seem to lack the deep tap root of seedlings and are somewhat slower to establish themselves in the field so must be well irrigated the first 2 years after which they may be left to subsist on the natural rainfall.

Rooted cuttings have several advantages: 1. A uniform plant with known production and wax content of the seed; 2. The desired bush shape for ease of harvesting; 3. Precocity, with a few blooms and perhaps a seed or two the second year but with a light crop the third year if well attended. Thereafter, crops will increase each year unless climatic factors are adverse, in which case there will be little or no crop. Contrast this with a minimum of 3 years and usually 4 to 6 years for seedlings to produce their first bloom and crop, and it is evident that even though cuttings may require more attention to root and establish the first 2 years, they will certainly pay off much sooner.

Transplanting

Most researchers have found Jojoba plants do not transplant easily, are slow to establish themselves in the field and in general have a high mortality rate the first year. It is suspected that perhaps the majority of these trials were conducted with either no irrigation after planting or only one irrigation at the time of transplanting. In trials conducted by the writer 90% to 100% survival, depending on the seed source of various batches of plants, has been achieved by sprinkler irrigation using "whirly" type sprinklers that gave complete coverage of the whole plot. Perhaps a somewhat lower percentage survive with furrow irrigation and drip irrigation. There are still a disturbingly high percentage of plants that, even though they survive, do not grow well and may sit for several weeks and sometimes months before finally commencing to grow. The letter quoted below may offer at least a partial solution to this problem.

Dr. Thomas K. Miwa of the United States Department of Agriculture, Agricultural Research Service, Northern Regional Research Laboratory, in Peoria, Illinois 61604, and now Chairman of the International Committee on Jojoba Research and Development, in a letter to the writer dated 18 January 1973 states:

"In growing six Jojoba plant seedlings on the window sill, I have discovered that active growth of the seedlings can be halted, dead on the spot, by rotating the pot 45°, in this case clockwise looking down. In an earlier instance of 1800 turning, three of the six started after a dormancy of 2 weeks. The fourth started a new shoot from the bottom, another started at the top but as a branch. The last one, 6 inches tall, has not grown at all for the last 4 months, even though it is equally healthy-looking.

On January 4, the pot with 6 seedlings was rotated 45°, and all growth was stopped for 7 days before two started to grow again. The next started Jan. 15 and another on Jan. 16. The 5th, and until then the fastest growing plant at 2 inches per month, has not yet started and is standing suspended in a most peculiar growth phase.

Very slow rotation of the pot does not affect the growth rate noticeably. This type of growth habit is unknown among us. Have you been aware of this or is this strictly a window sill peculiarity? None of our house plants are affected so dramatically."

In the book "*The Secret Life of Plants*", by Peter Tompkins and Christopher Bird (3), page 351 states:

"During her stay in England, Farrelly was intrigued that the De La Watts seemed to have radionically detected that every living plant has a critical rotational position (CRP), which is apparently established by the earth's magnetic field as the seed sprouts out of the ground. If the seedling is transplanted in such a way that it continues to grow in its CRP, it will thrive better than plants which have been transplanted out of that orientation. This phenomenon was also independently discovered by Hieronymus, who found that a reading on the dials of his

radionic device was maximum when the plant was rotated in a given position with respect to a compass rose."

In an effort to determine the extent of this geomagnetic orientation on jojoba as applied to field transplanting the writer made an initial planting of 177 small seedlings without respect to the original orientation. These were watered by drip irrigation at the time of planting and at 10 day intervals afterwards, having been planted on 23-28 October 1972. By the first of June 1973 many plants were dead and others in poor condition and on 10-11 July 1973, 54 new seedlings were used to replace those which had died. These were carefully lifted in their pots and placed in a nursery flat, carried to the planting location without turning them more than 50 in the process, and planted. All 54 not only survived but acted as though they had not been moved; those that were growing continued to grow with the dormant ones commencing growth as dictated by their individual "time clock" or growth pattern. A further experiment was carried out when a new planting of 124 seedlings and cuttings were moved without regard towards their orientation but when planted were again oriented to the same position as that in which they were originally grown. At the end of 2 months, 12 plants were dead and at 3 months, 10 more had died. The remainder look like they will survive at this writing.

The conclusion is obvious. Seedling and cutting grown Jojoba plants withstand the shock of transplanting far better when their geomagnetic orientation or CRP remains unchanged from that in which the seed was planted and the young plant first grew. Undoubtedly this would apply to a greater or lesser degree to all plants.

Twenty-three-year-old planting of jojoba at the Carob Demonstration Orchard on Buena Creek Road 5 miles southeast of Vista, California.

Culture

Limited cultural trials of Jojoba have established a few facts but leave many, more questions unanswered. At the writer's location of 330 45' north latitude, Jojoba seems to prefer a southern exposure with southeastern and southwestern exposures next in that order. At 10 miles from the ocean the prevailing wind is from the southwest, causing the soil to dry out faster and thus inhibiting growth. A northerly exposure is not well suited for good growth, with plants growing at 1/3 the annual rate as those on a southern slope which is much warmer. In desert areas plants on a north slope seem to show less effect from the high summer temperatures and retain their leaves better than those on the south slopes. On the other hand there is much variation among individuals adjacent to each other, with one plant standing leafless and the next retaining most of its leaves at the end of a dry season.

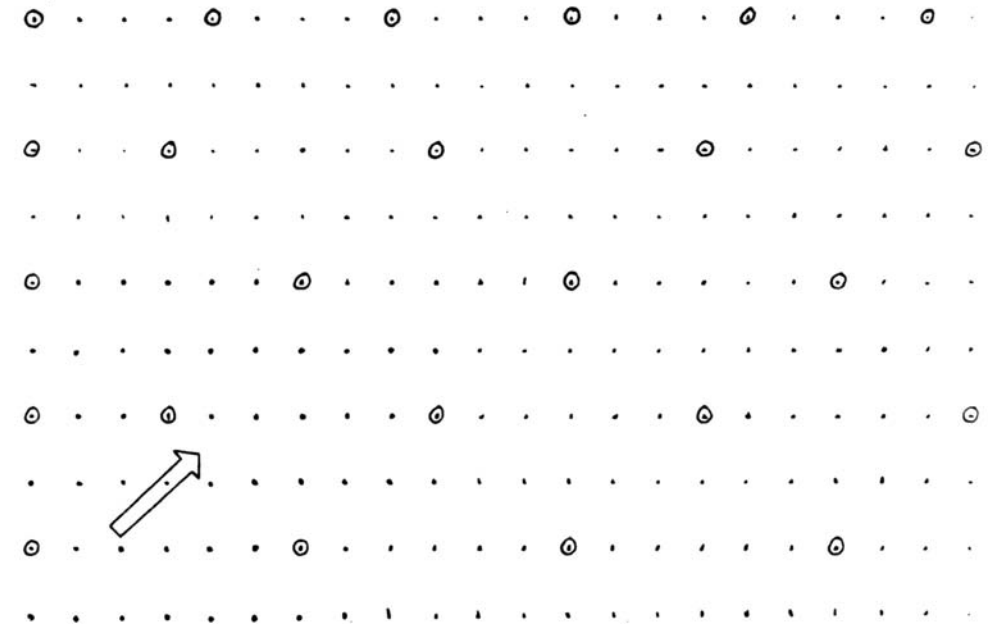
Timing of the rainfall is critical for good nut production. If there are early rains that penetrate deeply into the soil during the months of December and January, good crops can be expected, but if the rains come in February or March there will be a light crop at best. Early rains of sufficient amount to wet the deep root system, seem to trigger a favourable response for both bloom and growth during March and April when maximum growth occurs. The plant does not require additional rainfall during the hot summer to mature its fruit and supplemental irrigation seems to have little effect, other than to keep the bush greener than it would otherwise be in hot weather.

Low temperatures during the bloom period inhibit fruit set. When night time lows are in the 30's and low 40's much less effective pollination occurs than when they rise to the mid 40's. Even though there may be a good fruit set with expectations of an abundant crop, an early hot spell in late May or early June can sunburn the immature capsules and cause the drop of all fruits except those protected by foliage. In this connection one other important observation has been made. Whenever a plant was found that still carried a good crop after an early hot spell, it invariably had capsules with large, long sepals generally at right angles to the capsule which shaded and protected the capsule from sunburn. Selection for this factor could ensure a crop when there might not otherwise be one on clones with small sepals.

Since the plant responds with vigorous growth after a fire it was thought that it might be possible to harvest the crop by mowing off the top of the plant and threshing out the seeds. This was tried on a limited scale but results were highly unsatisfactory. Some of the plants died, about 20%, and the rest resumed growth very slowly and no longer retained their original shape but became a dense mat of many stems emerging from the cut off crown of the plant. Ten years later these plants have never recovered to the size they were at the time of top removal and have never borne good crops since.

Young plants kept in a greenhouse and pruned to a single stem have grown to a height of 6 feet and produced some blooms between 6 and 8 months of age. Those sprayed with 100 parts per million of gibberellic acid in their 21st, 24th and 27th weeks after planting grew 1 foot higher than the controls (4). This shows that when a plant is grown rapidly to a mature size, the effects of the juvenile stage of growth are overcome and the plant flowers. In this way the sex can be determined before setting in the field allowing a correct ratio of male to female population for pollinating purposes. Seedlings will vary from 50% female and male to as high as 75% male and 25% female, at best an unsatisfactory ratio for those wishing to plant seedlings and bring them to fruiting for selection. The planting of 3 or 4 seeds to a pot has been practiced in some operations in order to ensure at least one female per planting hole, but this does not permit optimum development of any of the plants for the best evaluation of their true potential.

Planting distances may vary with the purpose of the planting. If early selection and later removal of the undesirable plants is done, a close planting of 3 feet in the row and 6 feet



Female • Male © Arrow shows prevailing wind direction

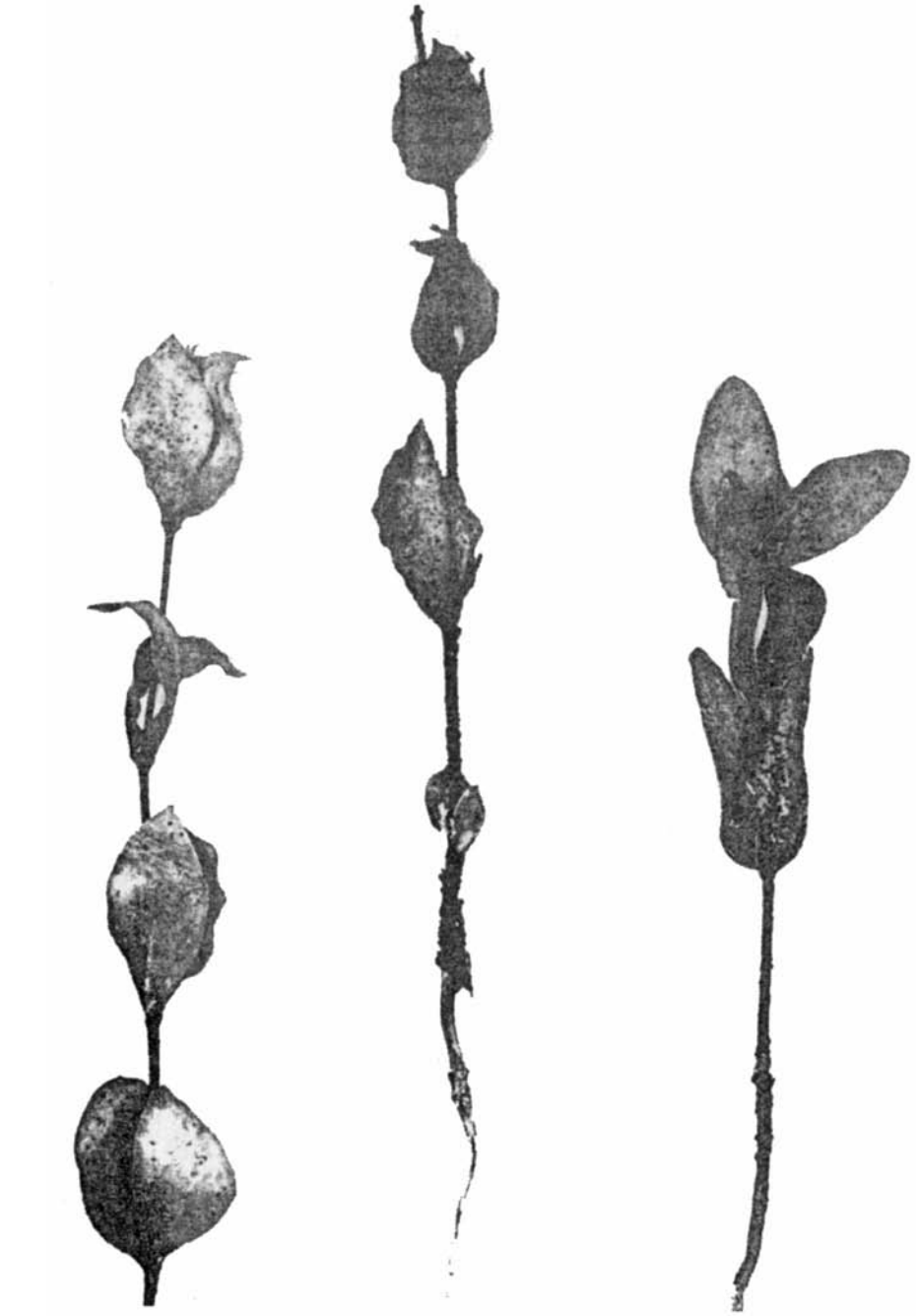
Diagram of orchard layout showing suitable pattern for placement of male and female plants for effective pollination. (Graph - Paul H. Thomson)

between rows is plenty. For a permanent planned planting which is to be irrigated for regular production, a distance of 8 feet in the row and 12 feet between rows will permit room for harvesting and cultural operations even though the ground will not be completely occupied for 8 or 10 years. The first spacing would give 2,420 plants per acre and the latter 453. With a ratio of 1 male to 10 females the productive or female plants would be 408. Another closer hedgerow type of planting would be 5 feet in the row and rows 10 feet apart giving 871 plants per acre. At this spacing every other plant would have to be removed at 6 to 8 years to prevent overcrowding.

Little is known of the fertilizer requirements of field grown Jojoba. Nursery plants respond well to light applications of fertilizer, but in a confined space this is to be expected. In the field the plant has a deep tap root with little observable lateral root structure and that of a size approximating the tap root itself. Whether applications of fertilizer would be utilized efficiently with such a root structure must be determined in the future. A small planting on a fairly heavy clay loam has been producing good crops for 20 years without any fertilizers, but with little or no crop in years of low rainfall. What it might have produced if well fertilized and irrigated is at this point open to question.

Pests and Diseases

The Jojoba bush is a browse plant for deer, goats, cattle and rabbits, which also eat the nuts as they mature and drop. Rats, mice and squirrels have been known to climb the bush and harvest the immature capsules. Gophers will eat the roots and then pull the rest of the plant into the hole and finish eating underground. The writer has found it necessary to place wire cages around small plants to protect them from the depredations of rabbits until they grow beyond reach. Wild pigeons have been found to have nuts in their crop during the season of seed fall. When the crop is small due to a dry year these animals leave little to be harvested by the planter.



Three two-year-old plants killed by the false chinch bug Nysius ericae Schilling. Dark spots on leaves are punctures made when sucking the plant juices. Dark stems are a shellac-like substance deposited by the insects (centre and right plants). (Photo - W.T. Borden)

Several insects will eat the leaves but do not seem to do serious damage. By far the most damaging insect is the false chinch bug *Nysius ericae* (Schilling). This insect matures several broods a year in this coastal area and in such great numbers that the ground appears to be moving as they swarm over it. These will cover the plant so nothing can be seen of the leaves or stem. Young plants 2 or 3 years of age are often completely killed as these insects suck the life juices from the leaves and stems leaving them dark brown, brittle and desiccated. Some years the larvae of some insect, perhaps a moth, bore into the soft, immature capsule and devour the growing embryo, destroying as much as 75% of the crop. There is some damage every year from this pest, of say 5 to 10% of the crop, but only occasionally is the damage severe.

Selection Criteria

Any plant, when moving from a wild to a cultivated state, will of necessity come under the hand of man who will rigorously select those that meet his need and reject those that do not. Here are listed some considerations that will need to be fulfilled if Jojoba is to become a cultivate, but not necessarily in order of importance.

1. Heavy production. At present most clones are moderate producers at best. Production should be about doubled and can partially be accomplished by good cultural practices.
2. Large size. For ease of harvesting alone nuts should weigh 1.5 to 2 grams. It is much easier to pick up 300 or 400 nuts than 2,000 to equal a pound. Production must be figured on pounds per bush instead of number of capsules, as larger fruited clones will normally have fewer capsules. Good cultural practices may increase size, too.
3. High wax content. A goal of 60% or more seems reasonable and expectable, but may be hard to attain in combination with the first two items.
4. An upright bush. Most bushes branch so low that they cover the ground around them making the harvesting of the nuts very difficult, in fact some are so dense that the falling nuts lodge in the branches and never reach the ground. A more open type with fewer stems or a single stem is indicated, otherwise considerable pruning will have to be done to raise its skirts for ease of harvest.
5. Fruit dehiscence. Capsule should split at maturity allowing the seed to fall. This eliminates a tedious and expensive hulling process on "sticktight" capsules.
6. Large sepals. These would give protection from sunburn during sudden hot spells.
7. Cold hardiness. Mature bushes should be able to withstand 15°F and small young plants 20° to 22° during the occasional cold winter that can be expected.
8. Fascicled and racemose types. This should be under No. 1 as it would increase production, but is limited to good cultural practices. When rainfall is insufficient the capsules abort and only one of a fascicle or raceme will mature
9. Flowering at every node. Theoretically this would double the production, over the majority of types which seem to flower at alternate nodes.
10. Late flowering. This would avoid the damage caused by late frosts.
11. Regular production. This is essential for a commercial crop.
12. Pollinator. Males must bloom at the critical time when female flowers are receptive. A male with a long blooming period would be helpful. Eventually hermaphrodite forms may be bred, but until then males will be essential for good crops.
13. Ease of propagation. If a plant will root readily from cuttings it would be easy to multiply a clone at a reasonable cost for commercial plantations.
14. Salt tolerance. Jojoba will tolerate 2580mg/litre of salts in the irrigation water (1), thus it is a good crop for areas with brackish water.
15. Short harvest period. Although the time of harvest may vary, bushes having a tendency to drop their nuts all at once would be preferred. With a prolonged drop the nuts must be harvested several times with a consequent increase in labour costs.

Thus far the most intensive program of breeding and selection has been carried out by the Division of Life Sciences, The Negev Institute, Beer Sheva, Israel. In the United States most of the work is being done by the Office of Arid and Studies, University of Arizona, Tucson, Arizona 85729, and the Department of Plant Sciences, University of California, Riverside, California 92507, under U.S. Government grants. The object is to develop a crop for the arid Indian Reservations in Arizona and California. Numerous individuals are working independently in both States, with additional help and co-operation from the U.S. Department of Agriculture and the National Academy of Sciences. In Mexico the Commission Nacional de las Zonas Aridas, the lnstituto Nacional de Investigaciones Agricolas, and the University of Sonora are working jointly with the United States. Other countries where there are small plantings and considerable interest are India, Chile, Argentina, Brazil and South Africa. There are many other countries lying in the arid zones of both hemispheres where Jojoba could be grown to good advantage.

With the money, time, effort and brains now allocated to Jojoba research great strides will be made toward its domestication and it is certain the rewards will be equally great when this is accomplished. The future looks bright indeed.

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EDITOR'S NOTE

The Jojoba in Australia. Various people in Australia, including myself, are trying to grow jojoba plants. The following comments were received in response to enquiries.

From: CSIRO Division of Land Resources Management, Alice Springs Field Centre, (P.O. Box 77, Alice Springs, NT., 5750). (M.A. Ross, Officer-in-Charge).

We are not directly involved with Jojoba ourselves, but have contact with two Missions who are assessing the species.

Santa Theresa Mission, east of Alice Springs and Ernabella in northern South Australia, have both established plants, but they are not yet flowering.

The Forestry Section of the Forestry, Fisheries, Wildlife, Environment and National Parks Branch of the Department of the Northern Territory in Alice Springs, is watching the progress of these two trials, but it is far too early to assess the performance of the plants yet. I would suggest you wait for a year or so, and contact the Forestry Section for a progress report.

From: Forestry Section, F.F.W.E. & N.P. Branch, Department of the Northern Territory, (P.O. Box 1095, Alice Springs, N.T. 5750). (C.D.R. Smith, Forester, Arid Zone).

I refer to your request of the 31st October, 1974 for information on *Simmondsia chinensis Syn californica*. We have established a small plot of about 12 provenances of this species under irrigations at Santa Teresa, an aboriginal township 60 miles south of Alice Springs.

The oldest plantings are just on twelve months old, survival is good and the seedlings just starting to get away. It is far too early to make any prediction on their suitability for this area. However, some observations on nursery behaviour which may be of value to you:

1. Seed is soaked in water overnight before sowing.
2. American recommendations are to sow seed directly into containers and germinate under a cover of glass or clear plastic. We found our seed rotted very fast under these conditions and germination was poor. We propose to sow future batches in seed trays in the shadehouse and prick-out at the cotyledonary stage, our normal procedure with most seed.

Notes on Nutgrowing In Tasmania

BILL MOLLISON*

The most common domestic nut here is the walnut. Most old gardens (planted between 1830 and 1880) have one or more walnuts, usually with a black mulberry tree as a companion. I suspect most are seedlings, but all bear well. Possums (near the bush) are the main hazard. I know of no commercial plantings.

Hazels and filberts have been planted, rarely in the south, but we have collected several suckers from old orchards in the north. There has been a renewal of interest recently; the Department of Agriculture is reputed to have many varieties planted. Old orchards are now neglected and unworked. We have salvaged some six or so (unnamed) varieties as suckers. New commercial plantings are being contemplated by IXL and others.

A very few old almonds exist - some are 20-30" in diameter and 40-50 feet high, still bearing in old walled gardens. Again, there are no modern commercial plantings, but a good many domestic trees made up of 6-8 varieties.

Of the pines, the bunya, *Pinus pinea, P. pinaster*, and *P. coulteri* are here, as old trees in bearing, especially in the north. The Forestry Commission grows sweet chestnut, English walnut, *Pinus pinea*, and *P. pinaster* commercially, from seed.

Sweet chestnuts are much more rare than horse chestnut, but there are no commercial plantings. A few good trees exist.

We have found four Macadamia trees bearing well in the cold Hobart climate. The bunya pine (*Araucaria bidwillii*) also seems to do O.K. here. No doubt all are seedlings.

Some 8-10 species of oak yield well here, as isolated trees and old hedgerows, usually with hawthorn trees. We have collected and are growing all available oaks for larger plantings. Cork oaks grow well, as do the turkey oaks and evergreen species.

Black walnuts were grown as isolated trees, but are not now planted. We have some new seed to try. We know of no large beech plantings, but again have some seed to try.

David Holmgren here is developing what is being called 'Permaculture' (an integrated perennial system of plantings), and the nut plants figure large in this.

As yet, Tasmania appears to lack pecan and pistachio trees. Pistachio seed is difficult to get here.

* Member, West Australian Nutgrowing Society

The Chilghoza Pine, An Important Nut Pine Of The Himalayas

B.N. GUPTA and K.K. SHARMA*

Local Names

Hindi - Chilgoza, neoza (seeds).

North Western Himalayas Chiri, gunober, prita, galboja, galgoza, kashti, mirri.

Western Tibet - Kannuchi, koniunchi, kaninchi, shangti.

Afghanistan - Chilghoza, jalghoza.

Introduction

Six species of pines occur in India, of which three are Himalayan, viz. *Pinus gerardiana* Wall; *P. roxburghii* Sargent and *P. wallichiana* A.B. Jackson.

The chilghoza pine, *Pinus gerardiana*, is a small to medium sized evergreen tree (Fig. 1) attaining a height of 17 to 27m and girth of 2 to 4m. Branches are short and horizontal forming a tree of compact habit, usually not whorled, the bark is thin, glabrous, silver grey, with a mottled appearance, exfoliating in irregular thin scales. Young shoots are olive green, ridged. Needles grow in threes, lasting three years, are 5-10cm long, dark green, stiff, basal sheath about 1.3cm long, deciduous during the second year. Cones are oblong-ovoid, 13-20cm long, diameter 8-12cm, glaucous when mature. Scales are 4cm long, 2.5cm broad, thick and woody, the exposed portion triangular are reflexed, the swollen apex ending in a recurved spine. The seeds are cylindrical, 1.5cm to 2.5cm long and 0.6cm in diameter. The seed wings are short and caducous. The wood is tough and resinous, with scattered and prominent resin ducts. Heartwood is yellowish brown, sapwood lighter. As a timber tree, it is of little importance, used only where other timber species are not available. The seeds or nuts are edible and form an important economic product, collected in quantity for export to the plains. The native population use them either raw or cooked on roasted.

Pinus gerardiana was discovered by Captain Gerard, an officer of the Bengal native infantry and was introduced in cultivation by Lord Auckland in 1839. The tree is a native of the NW. Himalayas, occurring in Afghanistan, Northern Baluchistan, and on the borders of Kashmir and Tibet. In exposed situations and on shallow soil the tree is stunted, but it is fairly tail and straight under favourable environments.

* Forest Research Institute, P.O. New Forest, Dehradun, India.

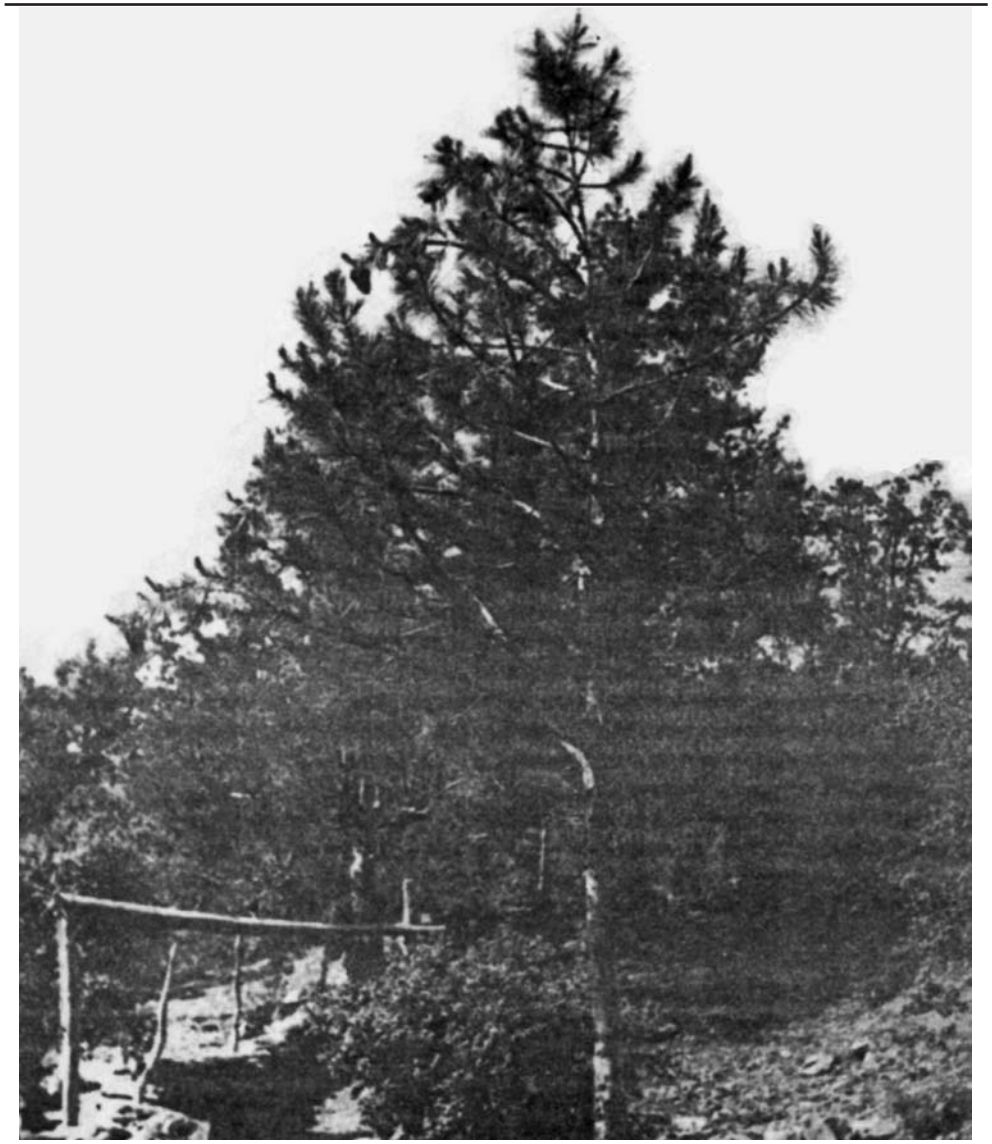


Figure 1. Pinus gerardiana tree

Distribution and Habitat

General distribution: Common in North Eastern Afghanistan, Northern Baluchistan and somewhat local in the inner arid valleys of the Western Himalayas, from Bashahr in Himachal Pradesh westward to Chitral in Kashmir. The tree is mainly found at an altitude of about 1,600m to about 3,300m. It grows gregariously forming more or less open forests, in association with *Cedrus deodara*, *Fraxinus xanthoxyloides* and *Quercus ilex* or in the trans-Indus with *Pinus wallichiana*.

Climate: The tree grows in the dry zone where there is very little summer rain but there is a heavy winter snowfall. In Sutlej valley it is found both on cooler and hotter aspects but on

the latter its optimum altitude is about 460m higher. On hot cliff-faces of the valley bottoms it grows in a bushy form. The total precipitation varies from 375 to 900mm which is received mostly in the form of snow during winter months. The winter temperatures are below freezing point in the months of January and February. The weather from April to October is mostly dry. The summer temperature within its habitat seldom exceeds 37.8°C. The tree stands severe cold in winter.

In valley bottoms up to 2400m where 750mm precipitation is 50:50 in form of snow and rainfall, it appears as a low level conifer in place of Pinus roxburghii on hot and rocky aspects, gentle slopes being occupied by *Cedrus deodara*, *Pinus wallichiana*, *Quercus leucotrichophora* (Q. *incana)* and *Q. ilex*. In the inner drier country with 500-700mm precipitation mostly in form of snow, this pine comes up on cooler aspects uphill as a pure community, mixed in its upper part with *Cedrus deodara*. Further in the interior, in the arid limits of tree distribution, with precipitation entirely of snow 250-400mm, the chilghoza pine occupies altitudes up to 3350m. At this extreme all species, viz. *Cedrus deodara*, *Pinus wallichiana*, *P. gerardiana*, *Fraxinus xanthoxyloides* and *Juniperus* spp., are confined to sheltered sites.

Soil: This species is capable of coming up on dry, barren hill sides with shallow soil. It acts as a protective cover over large areas and helps in soil conservation. On account of light needle shedding *Pinus gerardiana* forests do not contribute much to the organic matter in the soil. The ground flora is of xerophilous type and they also add very little leaf litter. *Quercus ilex* has a bushy root system and makes the best soil cover. The exposed soil is dry and friable, and subject to erosion.

Forest Types And Their Description

Forest type 13, the Himalayan dry temperate forest of Champion and Seth (5), covers the distribution of the chilghoza pine in India. It is found in varying proportions in three sub-types (viz. 13C1, 13C2 and 13C4); dry broad-leaved and coniferous forest (*Quercus ilex - Pinus gerardiana*), dry temperate coniferous forests, and West Himalayan high level dry blue pine forest respectively. In dry broadleaved and coniferous forest, *P. gerardiana* forms open forest in admixture with *Quercus ilex*, *Cedrus deodara*, *Acer pentapomicum, Celtis australis* in the first storey and *Fraxinus xanthoxyloides*, *Rhus succedanea, Parrotiopsis jacquemontiana, Olea cuspidata* etc. in the second storey.

This type occurs in upper Sutlej and Kishtwar valleys in the dry inner Himalayas from 1600m upwards. On cooler aspects the chilghoza pine occurs between 1700m and 2440m and on hot southern aspects it occupies the 2000m to 2700m elevation. The rainfall varies from 660mm to 900mm.

Dry temperate conifer forests have been divided into two sub-types viz. Chilghoza pine forest (C2a) and Dry deodar forests (C2b). Chilghoza pine dominates in the first sub-type and forms nearly pure forests with some deodar. *Fraxinus xanthoxyloides* comes in the second storey. *Lonicera hypoleuca, Artemisia maritima, Daphne oleoides* etc. form the undergrowth. The sub-type is confined to the arid zone with rainfall limited to 500mm, mainly during February-April. These forests occupy steep slopes and northern exposures. In the second subtype i.e. Dry deodar forests, the chilghoza occurs on drier aspects, leaving room for *Cedrus deodara* on cooler exposures. In more arid tracts *Pinus gerardiana* extends upwards and goes even beyond 3000m. This sub-type is confined in the upper Sutlej and Chenab (Kishtwar) valleys within an elevation of 2100m to 3250m, rainfall varying from 500-l000m. In addition to *Cedrus deodara*, *Pinus wallichiana* and *Picea smithiana* form associates of chilghoza in the first storey and *Corylus colurna* in the second.

At high elevations between 3000m and 3600m, with a rainfall below 500mm, the chilgho-

za pine is sometimes associated with *Pinus wallichiana* in the West Himalayan high level dry blue pine forest, as at Ladakh and Kanawar. *Abies spectabiis* may also occur in the overwood along with the pines. *Betula utilis*, *Sorbus foliolosa*, *Rhododendron campanulatum, R. anthopogon, Juniperus cornmunis, J. wallichiana,* J. *polycarpos*, etc. form the understorey.

Flowering and Fruiting

The tree flowers in May-June. The young female cones (Fig. 2) start increasing in size in the first year and grow rapidly during the second year. The female cones attain full size in July and majority of them ripen during September-October of the following year. Good seed years alternate with poor ones. Cones persist on the tree for some time even after seed shedding.

The number of cones per tree varies from 28 to 129 depending upon the age and size of the tree.

Figure 2. A female cone of Pinus gerardiana

Seed, Germination and Development of Seedling

Number of seeds per cone varies from 45-57 and a tree on an average yields about 7.4kg of seeds. 2820 seeds weigh approximately one kg. An average seed (Fig. 3) measures 20mm in length and 6mm in diameter. Collection is best done in September-October when the cones are still green. These are ripe enough to yield edible kernels. On heating, the cone scales open and the seeds are shaken out. Seeds are also separated by drying the green cones in the sun.

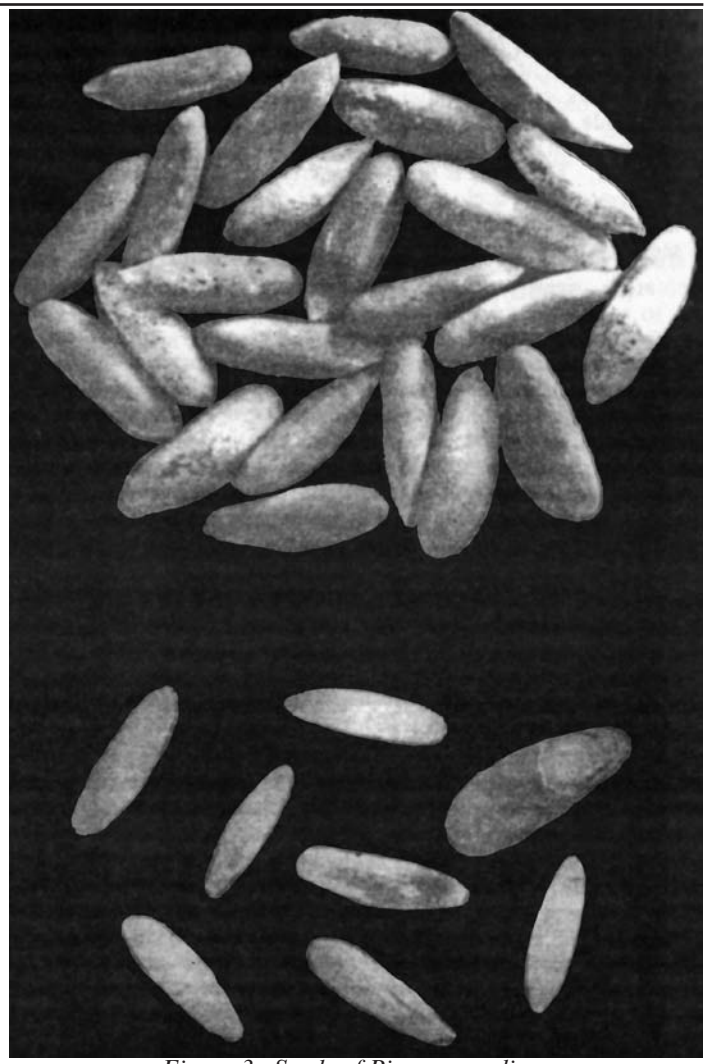
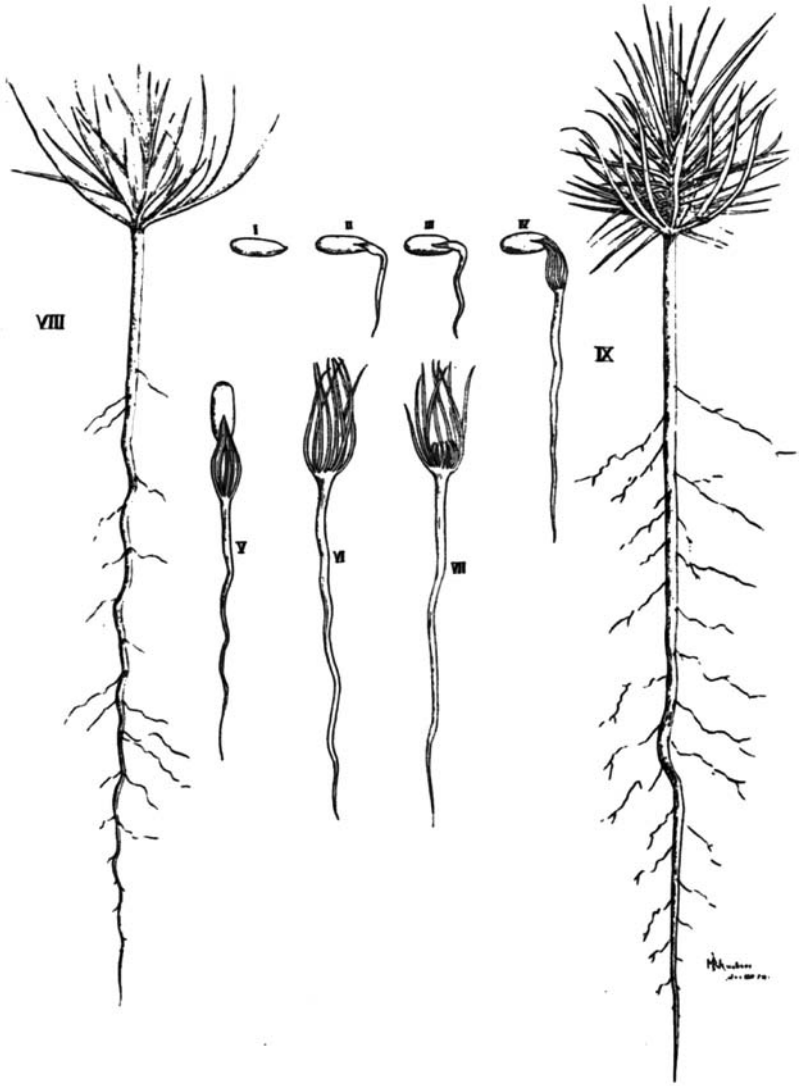


Figure 3. Seeds of Pinus gerardiana
A - Complete. B - Seed coat removed.

Germination is epigeal. With the availability of favourable conditions the radicle comes out of the seed and descends inside the earth forming the tap root. The hypocotyl elongates pushing the cotyledons above ground. The seed shell often remains intact with the cotyledons for some time after which it sheds permitting the cotyledons to open up and forming a whorl of the first set of young leaves. In many cases the seed shell is left behind in the soil while the cotyledons are pushed above ground with the elongation of the hypocotyl. The number of cotyledons vary from 9 to 12. A vegetative bud develops in the centre of the cotyledonary leaves which elongates and forms the young shoot. Rate of growth of root is very fast compared to that of shoot. The primaryroot grows more than 30em in one year and the shoot about 2.5 to 3cm. The primary root is long, terete, brown with numerous lateral rootlets. The hypocotyl is straight, 2.5 to 3.8cm long, terete, glabrous, pink and pale green changing to

dark green and then brown. Cotyledons are epigeous, 9-12, equal, sessile, the blade is needle-shaped, 3.8 to 5.8cm long, three-edged with concave faces, flat beneath, curving upwards, light green, sparsely and minutely surrelate, glabrous. The stem is erect, straight, wiry. The first-season leaves are primordial, arranged in a close spiral, 2 to 5cm long, with earlier leaves shorter than later ones, acicular, flattened, margins minutely but sharply serrulate. The seedling development stages are shown in Fig. 4.

Figure 4: Seedling development stages of Pinus gerardiana



Natural Regeneration

Natural regeneration of chilghoza pine in the areas of its distribution in India is more or less absent. Local inhabitants collect cones from the ground for extracting the chilghoza nuts, which are highly valued. No seed is therefore left on the ground for germination. It has been estimated that inaccessible areas from where cones cannot be collected constitute only 5% of the total area covered by *P. gerardiana* forests (16).

Other factors contributing to the conspicuous absence of natural regeneration are as under: -

1. Seeds are liked by birds, squirrels, rats and monkeys. Whatever nuts are left uncollected by man are mostly consumed by these animals. In case of chance germination young seedlings are nibbled away by birds because of their fleshy and tasty cotyledons.

2. Goat or sheep browsing is very inimical to regeneration and therefore the young growth is to be seen only under the protected thorny thickets.

3. In spite of their adaptation in possessing a long tap root, intense sun heat, desiccating winds, and lack of soil moisture account for heavy mortality of seedlings during the drought periods May-June and October-November. Shallow and dry sandy soil with very low water retentive capacity also contributes to the unfavourable factors for regeneration.

Chilghoza seedlings are strong light demanders, and prefer exposed mineral soil rather than acidic humus. At the bottom of its distribution there is a tendency towards an alternation of species between deodar and chilghoza pine. Each of these avoid shade of its own species, and therefore the regeneration of one species is frequently seen under the shade of the other.

Artificial Regeneration

Attempts to raise chilghoza plantations by sowing have persistently failed on account of the strong liking of various animals for the edible nuts. Covering the patch or pit sowings with brush wood or dibbling on the sides of rocks also did not give satisfactory results. Planting of nursery raised seedlings is therefore the only alternative.

Plants raised in the ground do not transplant well. Also plants with a ball of earth are cumbersome to plant, expensive, and are liable to root damage during extraction or transport. Seedlings raised in containers are therefore preferable for planting. Experiments for selecting suitable containers were conducted in Himachal Pradesh, India, where containers used were (i) *Betula* bark tubes 15-23cm x 10cm; (ii) earthenware tubes without bottom 25cm x 7.5cm at the bottom; (iii) tin tubes 25cm x 7.5cm; and (iv) polythene bags 25cm x 15cm and 46cm x 15 cm. Of these containers, polythene bags of the size 46cm x 15cm proved to be the best (Fig. 5).

For nurseries, sites at 1500 to 2200 metres altitude with irrigation facilties are preferable. Well pulverised soil with farm yard manure in the ratio 3: 1 with inoculation of mycorrhiza makes a suitable germination medium. *P. gerardiana* roots are associated with an ectotrophic mycorrhiza (11). Inoculation of the soil with mycorrhizal soil is therefore considered necessary for successful nursery work. Before sowing, seeds are soaked in water for 24 hours and then one seed is dibbled-in each bag with the apex of the seed pointing downwards. Sowings are done in November-December, before snowfall. Spring sowings just after the melting of snow can also be done. Bags are protected against birds, squirrels and rodents by providing a wire net.

Watering by rose can is done every alternate day in the beginning. Frequency of watering is reduced to twice a week in the second year and weekly in the third year. Seedlings are shaded from the overhead sun. Weeding is done as and when necessary.

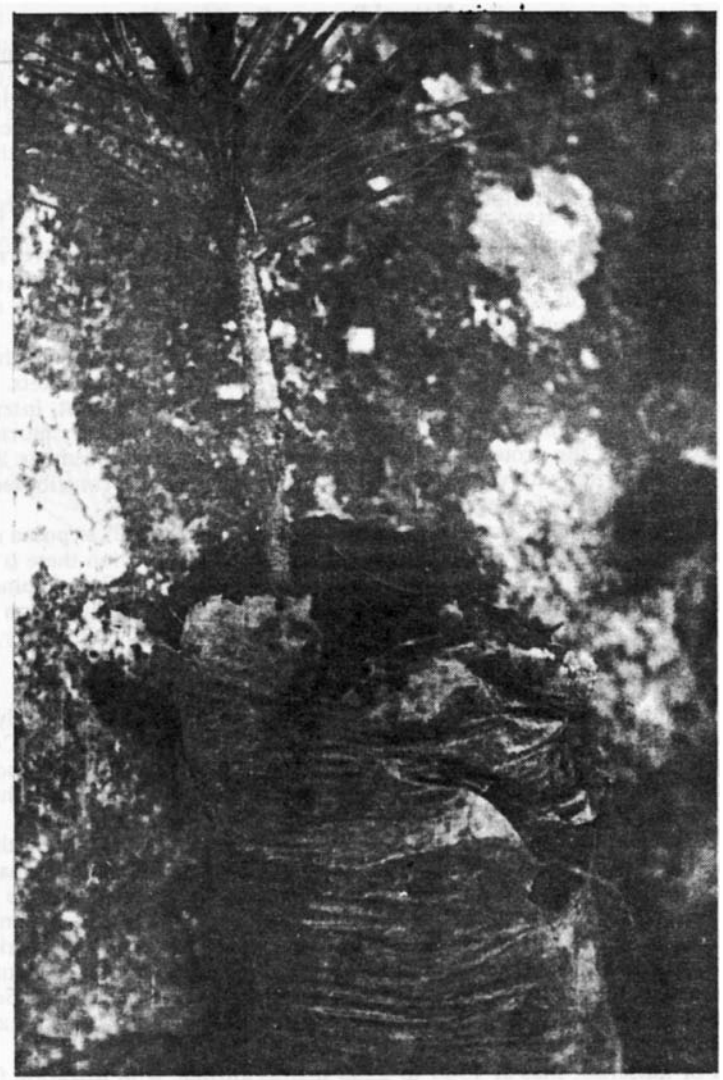


Figure 5. A four-year-old seedling of Pinus gerardiana raised in a polythene bag (46cm x 15cm

Seeds start germinating by the middle of March, and germination is complete within a period of about two months, depending upon the time of snowfall. Germination percentage is 80-90. Mortality in the nursery is fairly high and only about 50% of the bags give plants for planting out after three growing seasons. Younger seedlings meet with poor success in the field.

Field planting of nursery raised seedlings is done before snowfall or after it melts. Holes of suitable size are dug near places with some shade of bushes or boulders to provide protection from animals and early shade. Regular spacing for planting is not possible on account of the rocky and bouldery terrain (Fig. 6). Care is taken not to injure the root system when the polythene bag is removed and the seedling is planted.

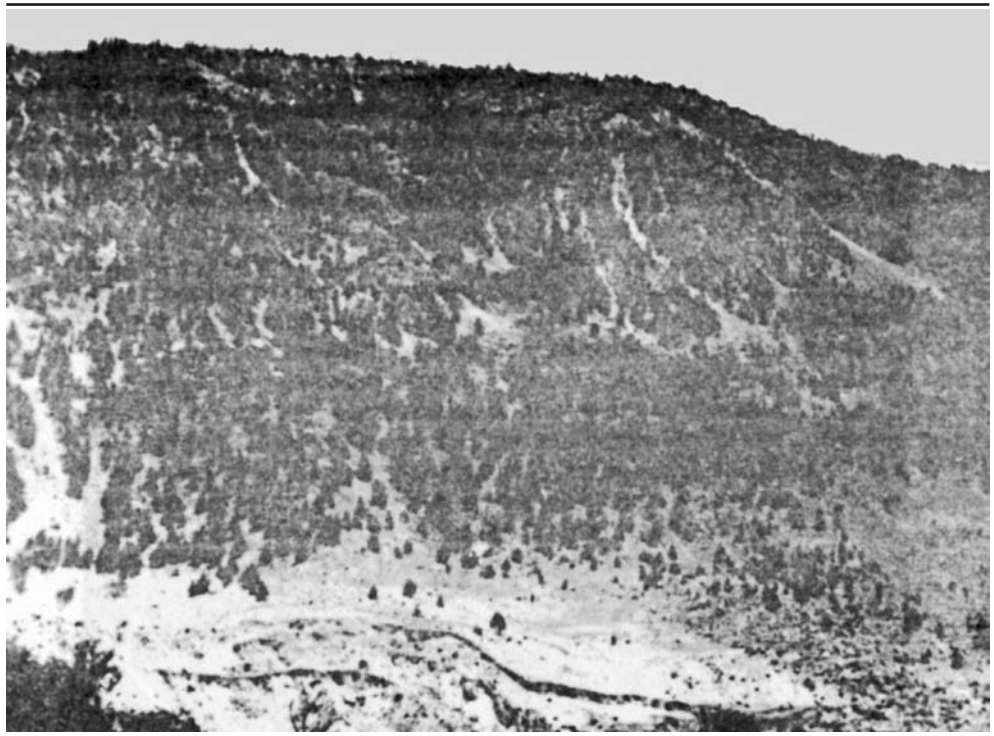


Figure 6. Pinus gerardiana plantation in Himalchal Pradesh, India

Grafting

The chilghoza pine takes several years to produce seedlings fit for use as stock for grafting purposes. Heteroplastic grafting of scions collected from the upper half of the crown of healthy, middle-aged cliilghoza trees on comparatively fast growing seedlings or saplings of *Pinus roxburghii* and *Pinus wallichiana* is physiologically possible. Grafting of chilghoza on the latter gives a better percentage of success. This saves time and also induces early flowering. Cleft grafting is preferable. Best results are obtained by grafting dormant scions on active stocks. In India grafting is done with higher success expectancy in March 14). Grafting of a chilghoza pine scion on *Pinus roxburghii* stock is shown in Fig. 7.

Tending Operations

Weeding in plantations is not necessary. Any growth of shrubs provides shade to the plants in the earlier stages and helps in the establishment of chilghoza seedlings. Established seedlings require overhead light for growth and therefore heads of plants should be kept free to a height of about 0.3m or more. Plantations should be protected against cattle damage. In later stages heavy thinnings are recommended for expansion of crown and maximum production of cones.

Injuries and Protection

Chilghoza trees are attacked by a number of bark borers and beetles, which ultimately kill the trees. Affected trees should be felled and burnt. Bark which is attacked by bark-beetles should be removed and burnt and branches lopped off and burnt. The larval and pupal stages appear at the beginning of June, themiddle or end of July, the end of August and in the mid-

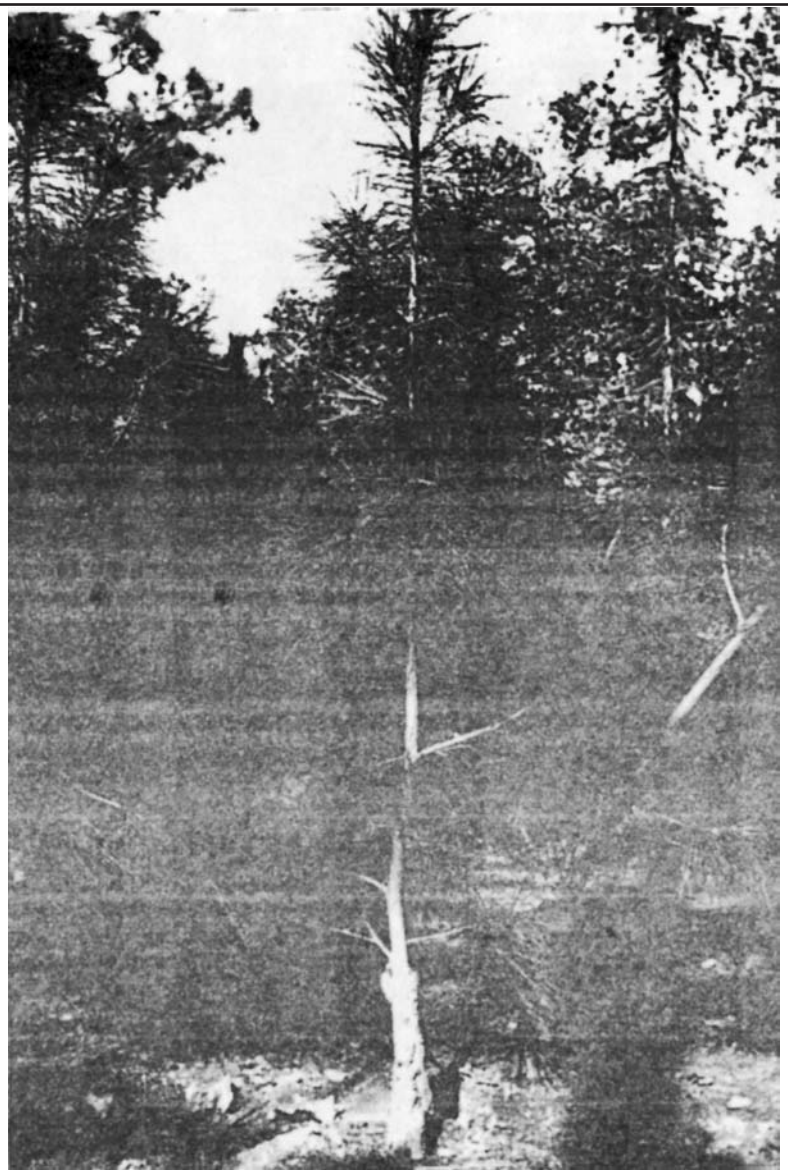


Figure 7. Pinus gerardiana graft on Pinus roxburghii stock

dle or third week of October. Beetles of *Pityopthorus chilghoza* and *P. gerardianus* bore into twigs and shoots. The cones are attacked by *Dioryctria abietella* and *Euzophera cedrella*. The larvae of the above species bore into the cones. The emergence period is from July to April. The *Dioryctria* species tunnel in shoots and branches. As a control measure all the affected cones seen between July and the next spring may be collected and burnt. The branches and shoots affected by *Dioyctria* should also be pruned and burnt (3). This pine is affected by red heart or pecky rot caused by *Fomes pini* (2). Considerable damage is done to the trees during cone collection as branches and twigs are ruthlessly torn down.

Rate of Growth

The chilghoza pine is a slow-growing tree. In one year seedlings attain height of about 2.5 to 3cm. Average height of plants at 5 years and 15 years age has been recorded as 0.8m and Sm respectively. The annual girth increment is about 1.2cm. It takes about 64 years to attain a girth of about 60cm at stump level (12).

Utilisation

(i) Seeds: The nuts of *Pinus gerardiana* are edible and of considerable economic value to the local inhabitants. Cones are collected in autumn and seeds extracted from them either by heating or drying in the sun. In the natural zone of its occurrence in India, cereals are scarce and chilghoza kernels form a staple food. Seeds are roasted and eaten. Collection rights to the nuts are vested in the local villagers, who supply them to the plains markets. The sale of chilghoza nuts is estimated to bring in 3.5 to 4.0 million rupees per year. The current price of nuts is 25 rupees per kg.

Chilghoza kernels have the following composition:

Moisture	7.5%
Protein	15.9%
Fat	49.9%
Carbohydrates	21.6%
Fibre	2.2%
Mineral matter	2.9%

Mineral constituents of the kernels are, calcium 90.8, phosphorus 92.4 and iron 2.4mg/ 10Ogm. Pectin calculated as calcium pectate is found to be 1.73%. A sample of kernels yielded 32% of transparent, pale-yellow oil. This oil is said to be used for dressing wounds and ulcers (1).

(ii) **Timber**: On account of availability of good timbers like deodar and blue pine in the region, chilghoza wood is not much used as construction timber. Trees are not felled for timber except when dead, since they yield valuable seeds. Chilghoza timber in appearance and strength properties is very close to *Pinus roxburghii*, but it is somewhat coarser and more resinous. The wood weighs 705 to 753kg per cubic metre (1). It is hard, tough and contains yellowish brown heartwood. The bark is used for making baskets and water buckets.

(iii) **Oleoresin**: The tree can be tapped for a good quality oleoresin, but on account of its restricted distribution, accessibility, and low yield, chilghoza pine is not commercially exploited. The yield of resin per 100 blazes of the chilghoza tree is only 36kg, compared to 187 to 224 kg obtained from chir pine. Chilghoza oleoresin yields 35 litres per 100kg of very good quality turpentine oil. This oil contains: γ–pinene (73%), β- pinene (7%), sesquiterpenes, and sesquiterpene alcohols (13).

The resin from *P. gerardiana* forms a basic raw material for the manufacture of synthetic camphor. The cones exude a white resin which is locally used for patching cracked wooden vessels. A valuable pine oil can be extracted from the needles and wood (9).

(iv) **Tar**: The wood can also be distilled for wood tar which is of the same quality as that from *P. roxburghii*. It is obtained by crude distillation in which the major portion of volatiles are allowed to be lost. At 30°C it is granular, dark reddish-brown in colour, with a density of 1.06. It is soluble in 90% alcohol at the same temperature (9).

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EDITOR'S NOTE

The Chilghoza Pine in Australia. I have been able to locate only one planting of the chilghoza pine in Australia. As well as bearing nuts, the chilghoza is one of the two 'lace-bark' pines (the other is *Pinus bungeana*) which have intricate bark-shedding patterns and are valued as feature trees. The following response to an enquiry refers.

From: Woods and Forests Department, Wirrabara Forest Reserve (Wirrabara, S.A. 5481). (G.G. Brown, District Forester, Northern).

Yes, we do have several mature trees of *Pinus gerardiana*. We collected a few seeds and successfully raised seedlings there from two years ago, so have no doubts about viability.

Problems of Bush Planting

DAVID NOEL*

For the past six years I have been planting nut trees on my 5 ha. block in the hills near Dwellingup. The block lies within jarrah forests, at an altitude of around 250m, and has the usual S.W. Australian climate pattern of six cool winter months during which most of the year's rain falls, followed by six warm to hot, dry months with occasional peaks around 40°C. Annual rainfall is comparatively high at about 1000mm, supporting excellent commercial stands of our principal hardwood, jarrah. A creek through the property runs for about 5 months of the year, with some areas of ground near the creek remaining moist all year. The surrounding jarrah forests have been afflicted in numerous places with the fungus disease *Phytophthora cinnamomi*, known locally as 'jarrah dieback', but elsewhere called 'avocado root rot', etc., according to the particular local flora affected. The area holds the all-time State record for minimum recorded temperature, -7°C, and there are several frosty spells each winter cold enough to form ice on the top of open water barrels.

When I started planting I had no experience with nut trees, and had to learn most things the hard way. As I can only visit the block on occasional weekends, I had assumed that the principal difficulties would be in watering the plants sufficiently in the dry season, and in the early years I spent most of my summer visits on hand watering trees from either a small natural dam on the creek, or from a shallow 2m deep well I had dug.

In fact my main problems turned out to be unconnected with water, and I have now ceased summer watering altogether, even for plants put in the ground in the previous winter. The technique I have evolved to do this is certainly not the only possible one, but I have proved to my own satisfaction that it can give survival rates well over 90%, whereas my initial survival rates varied from zero up to about 30%, even with careful watering. Some of the problems I have met with and, hopefully, solved, are as follows.

White ants. The block was roughly-cleared some ten years ago, but has considerable debris scattered around and also considerable regrowth of eucalypts, with dense native tea-tree thickets along the creek areas. To avoid the risk of erosion and provide some shelter from sun and wind, I have followed a policy of gradual replacement of native regrowth with nut plants, rather than expensive clearing of big areas. Nest of termites occur throughout the block, usually mostly underground based on part-buried branch and root fragments. I found that termites hungrily attacked many newly-planted nut trees, eating the roots and stem and killing the plants within a few weeks. They seemed particularly fond of chestnuts, clearing up almost every one, and reasonably partial to almonds. Pecans appeared to be more resistant.

I have been able to overcome this problem by puffing 30gm or so of dieldrin dust around the planting hole sides, before replacing soil in the hole and setting in the new tree. Dieldrin is held in some disfavour because it is a highly residual, long-acting insecticide, but in this case these properties are desirable as they keep the chemical permanently underground around the tree roots, and do not allow it to contaminate the water table or affect any above-ground crops.

* Member and Director, West Australian Nutgrowing Society

Rabbits. The second most serious problem was with rabbits, which killed many young trees by ring-barking. A partial solution was obtained by surrounding newly-planted trees with sprigs of one of the numerous thorny prickle bushes growing on the block. Even better results were obtained by painting the stems of trees with white plastic paint containing a proportion of the fungicide thiram (e.g. ICI Thiotox). This is an ecologically 'soft' solution, as the chemical does not poison the rabbits, it justs tastes so horrible that one bite is enough for them. However, thiram does not deter kangaroos very well, these will nip off the whole top of a young tree in one bite. Use of prickle-bushes still seems to be the best kangaroo deterrent, and in future I will be using these as well as thiram.

Lingering misery. Unlike white ant and rabbit attack, this problem was very difficult to pin down or even recognize. Symptoms were that trees would leaf out satisfactorily in the spring but become gradually weaker in the summer and autumn, getting generally unthrifty with poor new growth. Some trees would go into permanent hibernation in the first winter, others would struggle on for two, or even three years, before expiring. The problem was especially marked with walnuts, and I had several vigorous, 2m tall grafted walnuts succumb. In fact, of some 30 or 40 walnut trees planted in the first four years, I had only one survive.

I have now proved to my own satisfaction, at least, that this problem was due to the condition of the trees at the time of planting, and in particular to their lack of fibrous roots. Because there have been no worthwhile sources of nut trees within Western Australia, most planting stock has been imported from the Eastern States, bare-root to satisfy quarantine regulations. Moreover, most of this stock was field-grown from seed, and digging for transport usually meant cutting the tap root and losing much of any side roots which existed. What roots were left after digging and soil washing inevitably dried out somewhat during the 2-week rail trip. Bigger stock, with more taproot to lose during digging, naturally enough was more prone to the lingering misery syndrome.

My answer to this problem has been to grow on all trees imported from the Eastern States in containers for one year at least before bush planting. The trees are grown in a backyard nursery in bottomless plastic tubes, under partial shade, and when ready for planting can be shaken out of the tubes into the prepared hole with virtually no root disturbance. Growth in a container encourages fibrous side roots to form, especially if the taproot was cut to transport the tree. This approach has improved survival rates of all nut trees tried, and in the case of the difficult walnuts has increased survival rates from under 5% to over 80%.

Drying out. Even when planting from containers, with an undisturbed root system, young bush-planted trees are subject to considerable moisture stress during their first summer. Care must be taken at planting time if the trees are expected to survive without subsequent watering. I try to observe the following rules: plant as early as possible in the year after winter rains have saturated the soil (usually around May on); only plant as many trees as can be properly treated in the time (my limit is 12 in a day); dig a deep hole (around 1m) and fill the bottom with a mix of topsoil, sawdust, manure, leaves etc. (my holes are fairly narrow usually, around 30cm); saturate each tree in its plastic tube, in a bucket of water, before shaking it out into the hole; form the top of the plant hole into a shallow basin, and add a bucket of water to each newly-planted tree: and mulch the basin with about 3cm of sawdust, over a diameter of about 1m.

This year I am carrying out an experiment with a product called 'Ecologel', which is supposed to reduce the water needs of plants, but it is still too early to draw any conclusions.

General comment. My block now contains several hundred nut trees of many different species, some of which (chestnut, hazel, almond) have reached the flowering stage and should be producing soon. I only plant about 50 new trees each year, and have finished well before the rains cease, usually in August. Among the plants which have survived over at least one year, and went through the 70C freeze with minor or no damage, are: chestnut, almond, walnut, black walnut, bunya pine, parana pine, cork oak, portuguese oak, stone pine, moreton bay chestnut, tung, hazel, and pecan.

Almond Production In California

ROGER BACCIGALUPPI**

Some of you may have seen the film on almonds in California, called "Elegance is An Almond" which was made for the California Almond Growers Exchange around 1966. This film showed some background on how almonds are grown, processed and a little bit about how they are sold. Let me summarize some of the important points and then move on to the marketing aspects.

The almond is now the No. I tree nut in the USA, in terms of dollar value, and its been that since 1965 when it surpassed the pecan. The largest almond producing "nation" in the world today is California. More than fifty percent of the world's almond supply originates in the Golden State. In California, almonds are No. 1 of all tree and fruit crops in terms of total acreage, if you exclude grapes of all types. Today there are some 225,000 bearing and 75,000 nonbearing almond acres for a total of 300,000 in the State.

The total of all citrus is 252,000 acres. Other major crops and their total bearing acreage are: Peaches 71,000, Olives 28,000, Apricots 29,000, Pears 36,000, Prunes 81,000, Walnuts 162,000. At the end of 1973, the total farm value of almonds was $199m. By way of comparison, grapes (all types combined) was $609m, oranges $134m and walnuts $97m.

We make a distinction in California between tree and fruit crops, which are of a rather permanent nature, and the other types of crops which are less permanent; but of all California crops, tree, fruit and otherwise, almonds are now exceeded in dollar value only by grapes, hay, tomatoes, cotton, lettuce and sugar beets.

All U.S. almond production is in the State of California. It takes a unique Mediterranean climate to produce almonds commercially, so the only other major producing nations are Spain and Italy, with some small production in Portugal, North Africa, Chile and Australia. It takes an unusual combination of hot dry summers and cool summer nights and a dormant period sometime during the winter when the temperature at least occasionally falls below freezing. This set of weather factors is, of course, unique in the United States to California.

More than half the almonds grown here are sold outside the United States. In our manufacturing facility we shell nearly two million inshell rounds of almonds daily during our busiest season (from September through January or February), which yields approximately a million pounds of shelled almonds and a million pounds of shells. The latter are converted to charcoal briquettes at a nearby plant.

Our basic company philosophy, we say it's our only reason for being, is to maximize grower returns over the long run. Whatever we do in the way of marketing, or anything else for that matter, stems from this basic philosophy.

The crop harvest starts in August and goes on through November. We feel that to maximize consumption of almonds, however, customers must have them purchased and know they are going to get them and at what cost long in advance of when they intend to use them. It is for that reason that we generally sell the crop which is going to be harvested in the fall during May or June, based on estimate of what the crop will be. While we didn't follow this policy during this last year, we generally sell on long term contracts of about one year. These

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* Based on a talk given in 1973.

** President, California Almond Growers Exchange, P.O. Box 1768, Sacramento, California, 95808.

contracts are intended to assure buyers of a fixed quantity of the types of almond they want at a fixed price.

Long term contracts are something we have been using as a sales and marketing tool for some fourteen years now, and we think it has been an important part of our success. Unfortunately, we've been so successful that for the last three years we've been virtually sold out, except for about two or three weeks a year when we offer the crop. We really can't take all the credit, however, in that California production the last few years has not been what it should have been, given the acreage involved; and at the same time, Italy has fallen way off in their production and this last year was one-tenth of what it had been only ten or eleven years ago.

Diversification, of course, has been quite popular in business for quite a few years now. While we have not diversified into any areas outside of almonds, we do feel we have become a highly diversified company in that we offer some 2,000 different items. We've developed many new items as a means of developing new markets for our basic product. For example, we developed slivered almonds and now offer this in three different types. We developed diced almonds, to be differentiated from chopped in that they are very uniform in shape, and now offer these in four main type sizes with a host of possible variations. We developed sliced almonds and we offer these in both natural and blanched form in four different thicknesses - thin, extra thin, regular and thick. We developed flavoured almonds such as Smokehouse, Barbecue, Garlic-onion, Cheese, Mintees, Sweetees and Honees.

The film showed some of the major markets to whom we sell our products. This in a sense is another form of diversification, in that sale of our product is not confined just to grocery stores or candy makers, but rather we sell to a wide variety of businesses. The film mentioned that 42 percent of the almonds went into the confectionery trade, but actually this is closer to 35 percent today. The bakery trade takes 10 percent of our crop and here we serve large customers and thousands of retail bakeries (through jobbers) all over the country. The ice cream industry takes about 12 percent of our crop.

Food processors are now taking about 17 percent of the crop and some major customers in this area are for frozen foods with almonds, and now one of the biggest developments, companies for natural or granola type cereals. What we call the "grocery" business takes about 22 percent of the crop. This includes bulk sales to nutsalters and repackagers who then add our nuts to their packages for distribution to retail stores, as well as our own packages of raw and salted nuts. The hotel, restaurant and institutional field takes about 4 percent of our crop.

We also have a direct mail business and three retail stores. Some twenty years ago, we began selling a few almond gift packs out the back door, so to speak, and now produce a 16-page, 4-colour catalogue annually, offer more than sixty gift packs and have retail stores at Sacramento, San Francisco, and San Jose.

We package in everything from half-ounce foil packets, 6 and 10 ounce cellophane packages, one-pound cello inshell packages, 6 and 14 ounce, 3 and 4 pound tins, 25 pound and 50 pound cartons, up to 1500 pound bulk bins for large industrial users. We also pack inshell almonds in 50, 80 and 100 pound bags.

Our advertising has been increased over the last ten years or so in direct proportion to our success in moving additional quantities of almonds. We are now spending nearly $2 million annually, not quite half of that in Japan. Thanks to the US. Department of Agriculture we have one of the first FAS brand advertising programs in operation there, and it has been a very substantial contributor to our success in that nation.Our consumer advertising includes colourful ads in magazines like Time, Newsweek, Sports Illustrated and the New Yorker - and a long list of others - as well as trade advertising in specific magazines directed to the bakery, confectionery, food processing and ice cream trades and to restaurants.

In addition, as mentioned earlier, we produce a gift catalogue annually and prepare and distribute formula books for ice cream, bakery and confectionery manufacturers and recipe booklets and pamphlets for consumers.

As I mentioned earlier, more than fifty percent of the crop is sold in export. The reasons and types of uses overseas are similar to those here, though there are vast regional differences. For example, probably as much as eighty percent of Germany's consumption ends up in baked goods, compared to ten percent in this country.

The major consuming countries are Japan (where we now have a staff of 24, a retail store, a mail-order program, a large advertising budget and are working on a joint venture for roasting and packing in Tokyo), Germany, the United Kingdom, the Scandinavian countries (in Sweden, almonds are the fourth largest U.S. farm import) Switzerland, France and Russia.

Many people are surprised to learn we are also selling Blue Diamond Almonds in Czechoslovakia, Hungary, Poland, Yugoslavia and East Germany. In total, we are selling almonds in at least forty foreign countries. There is development work to do in these countries to increase consumption; and we are also working on some new markets, places like China or India, for example.

We are also devoting a good deal of our time to increasing consumption even further in this country. We are working on new products and flavours and new types of packaging. We developed a candy, new to this country, called Almond Nougat which we are now testing through our own retail stores and our catalogue. We feel a great deal of pride in the business we've developed recently with the cereal firms.

It is interesting to look back to the beginning of this century when there was virtually no almond industry at all in the United States. It began to form in the early 1900's and by 1912 the Exchange was founded. Until the 30's however, all almonds were sold in the shell, pretty much for the Christmas trade. It was in the 30's that we began shelling and started selling to confectionery customers who became interested in using California Almonds in their products.

The Exchange is comprised of 4600 grower members from the north end of the Central or Sacramento Valley near Red Bluff, south through the part of the Central Valley that's called the San Joaquin Valley and on into a few orchards in Los Angeles County, near Lancaster. The bulk of production is in the San Joaquin and Sacramento Valleys, though there are small production areas near Paso Robles and as already mentioned in Los Angeles County. The Exchange is a grower-owned, tax-exempt cooperative.

The non-bearing acreage which has been in existence has kept us aggressive and looking for new ideas and new ways to sell. We've been searching for better ways to sell so for the last fifteen years, we've basically- been working hard to innovate and create new demand as new acreage came into bearing.

Today we can say we've been very successful, but it wouldn't be fair to say we haven't had a great deal.of luck as well. Nevertheless, we could sit back with pride and look at our accomplishments, but the growers keep planting. The more successful we seem to be the more they seem to plant. So we are working harder than ever. Today there are 300,000 bearing and non-bearing acres compared to just over 100,000 thirteen years ago and they are talking about putting another 50,000 acres in this year and next. That acreage, 350,000 acres, is capable of producing 360 million shelled pounds or last year's all-time record world consumption. And don't forget, Spain is planting almonds too and there is also production in the other countries I've mentioned. Obviously, we can't rest. Perhaps a part of our success has been that none of us want to rest.

Bunya Pine In Queensland: Grafting, Pollination, Seeding, And Related Species

"QUECO"*

The Bunya Pine, *Araucaria bidwillii* Hook, is a Queensland native which produces a valuable timber. It has a limited natural distribution, occurring mainly in association with Hoop Pine in rain forest areas of southern Queensland as an emergent species. In 1948 an isolated patch of Bunya Pine was located near Mt. Molloy, west of Cairns. Most remaining sites containing natural stands of the species are located on State Forests, on which a permit may be granted for the collection of Bunya Nuts at $0.20 per cone. Bunya Pine has, of course, been widely cultivated in Queensland.

The Queensland Forestry Department does utilize Bunya Pine as a plantation species to a limited extent on rain forest sites. Our major plantings in rain forest areas are of Hoop Pine (*Araucaria cunninghamii* Alt.) which is more suitable for our purposes because (a) of its more rapid growth rate, and (b) it is easier to manage in the nursery. Bunya Pine is slightly more resistant to frost damage and more tolerant of grass competition and so is utilized in areas where these factors can be a problem.

Nursery practice. Nursery technique for Bunya Pine is relatively unsophisticated. Briefly it involves deep sowing of seed ("nuts") covered with a mixture of soil and pine sawdust, and potting into metal tubes when they reach about 6 ins, in height. Germination is slow and erratic; this refers only to the emergence of the epicotyl. The Department usually sows several hundred pounds of seed at a time, with emergence (and consequently potting) stretching over a considerable period. When potting, the original seed containing the cotyledons is kept intact. Plants are kept in the tube for at least 6 months before out-planting.

Vegetative propagation. Because of its limited importance to the Forestry Department, little attention has been placed on vegetative propagation of Bunya Pine. Considerable effort has however been applied to genetic improvement of Hoop Pine in Queensland and the broad principles will apply to both species.

Initially various cutting and air-layering techniques including root-cuttings were attempted with hoop pine (and *Agathis* species of the same family) but for reasons that will become apparent below, as well as the relatively low success rate, little attention is now placed on such techniques other than in exceptional circumstances. Successful grafting techniques have however been developed.

Grafting procedures rely on an understanding of the bud system of *Araucaria* and *Agathis* species (common with the Northern Hemisphere firs - *Abies* spp.). These are described in a Queensland Forest Service publication written by D.K. Nikles (1). The contents are not quite up to date, but would explain in some detail the problems. I will attempt to outline the techniques.

(a) The Bud System

It has been discovered that branch material does not produce satisfactory plants when propagated. This is because of the peculiar bud system of this group of conifers. Dormant buds are of two types - (i) plagiotropic bud traces on branches which if allowed to develop

*Our Queensland correspondent, who wishes to remain anonymous, is well acquainted with the practices of the Queensland Department of Forestry.

produce only branch habits - an "irregular, sprawling tree"; (ii) orthotropic bud traces on the main axis of stems which produce leader growth, from which lateral branches will still of course develop. (Fig. 1).

Consequently any use of branch material for vegetative propagation will produce plants which are in effect merely a branch or branches. (With Hoop Pine at least, rare seedlings may be encountered which also have the branch habit).

Because of the above, material available for vegetative propagation is limited to the stem axis, containing orthotropic buds. One such dormant bud is located in the axil of each leaf on the stem and is capable of developing a terminal shoot. (See Fig. 1).

As stated, cutting and layering techniques have been attempted, but even with the correct material, success rate has been limited, and grafting is now standard practice where vegetative propagation is required.

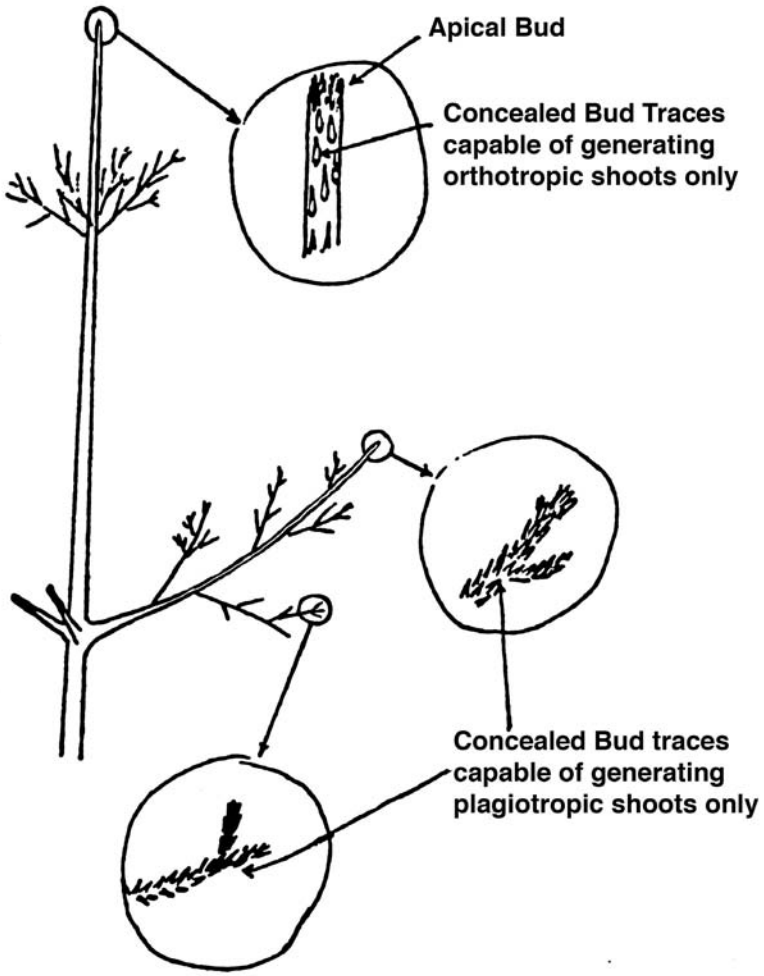


Figure 1. Bud Systems of Hoop Pine

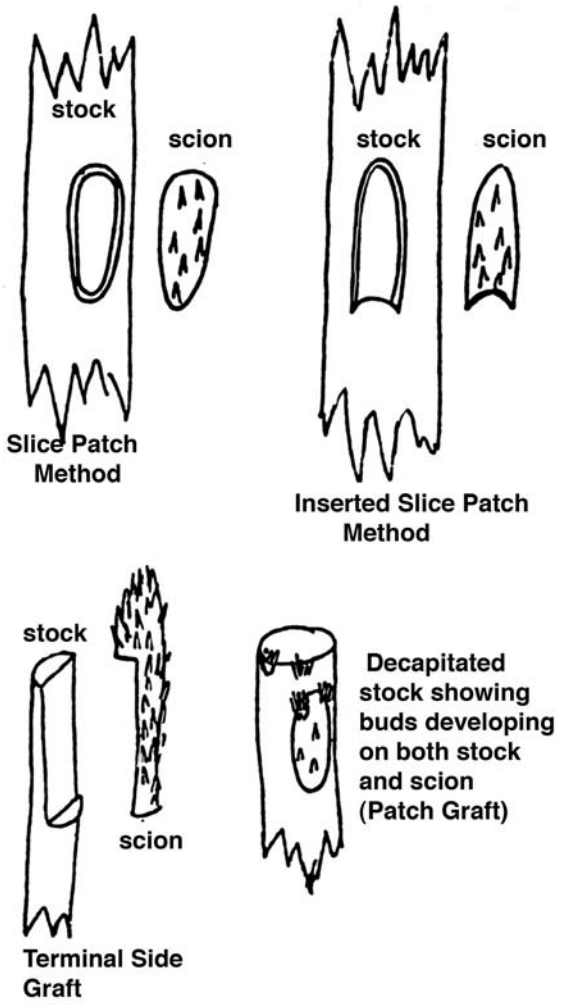


Figure 2. Hoop Pine Grafting Techniques

(b) **Grafting Material**

Material utilized for this purpose is limited to that portion of the terminal shoot which is of similar diameter to stock plants upon which the grafting is to be carried out, and which still contain chlorophyll in the stem epidermis. This has to be collected by climbing and removing the tops of parent trees for scion material (an unpleasant job for Bunya Pine). Of course, once successful grafts have been produced, the material from these can be utilized for further grafts.

(c) **The Grafting Techniques**

Many forms of grafting have been attempted for Hoop Pine. Best results for our purposes are achieved with (i) slice patch grafts and (ii) terminal side grafts. The amount of scion material available from a given tree is limited and so to make greatest use of this, the slice patch graft is the most efficient. This merely involves the removal of an oval shaped patch of tissue from the stock plant, just down to the wood, 2-3" long and an inch wide, with a matching

slice removed from the scion material (matching size, shape and tissue exposed as closely as possible). This scion patch is placed on the bared patch on the stock plant, bound with grafting tape (starting from above the patch and winding down to help keep moisture out) and sealing both ends with grafting mastic (e.g. Colgraft). Leaves or needles are first scraped gently off to facilitate the binding. Some 3 or 4 weeks later the tape can be removed and if the graft has "taken", the stock plant is decapitated about 1" above the top of the patch. For Hoop Pine success rate is generally in excess of 90%. Up to 100 grafts can be made from one leader of scion material for Hoop Pine, but I would imagine this figure would be considerably less for Bunya Pine.

The terminal side graft can be used for the top portion of the scion material. It and other techniques are shown in simple form in Figure. 2. The other techniques have no advantage, although some prefer the inserted slice patch which leaves one hand free for winding the tape.

Following decapitation the dormant orthotropic buds on the scion patch begin to develop within a few weeks, with one bud usually becoming dominant fairly rapidly. However dormant buds on the top section of the stock plant also emerge and require periodic removal until the shoot from the patch has taken full dominance and normal tree habit is resumed.

Some incompatibility problems can occur with hoop pine, following successful take of grafts, either at an early stage (i.e. within the first year) or several years later. The situation with Bunya Pine is unknown.

Flowering. A further problem is that different parts of the tree crowns bear the male and female flowers respectively. With Hoop Pine in particular, physiologically older branches bear the male sporophylls or catkins, i.e. the female flowers occur near the tops of the trees, while the male ones are lower down. This means that a graft will produce female flowers within two years of grafting (for Hoop Pine) but will not produce pollen until around 6 years later. This is probably less of a problem with Bunya Pine which produce catkins over a greater part of the crown, although an observation is that some Bunya Pines are far more prolific producers of pollen than others.

To overcome this problem in Hoop Pine the Queensland Forestry Department also graft plagiotropic shoots i.e. branches from the middle one-third of tree crowns on seedling stocks adjacent to the stocks with orthotropic grafts. (Terminal side grafts). These produce a branch as the apex which produces pollen and consequently open-pollination can occur between grafts within two or three years, with viable seed two years later. This would not be necessary if hand pollination were carried out.

Flowering of Bunya Pine has not been followed at all closely. Dallimore and Jackson (2) state "Male and female strobii are usually on different trees, occasionally on the same tree". I certainly have noted some entirely male trees. The same comments are made by Dallimore and Jackson about the Chile Pine (*A. araucana*). Many conifers (and certainly *A. cunninghamii*) will successfully self pollinate and produce viable seed. Our documented results demonstrate, however, that the resultant progeny are markedly inferior in vigour when planted. This may not affect production of nuts, but such seed should not be used for future growing stock. Seed orchards of conifers are normally designed to include a range of desirable parents, with clones located so as to avoid inbreeding as far as is possible.

An important point to note is that female flowers or conelets are receptive to pollen for only a few short weeks. This period of receptivity is best gauged by close and frequent examination of the very young conelet (i.e. starting when the conelets are only a centimetre or so long,). The conelets are receptive to pollen only while the conelet scales can be seen to be open. It may not be reliable to gauge this period by merely observing pollen flow from other

trees as considerable racial variation in timing of pollen flow may occur (certainly does for Hoop Pine).

Periodicity of cone crops is incompletely understood. Some refer to a three year cycle, but this in fact is by no means fixed and can vary widely. Seasonal conditions appear to be involved, as well as the effect of a heavy flowering one year precluding effective flowering the following year. Orchardists treat the latter aspect by spraying with growth retardants, thus promoting lighter flowering every year, but the seasonal effect is as stated improperly understood, and is more of a problem with species such as the Araucarias. There may be some variations between individual parents in this respect but observations suggest that good and poor flowering years occur uniformly on most trees in the one area.

Early bearing. No information is available on early bearing trees (which would be of little importance if grafting), or of the gourmet value of different seeds or nuts.

Other nut-bearing Araucarias. Hoop Pine (*Araucaria cunninghamii*) of course does not produce edible nuts. The Department has attempted to utilize Parana pine (*A. angustifolia*) in trial plantations. I am not familiar with the results ay other centres, but in the Yarraman District on sites receiving annual rainfalls from 32" to 45", mostly on krasnozems of basaltic origin and previously supporting rain forest, the species has not performed favourably and is no longer considered to have potential for our purposes. Unsuccessful cross-pollination with pollen from other Araucarias was attempted on one plot a few years ago (at the time, male and female flowers were on different trees). Local staff have indicated that they prefer the flavour of Parana pine nuts to those of Bunya Pine.

The Chile Pine or Monkey Puzzle tree (*Araucaria araucana*) has not demonstrated potential as a plantation species under our conditions.

Literature Cited

1. Nikles, D.G.:- "The Development of a New Method for Grafting Hoop and Kauri Pines". Queensland Forest Service; Brisbane; 1961. (Research Note No. 10

2. Dallimore, W. & Jackson, A.B.:- "A Handbook of Coniferae including Ginkgoaceae" Arnold; London; 1931.

Trial on Basamid

The following letters tell their own story.

aldebaran nut groves

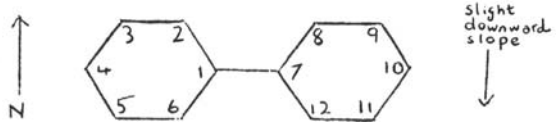
PO BOX 27, SUBIACO, WA 6008, AUSTRALIA David G. Noel, M.A.

Technical Manager, 1974-10-2
BASF Australia Ltd.,
Wood Street,
FREMANTLE W.A 6160

Dear Sir,

Trial on Basamid tt

In April 1971 I bought from you a quantity of Basamid to carry out a trial on the effect of this chemical on pre-treatment of tree planting sites. In the same month I prepared and treated six positions and prepared six control positions without Basamid. Every effort was made to ensure that the control and treated sets were completely comparable. The site was at an area near Dwellingup where I am growing nut trees. The layout of the trees was in dibenzyl formation, as sketched below. Chestnut trees were planted in all positions 10 weeks after treatment.



Trees 1-6 were treated with Basamid, trees 7-12 were controls. In 1972 Tree 2 died, and it was my impression that the treated trees were definitely retarded compared to the control trees. A few days ago, before bud opening, height and base circumference measurements were made on the trees:

Tree:	(1)	(2)	(3)	(4)	(5)	(6)	Ave.	Basamid
Height, cm	78	(died)	68	54	44	48	56	treated
Circum., cm	7.1		7.3	7.9	6.7	6.5	7.1	

Tree:	(7)	(8)	(9)	(10)	(11)	(12)		
Height, cm	152	69	124	123	95	94	109	Controls
Circum., cm	9.4	8.9	9.2	9.5	8.2	8.9	9.0	

These results show fairly conclusively that the Basamid treatment was detrimental to the trees. Control trees now have almost twice the height and twice the trunk cross-sectional area of the Basamid-treated trees.

This is not a claim for compensation, and if BASF has any liability toward me in this matter, I hereby waive it (although I reserve the right to publish these results). I would, however, be very interested in any explanation you might offer. It may be, for example, that Basamid destroys the mycorrhizal environment which may be essential for chestnuts, but unimportant for stone fruit. The 10 weeks between treatment and planting, with considerable rain, should have been more than adequate to ensure that the primary effects of the chemical were dissipated.

Yours sincerely,

David G Noel

BASF Australia Ltd.

(Incorporated, in ACT)

Chelsea House.
55 Flemington Road. North Melbourne Victoria, 3051
P0 Box 4705 Melbourne 3001
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15th October, 1976
C. :CC :P25

Mr. D. G. Noel,
P. O. Box 27
Subiaco, WA, 6008

Dear Mr. Noel,

Thank you for your letter of the 2nd October re Basamid Granular and its apparent detrimental effect on Chestnut trees. There are three possible causes we can think of which might explain this effect, only one of which is, we feel, plausible.

The first possibility is brought to mind by your very reasonable comment of the possible destruction of a mycorrhizal environment. Unfortunately we can find very little information about mycorrhiza and any symbiotic association they might have with chestnut trees. Discussion with several lecturers of the University of Melbourne left us with no further information and my following comments ore based on research with the symbiotic fungi in pine trees.

Work in New Zealand by Basset and Aill (1964) has shown that when sterilizing forest nursery beds with dazomet (the active constituent of basamid Granular) the incidence of mycorrhiza fungi is reduced but not eliminated. Tests in Germany have shown similar results and after sterilization, recolonization of the treated area with the fungi quickly occurred. Any mycorrhiza which formed a symbiotic relationship with chestnut trees would not necessarily be of the same species but it is reasonable to expect a similar reduction in numbers, but a similar rapid recolonization. Also if the trees you planted were transplants it is reasonable to expect that a mycorrhizal population was also introduced with the seedling and hence it is doubtful that the basamid has had the effect you mentioned.

The second explanation is that one of the by-products of the breakdown of Dazomet are specifically herbicidal against chestnut trees. Dresher and Otto (1968) conducted research on breakdown products which could last in the soil for longer than the sterilant gases. They did find one possibility, and that was that under high rate of usage, a triazine derivative is formed. As several triazine compounds are known to be herbicidally active, they did further work on this derivative, but found it to have no herbicidal, fungicidal or insecticidal activity, that crops grown under glass in soils containing 50 ppm of the derivative showed no damage and that it did not persist in the soil for long anyway.

It is therefore doubtful that this is a satisfactory possibility.

The third, most simple, and regretfully most probable explanation is that not all methylisothiacynate (MIT) was dissipated from the soil. MIT is the primary chemical associated with the biological activity of da-zomet and, of necessity in a total soil sterilant, is phytotoxic at low concentrations. For example a level of 5 ppm causes severe and permanent injury to tomato plants. The damage is by the death of roots and sometimes collapse of the stem base. And as you could imagine damage to main roots would affect the plant more or less permanently.

The only quick and practical say of ensuring no MIT remains, is by carrying out a germination test, and you do not mention a successful germination test in your letter.

Ten weeks between treatment and planting should be adequate for dissipation, but that statement is made with several reservations.

The first proviso is that the soil has been aerated. Movement of MIT in the gaseous form is limited both horizontally and vertically, even in light and sandy soils. Heavy soils, compacted soils and soils with a high organic matter contact are more restricted. Lower soil temperatures, and the associated implications of vapour pressure also decrease the rate of gas diffusion, although the soil temperatures in your situation would probably be high enough not to be a limiting factor.

You mentioned in your letter that you received a considerable amount of rain. This may have prevented you aerating the soil, and in actual fact, this could have caused more of a sealing effect; thus virtually the only method of dissipation of the MIT being by chemical and biological breakdown. This breakdown is an oxidation process, most rapid in soils of high biological activity (eg. composts). Should you have been unable to aerate the soil by cultivation or rotary hoeing etc., it is conceivable that levels of MIT remaining in the soil were high enough to be slightly phytotoxic. If you were able to aerate the soil, then these comments might not apply.

The other provisos include soil temperatures (they should be above 9-10° C. and below this two or three aerations may be necessary) and soil types (different soil types have different rates of dissipation and oxidation).

Thus these explanations hinge on whether you aerated the soil, or conducted a successful germination test. We cannot stress too strongly the importance of the germination test as the factors involved in dissipation are so numerous as to make it impossible to predict the length of time needed before planting. However if you followed both these recommendations, the mycorrhizal theory would have to be investigated more fully.

Thank you once again for your letter and comments, as we are always most concerned when a user of our products is not satisfied.

Yours faithfully,

G. HAMILTON
Technical Representative
Agricultural Division

David Noel's comment: No germination test was applied. In fact this is difficult to do conclusively for quite large heaps of soil from a deep planting hole. My feeling now, is that it is not worth using soil fumigation treatment before planting unless there is some special reason.

Prospects For Pistachio Nutgrowing in Australia*

D.H. MAGGS**

Pistachios are small nut trees from Asia Minor, known from antiquity as a luxury crop, and now receiving wide consideration as a candidate crop for irrigation in subtropical desert areas. Later in this paper potential average yield is conservatively estimated at 1500 kg/ha dried nuts; at $2.00/kg this would gross $3000 per hectare.

Potential Markets

According to FAO estimates, world production of all edible tree nuts is approximately 3 million tonnes. To this total, almonds, cashews and walnuts each contribute 0.5-0.6m tonnes, and hazels and chestnuts 0.3m tonnes. Pistachio nuts total 0.05m tonnes, and since their ecological requirements seem distinct from the other major nuts, total production may be expected to increase rapidly.

World commercial production and trade are summarised in Table 1A, B. Production has been averaged over four-year periods to minimise the annual fluctuations to which the unirrigated crops are prone.

TABLE 1A, B

Main commercial production and trade in pistachio nuts[1]

Average per year in 1000 tonnes (= 1016 tons)

A. Production[2]

Country,	Period 35-39	52-56	57-61	62-66	67-71	71-72[3]
Iran	n.a.	3.8	4.2	8.4	9.8	26.9
Turkey	3.2	n.a.	8.1	4.4	6.5	19.0
Syria	n.a.	0.8	1.1	1.0	n.a.	1.6
Italy (Sicily)	n.a.	1.5	n.a.	n.a.	n.a.	1.8
Greece	n.a.	n.a.	n.a.	n.a.	n.a.	1.0

B. Exports

To	Exported from Iran			Turkey		Italy	
	64-66	67-69	64	69	64-66	67-69	
U.S.A	3.2	4.2	2.8	1.7	<0.1	<0.1	
Europe	0.2	0.5	0.1	0.2	0.3	0.2	
Asia 4	1.2	1.5	0.1	<0.1	0	0	
TOTAL	4.6	6.2	3.0	1.9	0.3	0.2	

[1] Data courtesy U.S.D.A. (1970) except for Italian production which are from Spinna and Pennisi (25).

[2] Data not available for significant production in Afghanistan. USSR, Greece and N. Africa.

[3] Data FAO. 1973.

[4] Mainly to India, Iraq, Israel, Arab Emirates, Lebanon, Pakistan, partly in transit for re-export.

* Based on "The pistachio as an Australian crop" (18)

** Principal Research Scientist, CSIR0 Division of Horticultural Research, Merbein, Vic. 3505.

Iran is the only country where most of the commercial production is irrigated and is the only one to show a steadily increasing trend. The decline in Syrian and Sicilian trade may result from increasing domestic consumption and it is quite possible that this factor will eventually operate to limit the increase in Iranian exports, where large new plantings are beginning to bear.

In the USA, large plantings have recently been made or projected in central California to meet a current demand estimated at 15,000 tonnes (3).

Although imports have not increased as rapidly as production, demand in the USA is reported to be sufficient to absorb a 50% increase in imports if they were available. The European Common Market could also develop a greatly increased trade if regular supplies were assured. Consumption will also increase in the Middle East and North Africa as living standards increase.

In Australia, the imported nut has been available in large towns for years. It is becoming more widely known and it is now sold in rural centres. Imports currently run at 70 tonnes valued at S140,000 f.o.b.

In 1935 trees imported by the N.S.W. Dept. of Agriculture grew and fruited at Yanco, and from them others were established at Wagga Agricultural College. These are still bearing under natural rainfall (540 mm). These trees, and the collection subsequently built up at Merbein, clearly demonstrated that the crop has some potential for Australia. However, since yield estimates must at present be based on scanty overseas data, projections of economic prospects must be regarded with reserve; trial plantings should be made only on a scale that would not jeopardise a business if they failed.

Description

The pistachio (*Pistacia vera* L.; Anacardiaceae) is a small deciduous tree somewhat like the fig in its sprawling habit, growing to Sm high and 10m across (Fig. 1). The trunk is at first smooth and grey; later it becomes fissured and finally blackened, like the butt of an ancient almond. The widely spaced leaves have 1, 3 or 5 flat, leathery, grey-green leaflets. The whole plant is permeated by resin ducts whose contents give the plant its characteristic smell (19).

Seedlings produce thin sprawling shoots for the first two years. Subsequently vigorous stout water-shoots form the scaffold branches, bearing 1 cm diam. laterals. Flower buds develop only on these thick mature shoots.

The vegetative buds are small and easily distinguished from the much larger flower buds (Fig. 2). These contain no vegetative primordia and trees which crop excessively become very leggy.

Jones (12) has described fruit bud development. The floral primordia differentiate very early, probably in early November, and the large buds are clearly distinguishable in December. In spring, flowering is finished before the foliage develops. Shoot growth is very rapid and the first flush finishes by November. Under irrigation it usually resumes in December and even again in March.

The individual flowers are small and clustered together in short lateral spikes (Figs. 3, 4). As with all Pistacia species, male and female flowers are produced on separate plants. Pollen is carried by the wind, not by the bees which in fact frequent the male trees to collect pollen and resin. When the females are receptive the stigmas develop a red tinge. Receptivity lasts about four days (26). When ripe, the anthers burst open to show the bright yellow pollen. The male flowers tend to open before the female, so that commercial orchards use specially selected late-flowering males that synchronise with the females.

Growers selecting their own males should check that the pollen sacs (anthers) are well

Figure 1. Young pistachio tree planted 6 years. Height 4.1 m

Figure 2. Dormant shoots showing the large fertile buds. Note the wide branch angles.

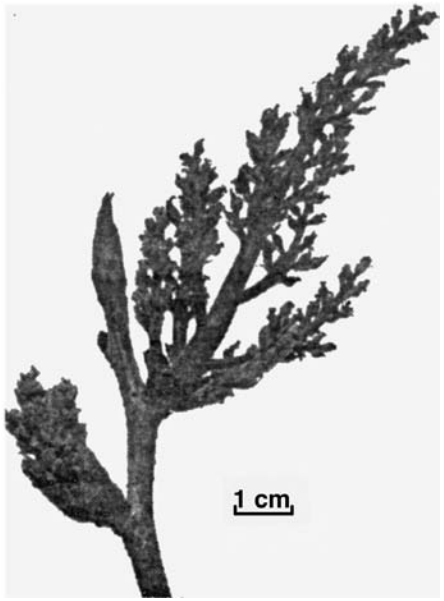


Figure 3. Female inflorescences, 2 October. Note the leaves are too small to give protection against spring frosts.

Figure 4. Male inflorescences, 2 October. Males must be selected to coincide with female receptivity.

filled, as several sterile males have been noted among seedlings at Merbein.

The fruit consists of a single large seed lying inside a thin hard bivalve shell surrounded by a resinous fleshy hull (Fig. 5). After pollination the fruit enlarges rapidly and is full-sized with a firm shell within 6-8 weeks. During this period the embryo itself develops little although the stalk (funicle) joining the embryo to the seed wall enlarges and might be mistaken for the embryo (Fig. 5, left). Subsequently the embryo enlarges rapidly and the seed is full-sized in 16 weeks and ripe 4-6 weeks later (Fig. 5, right).

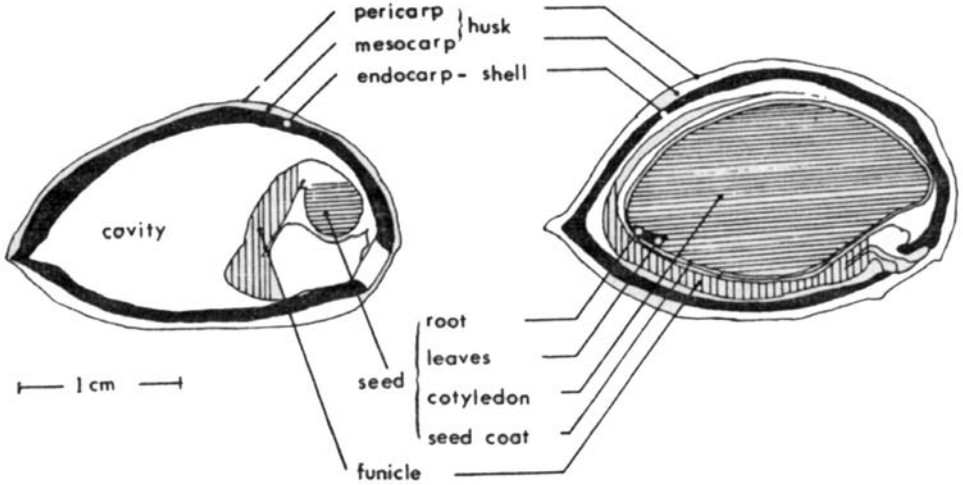


Figure 5. Sections through developing fruits to show lag in seed development.
Left: 80 days after pollination (21 December).
Right: 140 days after pollination (19 February).

The fruit can continue to develop even if the embryo aborts from several causes. Grundwag and Fahn (9) have listed malformations of the egg-cell and adjacent tissues, imperfect pollination, spring frosts, and insect damage. In many cases the empty fruit is superficially indistinguishable from full until harvest.

When the fruit ripens, the fleshy hull becomes soft and partly separates from the shell; the shell itself becomes opaque white and splits from its apex into two valves, exposing the purple-red coat of the seed inside. Failure to split appears to be an atavistic character, and a commercial variety must average at least 70% split nuts.

Fruiting is often extremely biennial, and if the tree is grown without irrigation a heavy crop may be borne only one year in four.

Distribution

The original centre of the pistachio was probably from north Afghanistan to Lake Issyk-Kul in Kirgizia, from whence it spread west and south to Iran, Baluchistan, Turkey, and Syria, and in Roman times to Greece and Sicily (27).

Wild pistachios grow on the lower slopes of mountain ranges fringing the deserts of central and S.W. Asia, on open stony hillsides and gravelly plains, often in association with maquis-type vegetation - mountain oaks, bushy almond species (7). The root system can reach 6m depth, penetrating fissures in the rocks and tapping underground water stored from winter rains and melting snow. As with most species from such habitats good drainage is essential for healthy growth.

Varieties

For a crop known to be widely distributed for at least two thousand years, relatively few varieties have been described. From 5 to 10 varieties are usually listed for each area (21, 8, 25, 29, 14, 4, 11, 18) although Azmi (5) gives 25 for Iran.

Female varieties are distinguished mainly on nut characters (on which commercial value depends); fruit colour, time of ripening, leaf and tree form and vigour. The important commercial qualities are:

Kernel colour - the meats of kernels from N. Iran, Turkey, Greece and Sicily usually have a green tinge, particular towards the outside, whereas those from east and southern Iran and California are creamy white or yellow. Immature and inadequately ripened kernels are also green.

Kernel flavour - a good pistachio nut has a fragrant aromatic taste before processing; others have only a nutty texture.

Nut size - nuts of varieties such as Kerman and Neb el Djamel weigh 1.1 - 1.3g air dry, whereas from pistachio forests of Afghanistan and Tadzhik S.S.R. they weigh only 0.4 - 0.8g. Large nuts are preferred in the U.S.A.

Nut shape - shape ranges from long, narrow ('almond shape') to sub-spherical plump and round ('hazel shape'). Hazel shaped nuts like those from the cultivar Ghafuri are considered best quality.

Shell opening - varieties may differ in the percentage of nuts with split shells. One Merbein selection regularly has over 90% split, whereas others have none, thus resembling the closely related species *P. khinjuk*. In several Merbein selections the unsplit nuts contain no kernel and can readily be separated during processing either by colour or density.

Staining - some seedlings produce nuts whose shells are incompletely developed and disfigured by brown staining. This defect first appears as a blackening of the immature hull. It does not appear due to a pathogen and may be analogous to oleocellosis in citrus. Joley (11) considers it to be inheritable.

Other characters are:

fruit colour - from deep red to pale green when ripe;
bunch shape - varies from groups of short spikes 4-6cm long, to branched racemes up to 15cm long;
time of ripening - from mid February until mid March;
fruit shed - seedlings have been noted whose fruit when ripe falls after quite a light shake. This character is obviously important for mechanical harvesting:
leaf form - leaflets vary in size and length/breadth ratio, number and colour:
tree form and vigour - erect forms may be better adapted to mechanical harvesting.

Male varieties have been selected for late flowering to coincide with peak female receptivity and for regularity and abundance of pollen production. A hermaphrodite variety has been reported from Syria and Turkey (21, 20).

The list of known clonal introductions into Australia given by Maggs (16) includes Bronte, Kerman, Lassen, Peter's Male, Kaz Male, Sfax, Trabonella.

At Merbein over 200 seedlings and 10 cultivars are under selection of which 18 have fruited to date. Five have been included in acclimatisation trials to measure how far commercial characters vary from place to place. To meet the demand from growers for budwood

we have at this time provisionally selected Kerman and 15.11 for release, although reliable Australian yield data are not yet available.

Kerman is the main Californian variety with very large, clean nuts 70-90% split and 15.11 is a consistently good quality seedling with over 95% split nuts.

Propagation

Although approximately half of any batch of pistachio seedlings will be female, results so far suggest that only a quarter of these will yield satisfactorily. Therefore some 80% of the progeny will be useless. Although these can be frameworked to an acceptable variety, a commercial orchard must be established by budding one-year seedlings with varieties of known commercial and orchard characteristics. The rooting percentage of cuttings is unacceptably low.

Rootstocks

The pistachio can be grafted on a range of *Pistacia* species but grows and crops well only on *P. vera*, atlantica**, (including ssp. *mutica**) from SW. Asia and N. Africa, *terebinthus** from the N.W. Mediterranean coast, *Khinjuk** from Turkey, Iran and Afghanistan, and *palaestina* (Whitehouse (29)).

*(Those species represented in the Merbein collection are indicated by *).*

The classification of *Pistacia* is unsatisfactory and to date there are no reliable diagnostic characters. In these circumstances and in view of our very limited experience, we identify our rootstocks at present by the name under which they were received. However, the *atlantica* group usually has 3 or more pairs of leaflets while *khinjuk* tends towards the trifoliate *vera* but with smaller indehiscent flattened nuts. *Atlantica* has a dense, closely twigged habit and *khinjuk* a sparsely branched open form.

Detailed species descriptions are given by Zohary (30) and Rechinger (23).

At present rootstock mother trees are undergoing progeny tests for nursery characters such as good germination, freedom from side branches, growth rates high enough to produce buddable plants by their first autumn, resistance to leaf spot, and to orchard characters as resistance to rootknot nematode (Meloidogyne spp), tolerance of excessive chloride levels in the soil, tree size, cropping ability and nut quality.

The present mother trees are *P. atlantica* cvs. B2, B9, BlO, B15, Bl8. Selections of *P. terebinthus, mutica* and *khinjuk* may become available by 1980. With the exception of Bl8, our *atlanticas* are dense, globular trees reaching 5-6m, with persistent but not evergreen leaves having (on shoots over 20cm long) 3-4 pairs of leaflets each 2.5 - 3.5cm long. They are good garden and shelter trees. B18 is more vigorous; the internodes are longer and the leaves larger. Its fruits ripen turquoise green. It is an excellent nursery rootstock.

P. vera is not at present recommended as a rootstock because of its poor nursery characters (slow growth, straggling habit) and susceptibility to Meloidogyne. However it is being field tested in case it has some outstanding qualifications for the orchard tree.

Germination and nursery procedures

Pistachios are reputed to transplant with difficulty and in California seedling rootstocks are field planted from deep pots to be budded subsequent to establishment. At Merbein mortalities may be high if the roots are allowed to dry while out of the ground, but if reasonable care is taken, 1 - 2 year old trees can be transplanted successfully even after several weeks storage in closed polythene bags. This is in line with Tunisian experience (10).

Freshly gathered, dehulled seed stores well at 2 - 5°C. Seed may be germinated direct in a nursery row if facilities are good or in a cloth roll where a preliminary period in pots is necessary (Fig. 6). Rolled seed should be germinated at 15 - 20°C inside a polythene bag and

seedlings removed twice weekly so that the brittle radicle is not damaged. When this radicle has grown 1 - 2cm it develops a deep violet colour which is quite normal. Before sowing in a nursery it is advisable to test-germinate a sample in a cloth roll so that the sowing rate may be adjusted to produce plants at about 15cm spacing.

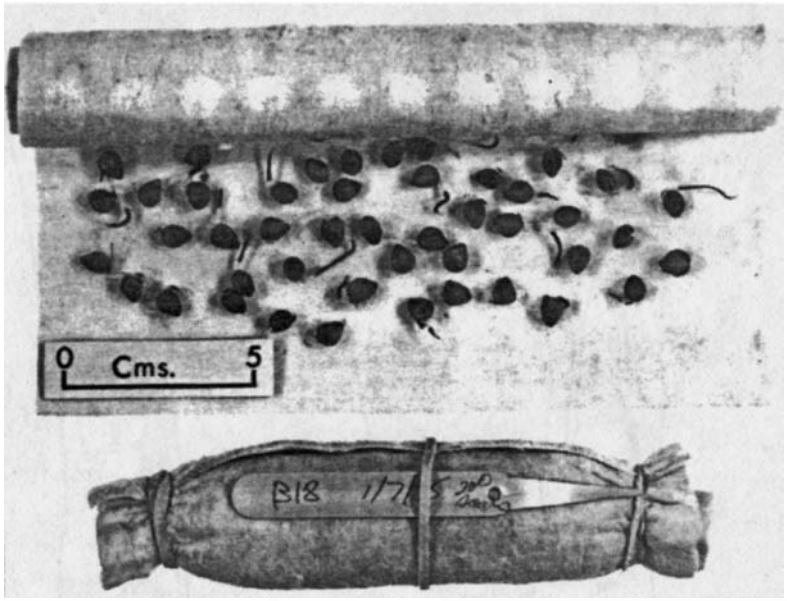


Figure 6. Seed germinating on damp cloth roll.

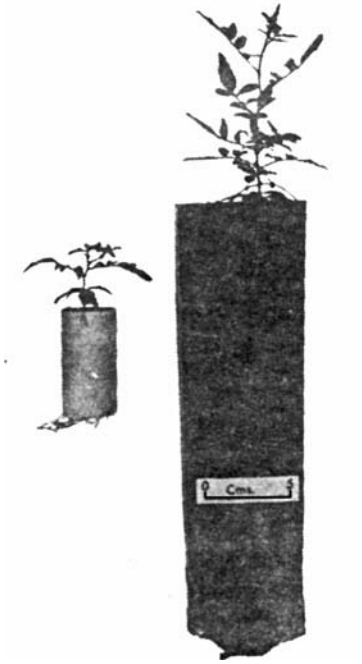


Figure 7. Seedling transferred to tube and then to polythene bag.

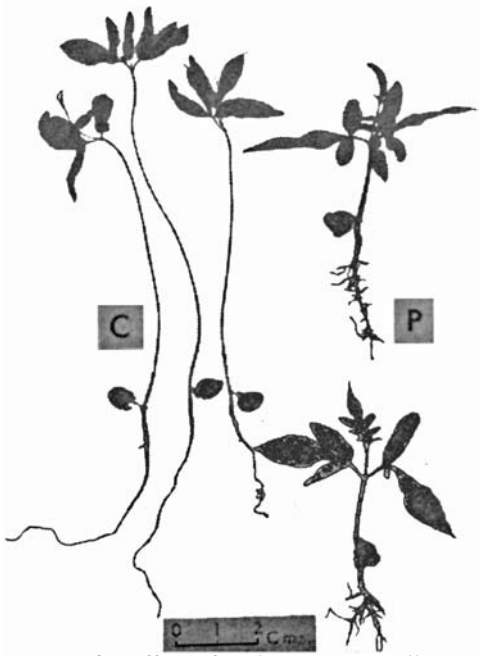


Figure 8. Effect of undercutting seedling roots in nursery. C. Unpruned control. P. Rootpruned. Seedllings courtesy A. Weare).

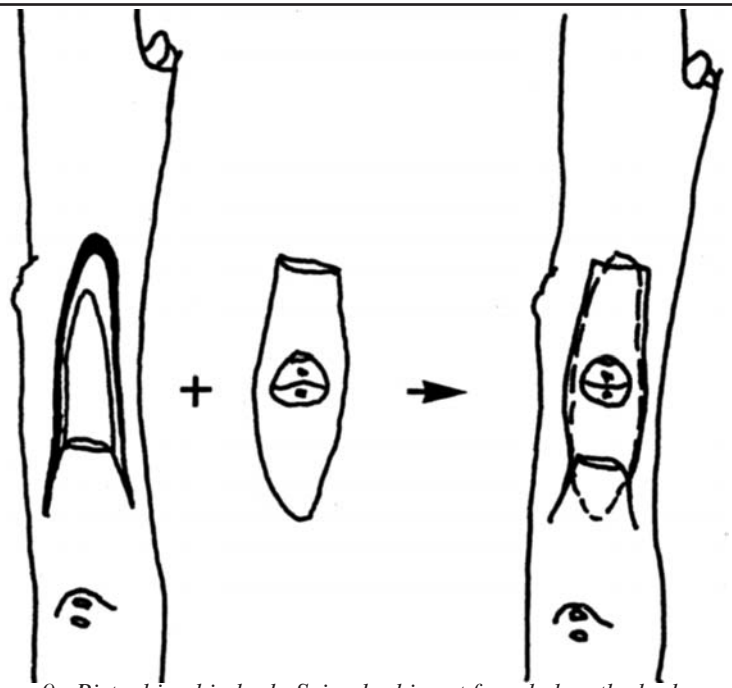


Figure 9. Pistachio chip bud. Scion bud is cut from below the bud upwards. Back wood is not removed.

Germinated seeds may be grown on in plastic tubes (10cm sections of 1 irrigation pipe) in a light, airy place and then black polythene tubes etc. or in the nursery (Fig. 7). The seedlings are frost-hardy and the nursery should be established by November. Once established, the taproot should be cut 10 - 15cm below soil surface with a long-bladed knife (Fig. 8).

The nursery should not be shaded by trees and the seedlings will have to be watered twice a week in hot periods until they are 5cm high. If the plants are set out in October they should be big enough to bud the following February (1 cm basal caliper). Half strength soluble feed should be given every 3 weeks November to mid-January. Chip-bud in February - March and polythene tape over the bud (Fig. 9). Budwood must be mature. Cut tapes after 4 weeks, If the stocks are too small to bud, they should be cut to 2cm in June and budded the following February.

Undercut the stocks in May - June and head them to 15cm above the bud in late August. The developing scion shoot can be tied to this 'snag' to prevent its blowing off in gusty winds. Waste knitting wool is good for the first two ties while the shoot is less than 10cm long. Rootstock sprouts must be removed weekly. Cut off the snag flush with the scion in January and seal the wound with bituminous grafting emulsion. This budding schedule would also apply to field planted rootstocks budded in the orchard, except that the taproot would not need undercutting.

The young tree should be trained to develop a framework suitable for shaking and high enough to allow catching frames to be put under the canopy. The one year stem should be headed back to 1.2m (unless a crown at this height has already been developed in the nursery) and 3 - 4 main limbs allowed to develop.

The only other pruning that appears necessary is to cut out crowded branches and shoots that cut across the general radial pattern of the canopy.

Branches should always be cut flush with the major limb and large wounds covered with bitumastic grafting emulsion.

Soil and Site and Layout

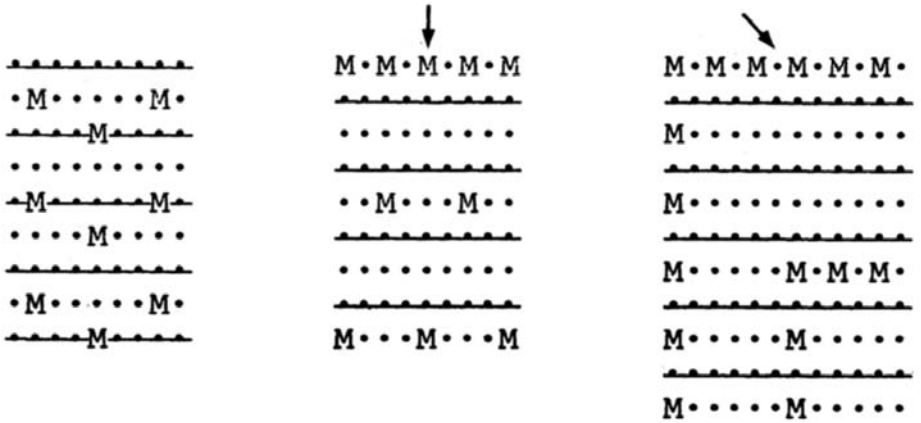
The pistachio is noted for its ability to grow in windy sites on poor denuded soils - provided the drainage is good. Nevertheless, growth and cropping improve as soil conditions improve. Alkaline and saline conditions are tolerated (25, 7, 14, 29). An average spacing for older irrigated orchards is 6 x lOm. Present opinion favours a hedgerow type of orchard. A spacing 5 x Sm would give early cover along the tree line and alternate rows could be removed at about 12 years to give a final 5 x 10m.

Where trees are grown without irrigation, the spacing depends on average rainfall e.g. 10 x l0m under 600mm (25") and 13 x 13 under 400mm (15"). Weeds must be kept down.

Arrangement of Male Trees

Pistachios are wind pollinated and the major factor determining the position of the males is where moderate winds blow from in October - November.

If these winds come from a prevailing direction the males should be set across it, but if it can come from any direction (and light winds are usually very variable) then the males will have to be more regularly scattered. The distance between trees is determined by the rate at which pollen settles to the ground or is swirled up out of the orchard into the main air-stream. Data on the spread of other wind-borne pollen suggests that 20m downwind, the pollen concentration would be at least 10% of that close to the male tree (22). Fig. 10 show some alternative arrangements.



(a) (b) (c)

(a) Wind equally from all directions; density of males 1:9

(b) Prevailing wind from N; density 1:16 increasing to 1:8

(c) Prevailing wind from NW, rows EW; density 1: 10 approximately.

M Male trees

Trees to be thinned.

Figure 10. Various arrangements of male trees according to prevailing wind conditions. Spacing at 5 x 5m to allow subsequent thinning to 5 x 10m.

Male trees should carry both an early and a late flowering variety to ensure a prolonged period of pollen production.

Irrigation and Fertilizer

The pistachio is geared to make its growth in early summer while there is (in its homeland) abundant soil moisture from winter rains and melting snow, and to develop the substance of the crop from midsummer to early autumn under increasing drought. Late winter and spring irrigations will favour the main flush of growth while summer irrigations will favour fruit development, reduce the shedding of young nuts and maintain an efficient canopy.

Near drought in February - March is necessary to mature the nuts, and then an autumn irrigation will promote rootgrowth before leaf-fall in May - June (cf. Table 4).

For the first three years maximum growth rates are desirable in order to ensure high yields during the early years of the orchard, and frequent irrigations throughout the growing season are needed.

No experimental results on manuring have been reported, but like other nut crops the pistachio responds well to nitrogen (11). Although luxury levels will increase susceptibility to disease, a mature orchard will probably require each year 40-80kg N/ha applied in April and November and 200kg superphosphate. A dormant spray of 3% zinc sulphate will probably be necessary, especially on sandy soils.

Weedkillers should be used cautiously until more information becomes available.

Pests and Diseases

Because of its antiquity and wide distribution, the pistachio is host to a wide range of insects and fungi. Those that have proved troublesome wherever pistachios are grown are summarised in Table 2.

In a new territory such as Australia, endemic pests may adapt themselves to the newcomer, and although quarantine measure may keep out the recognised parasites, trouble must be anticipated sooner or later.

So far we have noted a black spotting on the young leaves in autumn and in prolonged wet periods; this is controlled by copper sprays.

Harvesting

The fruits do not all ripen simultaneously; those that ripen first are the best quality. The earliest varieties ripen about 3 weeks before the latest. Methods of almond harvesting should be applicable. In Iran as well as the U.S.A. experienced growers are confident that mechanical harvesting with tree shakers is feasible.

After harvest the fruits may be dehulled straight away, or dried and stored in hull. Quick, even drying is necessary to avoid staining the shells and this is usually done by spreading the fruits in a thin layer on a clean shaded drying-floor. Dry nuts can be stored in air for up to two years (28).

Processing (Fig. 11).

Dehulling is done very satisfactorily using a potato peeler with a basal rotating abrasive disc in a cylinder flushed with a stream of water.

The nuts are then graded for size, staining, opening of the shells and filling of the shell by kernels. At Merbein we can distinguish empty nuts by their water-logged colour when they leave the dehusker. Block and Brekke (6) have described a fairly straight-forward separation based on densities in water and wind. After drying to 5 - 10% moisture (roughly when the kernels are brittle and crisp) the good nuts are then passed through a brine bath and rapidly dried to give the estimable salt-roasted pistachio (Fig. 11).

Table 2

Some pests and diseases of pistachio.

**Indicates the species has been recorded in Australia on pistachio.*

A. Pests

Name	Group	Part of plant attacked	Remarks	Authority
*Meloidogyne** sp	rootknot nematode	roots	*P. vera* susceptible *P. atlantica* resistant	Whitehouse Sauer (priv. comm.)
Caprodis cartosa	borer	stem	widespread	Ayfer, Schneider
Scutiphora pedicillata*	metallic shield bug	leaves		Slater (priv. comm.)
Anoplognathus sp*	Christmas beetle	leaves	may become epidemic	Slater (priv. comm)
Tinea pistaceae	moth	shoots	assoc. with *Phomopsis*	Whitehouse
-	scale*	stem, leaves		Evreinoff
-	mites, aphids	flowers	pollen feeders	Evreinoff
	thrips*, weevils			Pech
	bees*			
Recurvaria pistaciola= *Schneideria pistaciella*	moth	fruit	inside nut transported in produce	Larue Schneider
Megastigma pistacia	wasp	fruit	transported in produce	Schneider
Plodia interpunctella	moth	nuts	storage pest	Whitehouse

B. Diseases

Name	Group	Part of plant attacked	Remarks	Authority
Phytophthora spp	water mould	collar rot, root rot	especially where drainage is poor.. *P. terebinthus* resistant	Kouyeas
Verticillum sp*	wilt	root		Evans (priv. comm)
Armillaria mellea	Bootlace fungus	roots, butt		Whitehouse
Schizophyllum sp*		wood		Casalicchio
Phomopsus sp.	buds			Anagnostopoulos
Pileolaria terebinthi	rust	leaves		Rieuf
Septoria spp*	leaf spot	leaves	controlled by Bordeaux, Zineb	Maas

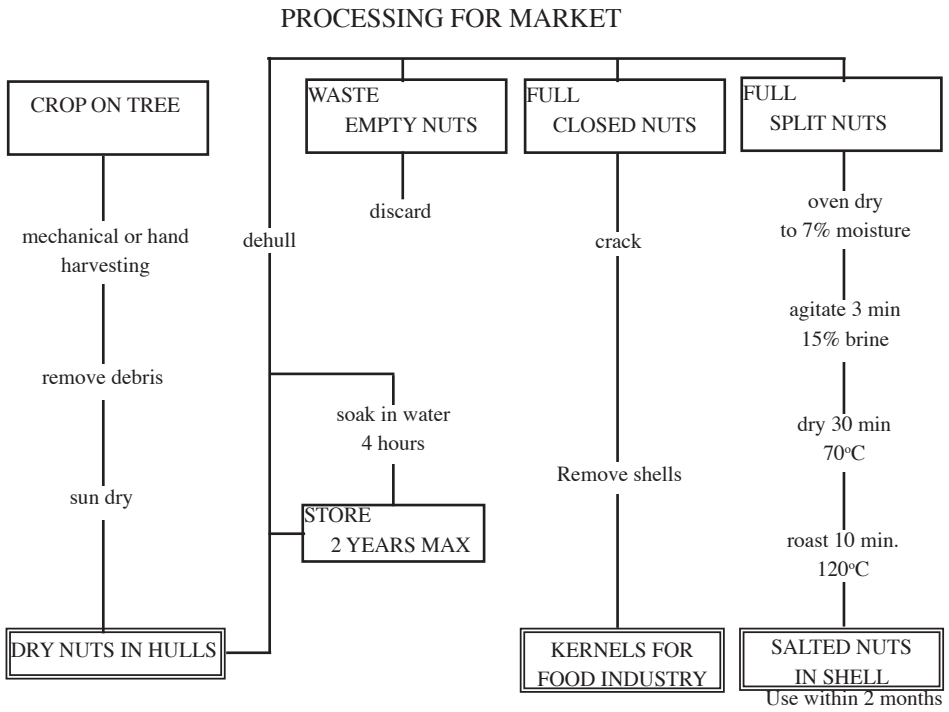


Figure 11. Processing for market.

Yields

Published data on yields must be regarded with caution. Often it is not clear whether they refer to trees in their cropping year or averaged over a series of off- and on- years. Sometimes they probably refer to grafted wild orchards and sometimes to planted orchards. As yields per tree continue to increase with the growth of the tree for many years, tree age must also be taken into account. Available information is summarised in Table 3. Joley's data for grafted clean-cultivated trees at 30' square are probably the most reliable and relevant. These show clearly the large effect that variety can have on yields.

The average yield for a good variety under irrigation seems to be about 1kg dry nuts in hull for each year of field life up to a steady level of 30kg. Yields for years 1 - 5 should be taken as nil. Thus average yield at 20 years from planting would be 20kg per tree. These results should be applied to Australian conditions with some caution, and it would be advisable to calculate on the basis of half these values.

At 200 trees/ha (e.g. 5 x l0m) yields at this conservative rate would be 1500 kg/ha at 15 years rising to 2500 kg/ha at 25 years and remaining at around that level for 50 years or more. Hedgerowed at 3 x 6m (555 trees/ha) they would probably reach maximum yield at 15 years. The long term feasibility of a hedgerow system has not yet been demonstrated.

These data are for ungraded nuts. After removal of hulls and empty and damaged nuts yields of good commercial in-shell nuts would be reduced by 10 - 20%. At $2.00/kg the gross return on a 1500 kg/ha yield would be $3,000/ha ($1,330/acre).

In 1973-4 the average price of imported Iranian nuts was $2.00/kg f.o.b. with a 4.2c/kg

Yield data on pistachio (kg dry nuts/tree)

Country	System	Whether irrigated	Tree age (Yrs.)	Yield per tree	On-year or average	Authority
Turkestan	grafted	0	7-15	1-8	on	Evreinoff
	wild		25-30	40-50	on	
			30+	70-100	on	
Iran	orchard	+	20-50?	20-30	av	Larue
Turkey	orchard	0	20	8-10	av	Ayfer
Syria	orchard	0	30	50, increasing with age	on	Pech
Syria	orchard	0	10	10	on?	Chapot quoted by Lemaistre
			40	40	on?	
			old trees	100+	on?	
Sicily	grafted	0	?	2-30	?	Spinna and Pennisi
	wild					
California	orchard	+	5-20	22.6[1]	av	Joley
			6-20	11.3[2]	av	
			8-20	6.5[3]	av	
			8-20	4.5[4]	av	

Table 3

1. cv. Kerman
2. cv. Bronte
3. cv. Trabonella
4. cv. Red Aleppo

import tariff. Present retail price in Australia is about $5.7/kg.

Potential Areas in Australia

An indication of potential production areas in Australia may be obtained from comparisons of the climates of producing areas with those of Australia. The important criteria are high summer and autumn temperatures for proper ripening, absence of autumn rain and prolonged humid spells in the growing season, winters cold enough to satisfy the chilling requirement and absence of frost at flowering (4, 11, 15). Frost during winter is beneficial. From the data for typical pistachio areas summarized in Table 4 it appears that the following standards should be met:

Summer temperature. The mean maximum temperature in January should be over 32°C (90°).

Winter temperature. The mean minimum temperature in July should be below 5°C (41°F). The highest mid-winter minimum temperature is 8°C (46°F) for Palermo. Ayfer (4) gives 5.5°C (42°F) as the maximum permissible January (winter) mean temperature and Joley (11) 8.5°C (47°F).

Absence of frost at flowering. Pistachios flower from the end of September to mid-October. Merbein averages 250 frost-free days a year and Wagga 200.

Assuming a correlation between the frost-free period and freedom from frosts in the flowering period, 200 frost-free days may be taken as the required level. It must be remem-

bered that frost damage is much influenced by local topography and local advice should be sought.

Absence of excessive autumn rain. Rainfall during the ripening period February - March will hamper natural drying of the nuts and greatly increase their susceptibility to normally saprophytic moulds. Mean monthly rain should not exceed 25mm (1 inch) from January to March, unless drying facilities are available. Pistachios are susceptible to leaf-spots which can become epidemic in prolonged wet spells.

Table 4

Temperature and rainfall for pistachio areas

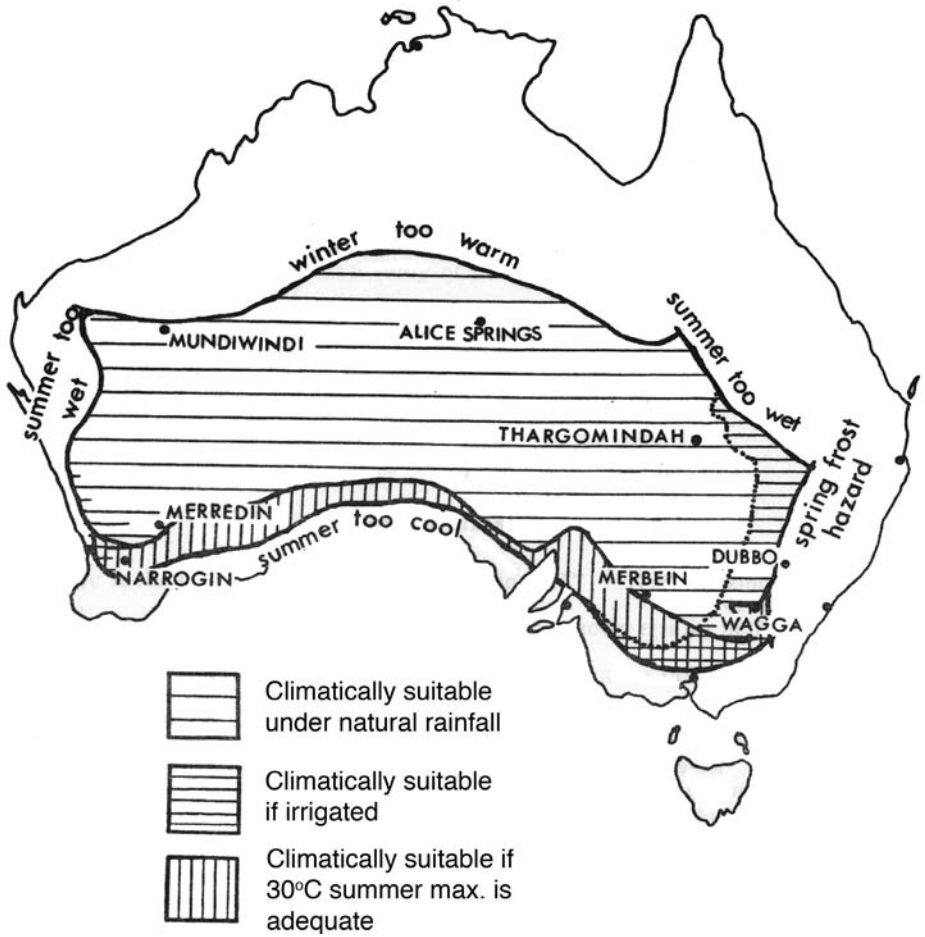
a) average monthly maximum ^{0}C
b) average monthly minimum ^{o}C
c) average monthly rainfall mm

Northern Hemisphere Southern Hemisphere	January July	April October	July January	October April
Kerman, Iran (30°N 57°E alt. 1860m) Annual Rain. 137 mm.				
a	14	25	38	29
b	-3	8	18	6
c	13	18	0	2
Gazianteb, Turkey (37°N 37°E alt. 915m) Annual rain. 554 mm.				
a	6	19	34	24
b	1	7	21	9
c	102	53	0	33
Aleppo. Syria (36°N 37°E alt. 390m) Annual rain. 398 mm.				
a	10	24	36	27
b	1	9	31	12
c	89	28	0	94
Palermo, Sicily (37°N 12°E alt. 25 3m) Annual rain. 690mm.				
a	14	19	30	24
b	8	12	22	17
c	122	42	2	94
Fresno, California (37°N 120°W alt. l0lm) Annual rain. 234mm.				
a	12	23	37	26
b	3	9	18	11
c	42	23	2	13
Merbein, Victoria (34°S 142°E alt. 56m) Annual rain. 261 mm.				
a	16	24	32	24
b	4	10	14	10
c	20	20	10	15
Wagga Wagga, N.S.W. (35°S 147°E alt. 186m) Annual rain. 541 mm.				
a	14	23	32	23
b	4	9	17	9
c	46	53	36	41

Annual Rainfall

400-600mm (15-25 inches) with a dry summer is required for non-irrigated pistachio. Yields are likely to be erratic.

Fig. 12 based on Bull. I of the Bureau of Meteorology shows the general areas delimited by these criteria.



The areas most likely to be suitable for pistachio production, provided regular irrigation is available, are:

- Southwest W. Australia between Narrogin and Merredin and N.W. towards the coast,
- The Nullarbor plain between 100 and 300 miles inland,
- The high land around Alice Springs, and the plateaus to the west,
- The strip inland from the S.E. Dividing Range joining Renmark, Menindee, Moree and Echuca.

The areas where irrigation, though beneficial, is not essential are:

- W. Australia from Narrogin to Manjimup (frost risk?) and N.W. to Watheroo,
- A strip along the line from Wagga to Dubbo,

In view of the coarseness of the scale on which this selection has been made there must undoubtedly be other areas equally suitable for commercial pistachio cultivation, but those listed should have the greatest likelihood on present information.

It must also be remembered that the pistachio is already grown in a range of habitats, and selection in the southern part of its Asiatic range could well reveal varieties with chilling requirements lower than those at present available.

Acknowledgements

I am indebted to many people for references, items of information and geographical comment, to growers and gardeners for interest and experimental assistance, to E. Lawton for photographs, to Mrs. R. Wren for librarianship and to my assistants Messrs. R.A. Needs and G..J. Martin for their unfailing enthusiasm in bringing the Australian horticulture of this crop through its early infancy.

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Photographs of Cashew Nut Trees in The North West

FRED LULLFITZ*

Figure 1. Young cashew tree at the Kimberley Research Station, Kununurra.

Figure 2. Nuts and fruit (cashew 'apple') on a mature tree (6m high, 10m across) at Lombadina Mission near Broome.

* Member, West Australian Nutgrowing Society.

Cashew Production In The Kimberleys

DEREK WHITE*

I have a small property at Kununurra, in the Ord River irrigation area, and for some time now have been investigating the feasibility of growing cashew nuts and other cashew products. The main drawback from the economic point of view appears to be the high cost of shelling or decorticating the nuts if hand labour is used. In fact, although the cashew market in Australia is large financially and also in tonnage, the costs of production, on the figures available, appears to put the cost per ton higher than the retail price!

In 1971 Gunn and Cocks published a paper on "Potentialities for Cashew in Northern Australia" (I). Their conclusion was that cashew is a crop well adapted to certain areas, which this is one, and that a preliminary assessment indicates that an integrated cashew industry has a reasonable prospect of being commercially viable.

On costs, Gunn and Cocks quote hand decortication figures in India of $5 1.8/ton of nuts, with the equivalent Australian wage giving $1300/ton.

Production costs based on the plant designed by the Tropical Products Institute in London, with a capacity of 2500tons/annum and costing $200,000, gave a figure of $7.6/ton:

	1971	1975
Depreciation (8 year plant life)	$25,000	50,000
Interest (6% average value of plant)	6,000	12,000
Labour (10 men @ $5,000)	50,000	160,000
Materials ($4/ton through put)	10,000	6,250
Repairs (10% initial plant cost)	20,000	40,000
Miscellaneous (10% cash costs)	8,000	16,000
	$119,000	$284,250
		t
	= $47.6/ton	= $227/ ton

The 1975 figures are based on figures I recently received from Sturtevant Engineering Co. who make the T.P.I. plant. This plant produces 1250 tons per annum, costs £151,965 (Sterling) F.O.B. a British port and requires 20 men to operate. If you use an inflation accounting system on depreciation the final figure is around $300/ton.

Really, inflation appears to be making a nonsense of business figures, but the aim of the game is to beat it.

Now, this is only one cashew plant, there is one at least as good produced by an Italian company and another produced, I believe, in Hamburg, and I hope to have details of these in due course. The best plant might eventually turn out to be an amalgam of at least two different manufacturers products, and it is in this context that the suggestion (2) of computer-controlled operations really does look to be a key to the problem.

The Department of the North-West know of my interest in the cashew and send me all the information they can find on all aspects of the crop; but they have no technical side and only a limited budget. C.S.I.R.O. and the Department of Industrial Development would most probably be the best two sources for further development. However, overseas a lot of time and

* Member, West Australian Nutgrowing Society

money has been spent and there are a number of firms brains to pick first of all, and although most of these plants have been designed for the African native to operate, the idea of applying modem computer technology seems to be something no one has thought of previously.

Before we reach the stage of installing a plant one has to grow the nuts, which should be produced at about the rate of one tonne/hectare of raw nuts as a minimum figure. It is known as the easiest crop to grow, and the major enemy is the white ant which unfortunately is all over the north in large quantities. The white ant was a major cause of failure of the experiments in the Northern Territory some 10 years ago, although I think they were not pursued with the enthusiasm and determination that is required, and that the planting of cashew orchards in aboriginal missions is not conducive to success.

My ideas on the cashew have changed recently, and after some correspondence with the Cashew Corporation of India I am looking to eventual large scale plantings with the initial intention of exporting the raw nuts to India for processing. This I feel is a necessary first step for one has to be able to offer a crop to be processed before one can start asking somewhere for around $4-500,000. There does of course have to be a market for your product, but this we have.

At this stage, of producing the raw nut, the first mechanical device one has to look for is a harvester and I feel this should be the basis of the first approach to one of the government Departments. These Departments could well be useful for research purposes but I am basically against public-facility basis like the W.A. Government's gold ore-crushing batteries - any business must float its own capital and be self sustaining - a local growers co-operative would be acceptable.

Before asking someone to produce a harvester, one must produce the nuts to harvest, and this requires a fair amount of work in selecting high specific gravity nuts for breeding purposes and the time for these seedlings to produce nuts and prove themselves to be useful parents for marcotting or air layering. Genetic influences are little known as far as the cashew is concerned.

As far as growing the cashew further south is concerned, the climate in the south of the state is simply not warm enough to sustain the cashew throughout the year - for example, the minimum temperature here in the dry season this year was about l4°C or 56°F, and at this time the cashew does not make any growth, so it would be necessary to provide hot house conditions to ensure any healthy growth if the temperature goes below, say, 15°C or about 60°F.

The phases of nut production are:

(i) Grading for size and humidifying
(ii) Roasting to remove anacardic acid from the shell
(iii) Drying to remove excess acid
(iv) Decortication (centrifugal, decompression, cutting)
(v) Peeling, mechanical (brushes) or pneumatically
(vi) Re-humidifying
(vii) Grading
(viii) Packing

Most of the mechanical processes appear to produce at least 70% whole kernels, with one Italian machine reaching 80% - this is the one on which I'm seeking information. There is presumably a market for the CNSL (cashew nut shell liquid) in this country, presumably the oil is all imported at present - this is not include in the costing - neither is the apple, which being very soft will not travel. The idea of air-freighted apples is attractive but they would be

more difficult to ship than strawberries, and being heavy would end up being rather expensive. They could be processed here to make wine, jam, chutney, juice and pickles - we have recipes so there is a big future for this neglected part of the crop.

I am sure that there is a big future for the cashew here, but one must get one's priorities right. Firstly, one must produce heavy-bearing trees, with the intention at this time of exporting the raw nuts -- and look at the development of a harvester. At the same time there is a need to look at a variety of decorticating plants arid adapt the most efficient pieces of machinery to our technological society and capabilities in an attempt to get the costing right for the establishment of a complete cashew industry, embracing kernel and CNSL. The time scale is about 10-12 years.

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History Of Nut Trees*

GEORGE L. SLATE**

Nut trees have been around for a long time. Ancient fossils prove their presence on earth long before man arrived. They, have been an important food from the earliest days that man wrote about plants. References to nut trees in ancient literature are numerous. Theophrastus, who was born 370 B.C. referred to the walnut, and mentions hazels and chestnuts as growing in the mountains of Macedonia. Virgil, 70-19 B.C., wrote that chestnuts were abundant in Italy in his time. The almond, known to the ancient Hebrews, was carried by the Phoenicians to the Hesperian Peninsula.

Pliny, born A.D. 23, referred to nine varieties of the walnut and two varieties of the hazelnut. He wrote of an almond with a thin brittle shell and another with a harder shell which was remarkably large with an oblong shape. Eighteen varieties of chestnut were known to Pliny. One was flat, another was rounder and easily peeled, one had a smooth outer shell, and another had a red skin. Other kinds were grown to feed the pigs. According to DeCandolle, the Romans cultivated the walnut from the time of their kings. Chinese authors say it was introduced into their country from Tibet about 110-150 B.C. Charlemagne, 742-811 A.D., recommended the propagation of chestnuts to his people.

More recently, Miller's Gardener's Dictionary, 8th edition, 1768, describes *Juglans regia, J. nigra*, and several hickories under Juglans. He names 5 varieties of the common walnut and says they all vary when raised from seed. Miller describes *Corylus avellana, C. maxima* and *C. colurna, Amygdalus*, and the walnut tree of which he describes several varieties. Under *Castanea* he describes *C. sativa, C. pumila*, and another which is probably the American chestnut.

Duhamel du Monceau in Traité des Arbres Fruitiers. Paris, 1768, describes eight varieties of almonds with illustrations of four.

Two European books on filbert varieties and culture are Koch, Die Haselnusz, Jena, 1858; and Franz Goeschke, Die Haselnuss, Berlin, 1887. Goeschmke's book is a complete treatise with much historical material, cultural information, and detailed descriptions of many varieties.

In North America we learn from Sturtevant's Notes on Edible Plants that the shagbark hickory was used extensively as food by the Indians, who made a milky liquor from the nuts. They also ate pecans, calling them pecaunes. An oil pressed from these nuts was used to flavour their food. Other hickories, though not the bitternut, were also eaten. Chestnuts mixed with pottage were used by the Indians of New England. Undoubtedly the early settlers made good use of the abundant supply of nuts in the forests.

Nut trees were soon being planted in America. Two pecan trees on the lawn at Mount Vernon were grown from nuts given to George Washington by Thomas Jefferson in 1775. They are said to be the oldest trees on the estate.

A broadside list of trees for sale by William Prince at Flushing Landing, Long Island, New York in 1771 offers "Madeira nuts" (Persian walnuts), black walnuts, and both sweet

* Reprinted from "Handbook of North American Nut Trees", ed. R.A. Jaynes, N.N.G.A., 1969.

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and bitter almonds. The Prince catalogue for 1790 offered hard-shell almonds, sweet almonds, Madeira nuts, long black walnuts, round black walnuts, white walnuts, and many sorts of American hazelnut trees and Barcelona nuts.

Daniel Smith, a nurseryman of Burlington, New Jersey, offered on a broadside list in 1806 the Madeira nut or English walnut, and the pecan or "Illinois nut of the Western Country".

Bernard McMahon in the American Gardener's Calendar, Philadelphia, 1806, the first gardening book of any consequence published in the United States, recommended planting the boundaries of large orchards with English walnuts and Spanish chestnuts to "afford an abundance of fruit, but protect the trees in general from the power of tempestuous winds". He gave instructions for the planting of seeds of chestnuts, walnuts, and hickories, "first throwing the nuts into a tub of water and rejecting such of them as swim..." He recommends cutting the tap-root after one or two years in the nursery. Instructions for layering filberts and budding almonds are also given.

A. J. Downing, one of America's greatest horticulturists, described in his "Fruits and Fruit Trees of America", New York and London, 1845, five filberts, the European chestnut, the chinquapin, the hickory nut, the European walnut, the black walnut, and the butternut. Seven almonds are described. He states that the European walnut "may also be grafted with due care, on the common hickory nut".

The first authoritative book on nut culture in the United States was the "Nut Culturist" by Andrew S. Fuller, New York, 1896. The author was a well-informed horticulturist who lived in Ridgewood, New Jersey. The 289 page book is mostly a discussion of northern nut trees, with a chapter on miscellaneous nuts. It is well worth owning and reading if one can find a copy in a second-hand book store.

Fuller published a description of the Hales' Papershell Hickory in the Rural New Yorker in 1870. This indicates an early interest in selecting superior native nuts. A picture of Mr. Hales and his hickory tree is the frontispiece for the first published report, 1911, of the Northern Nut Growers Association.

Commercial nut culture in the United States is limited chiefly to wild and cultivated pecans in the South, Persian walnuts in California and Oregon, almonds in California and filberts in Oregon and Washington. Chinese chestnuts are just beginning to be planted commercially in the South. Commercial black walnuts are mostly from wild trees.

Research on the problems of nut culture has been limited to the states where commercial nut growing is important. In the states north of the Ohio River, where there is no commercial nut culture, the only research that is done is by interested persons at the agricultural experiment stations who "dabble" a little as time permit. Private individuals do considerable variety testing and cultivate nut trees for the fun of it, but their projects lack continuity and usually disappear when the grower loses interest or dies. The organization of the Northern Nut Grower's Association in 1910, the holding of annual meetings in various places in the central and eastern United States and Canada, and the publication of the proceedings of these meetings, brought together professional and amateur nut people in a mutually profitable arrangement that has continued ever since.

One of the important activities of this Association has been the location and dissemination of superior clones of nut trees, native and introduced. Interested persons have roamed the fields and tested the nuts from wild trees; others have offered prizes for the best nuts. The Association and several state organizations have conducted contests for the best nuts. A large number of superior nuts have been brought to notice and tested by interested persons, and a few of these are now being propagated.

Some breeding work has been done and new varieties introduced from these projects, mostly, at public agencies. A complete account of early, nut-tree breeding in the United States by H. L. Crane and C. A. Reed may be found in the USDA Yearbook for 1937, pages 827-889. The article contains considerable history, a bibliography of 52 titles and much useful information on nut-tree varieties and breeding.

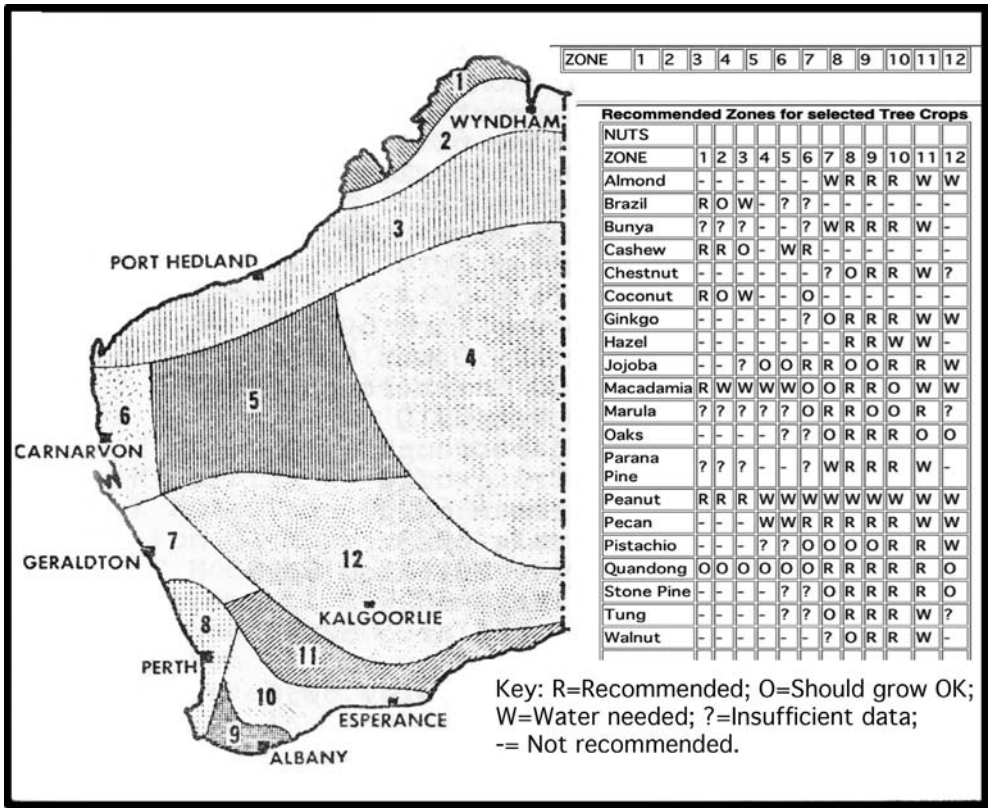
The Nutgrowing Zones of Western Australia

DAVID G. NOEL*

Once somebody knows that you are interested in growing nuts, the first question asked is often "What nuts can I grow in such-and-such a place?" In an attempt to produce a preliminary answer to this question, the map shown below has been produced. The State has been divided into 12 zones. To see what nuts you should be able to grow in your area, locate its zone on the map. Then consult the column for that zone in the table below, which lists 20 different species or groups of nuts plants.

I must emphasize that this table, and the division into zones, is only tentative. Some of the information is based on my own experience, but most is derived by applying overseas experience to Australian conditions. Moreover different varieties of the same sort of nut may differ considerably in success in a particular set of conditions.

Help me to make this information more accurate by writing in with details of nut trees which are bearing well outside the marked zones, or of ones which have generally failed within a zone marked for probable success.



ZONE	1	2	3	4	5	6	7	8	9	10	11	12

Recommended Zones for selected Tree Crops

NUTS												
ZONE	1	2	3	4	5	6	7	8	9	10	11	12
Almond	-	-	-	-	-	-	W	R	R	R	W	W
Brazil	R	O	W	-	?	?	-	-	-	-	-	-
Bunya	?	?	?	-	-	?	W	R	R	R	W	-
Cashew	R	R	O	-	W	R	-	-	-	-	-	-
Chestnut	-	-	-	-	-	-	?	O	R	R	W	?
Coconut	R	O	W	-	-	O	-	-	-	-	-	-
Ginkgo	-	-	-	-	-	?	O	R	R	R	W	W
Hazel	-	-	-	-	-	-	R	R	W	W	-	
Jojoba	-	-	?	O	O	R	R	O	O	R	R	W
Macadamia	R	W	W	W	W	O	O	R	R	O	W	W
Marula	?	?	?	?	?	O	R	R	O	O	R	?
Oaks	-	-	-	-	?	?	O	R	R	R	O	O
Parana Pine	?	?	?	-	-	?	W	R	R	R	W	-
Peanut	R	R	R	W	W	W	W	W	W	W	W	W
Pecan	-	-	-	W	W	R	R	R	R	R	W	W
Pistachio	-	-	-	?	?	O	O	O	O	R	R	W
Quandong	O	O	O	O	O	O	O	R	R	R	R	O
Stone Pine	-	-	-	-	?	?	O	R	R	R	R	O
Tung	-	-	-	-	?	?	O	R	R	R	W	?
Walnut	-	-	-	-	-	-	?	O	R	R	W	-

Key: R=Recommended; O=Should grow OK;
W=Water needed; ?=Insufficient data;
-= Not recommended.

* Member and director, West Australian Nutgrowing Society

Membership List

The following list of members is essentially in postcode order. The member in your vicinity is usually the best source of information on local factors affecting nutgrowing, so the list is arranged to make it easy to locate such members.

163 N Burtenshaw 67 Hordern St Newtown NSW 20142
112 Mr R D Thompson Villa 2, Byron St Lennox Head NSW 2478
139 Librarian(Deposit) National Library Canberra ACT 2600 *
98 Mr W H Chislett P0 Box 743 Orange NSW 2800
34 Dr W N Chin 1027 Nepean Highway Moorabbin VIC. 3189
117 Mr L Harvey R.S.D. PO Woorinen 111C. 3589
73 Mr H Salt Camms Rd Monbulk VIC. 3793
161 Mr L Higgins 'Rhonda Park' Greenbank Road,PS 1637 Jirnboomba 4280
35 Mr D Kumnick Kumnick Rd Lenswood S.A. 5240
149 Mr P Godkin Govt.Chemical Labortories 30 Plain St Perth 6000 *
138 Librarian(Deposit) State Library James St Perth 6000 *
166 Mrs H Clements 4 Ventnor Ave West Perth 6005
1 Mr D G Noel P0 Box 27 Subiaco 6008
144 C H Ruben 23 Waylen Rd Shenton Park 6008
43 Mr L G Deason 77 Lawler St Sublaco 6008
12 Mr J G Bennett 30 Hobbs Ave Dalkeith 6009
22 Mr F N Bockxmeer Physiology Dept University of WA Nedlands 6009
148 Mr A Pearson 22 Phillip Rd Dalkeith 6009
21 Mr P Sinclair 70 Viewway Nedlands 6009
15 Mr B Dell Botany Dept University of WA Nedlands 6009
181 Mrs L Hodan 9 Leura St Nedlands 6009
58 Mr G K Abbott 147 Claremont Cres Swanbourne 6010
72 Mr P Rolfe 154 Alfred Rd Mt Claremont 6010
44 Mrs R F Hearne 75 Davies Rd Claremont 6010
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20 Mr R L Routley 1 Overton Gardens Cottesloe 6011
174 Mr R Wallace 148 A View St Cottesloe 6011
131 Mr D Ritchie 12 Rudwick St Mosman Park 6012
52 Mr C Piesse 69 Alexander St Wembley 6014
51 Mrs B Law 25 Ulster Road Floreat Park 6014
167 Dr L Zaninovich 211 Main St Osborne Park 6017
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180 Mr J A Thompson 134 Northstead Rd Scarborough 6019
24 Mr P Good 8 Norman St Wembley Downs 6019
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158 Mr W R Cooper 31 Chrysostom St Trigg 6020
12 Dr M J Washer 9 Suiza Place Waterman 6020
49 Mr B Balding 3 Firth Court Duncraig 6023
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18 Mr R H Mizen 11 Moyle Place Hillarys 6025
27 Mr J Mercer 45 Bridgewater Drive Kallaroo 6025
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157 Mr A W Higgins 40 Clotilde St Mt Lawley 6050
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103 Mr A Y Steel Viveash Rd Swan View 6056
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143 Mrs W Dachtler Lot 23 Hartfield Rd Forrestfield 6058
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107 Mr F Jankovic 3 Collins St Yokine 6060
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80 Mr A Creswick 22 Shaw Rd Wanneroo 6065
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25 Mr R A Lancaster 13 Rome Rd Melville 6156
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59 Mrs M Garrity 41 Birdwood Circus Bicton 6157

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75 Mr W Spence 14 Quince Way Coolbellup 6163
40 Mr C Pfaff 38 Headland St Hamilton Hill 6163
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119 Mr K Nendel 58 Calista Ave Calista 6167
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101 Mr G Paverd P0 Box 395 Mandurah 6210
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86 Mr J Burns P0 Box 96 Harvey 6220
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68 Mr Z Mielens Giblett St Bridgetown 6255
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79 Mrs E Wilson P0 Northcliffe 6262
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155 Mr A Hardy P0 Margaret River 6285
150 Mr J M Ulbrich RMB 252 Margaret River 6285
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89 Mr R McKellar P0 Box 45 Augusta 6290
165 Mr C M Hall P0 Box 143 Wagln 6315
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125 Mrs S M Keogh Cuthbert Albany 6330
173 Mr B B King Millbrook Rd King River 6330
153 Mr C T Saggers 'Blue Waters' Lower Kalgan Albany 6330
160 Hr D C Mattinson 19 Swarbrick St Emu Point Albany 6332
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97 Mr R K Duckham Police Station Kulin 6365
164 Mrs C Turner P0 Box 106 Kulin 6365
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110 V C Pascoe P0 Box 63 Williams 6391
118 Mrs J Barrett RMB 399 Jlngalup 6395
177 Mrs K J Mathwin RMB 314 Kojonup 6395
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48 Mr B Mollinson 316A StrIckland Ave South Hobart Tas. 7000
33 Mr B G Dent Underwood Tasmania 7254
30 Mr G R Hambleton Rt#2 Niagara-On-The-Lake Ontario L0S 1J0 Canada