ASPECTS OF KAURI PROPAGATION BY SEED

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Kauri (*Agathis australis*) is a characteristic tree of forests in the northern part of the North Island (New Zealand) from near North Cape to latitude 38°. The genus *Agathis* contains about 15 species in the Pacific basin from the Philippines to Polynesia and Australia. The single New Zealand species is endemic. Much has been written about the N. Z. Kauri — of its botanical features and large dimensions, of its timber quality, and of the exploitation by man for lumber, kauri gum, and clearing of kauri forests for pastoral purposes. This has led to a serious depletion of the original virgin forest (from 1.2 million hectares to 5,200 ha.) but has left behind a legacy of natural regeneration much of which is retained in reserves and state forests. Kauri is one of the few native trees which exhibit potential for management; it associates gregariously, forming almost pure stands, (under certain conditions) and is a natural colonizer of shrublands, having good seed production and seed dispersal.

Silvicultural management of Kauri stands, (that is by tending regeneration or artificial establishment) has been of limited extent, although compared to management of other native tree species, Kauri has received somewhat more attention. Management research has been done in Northland — Auckland by the N. Z. Forest Service and other agencies seeking answers to fundamental questions about Kauri ecology, regeneration, thinning and artificial establishment, including nursery practice. Unfortunately many of these research projects have not had the continuity necessary to provide sufficient information on which to base firm management systems. The reasons for this "stop-go" research can be found in past Government attitudes towards indigenous forest management (1). Research has, however, provided sound guidelines for nursery production of Kauri, and this is largely due to work by F. T. Morrison at Waipoua Forest (5, 7).

Early work at Waipoua developed basic techniques of Kauri propagation in open ground beds, and provided valuable information on seed trees, seed collection and extraction, methods of sowing, and general nursery handling of seedlings. During later years research commenced on growing plants in containers and the survival and growth of such plants in the field gave encouraging results. Our nursery system at Hunua, is a continuation of this latter development — growing in containers but with emphasis on propagation under more controlled conditions, i. e. germination of seed under glass and growing on in a shadehouse.

Seed collection and extraction. Kauri seed crops are borne annually on trees after the age of about 35-50 years and, although seed quality varies by years and between trees, there is usually a plentiful supply.

The cones break up on the tree as they mature and it is thus necessary to collect whole cones before the period of final ripening. Trees are climbed with the aid of aluminium ladders ascending to the upper part of the crown where most cones are found. Trees selected for climbing are usually poles in the 60 to 100 year age range and about 10 to 20 metres in height. It was found[1] from studies at Waipoua that about 20 cones weigh 1 kilogramme, with sound seed per cone ranging from 42 to 94 (average 70). (5). We know from our own experience that seed quantity and viability varies between individual cones, even quite considerably within the same tree. A recent count of seed in 40 cones from the same tree yielded a range of 18 to 86 sound seed (average 60) and total seed per cone averaged 93 (ra. 72 to 109). Cones break up at room temperatures in about 5 to 10 days and seed is extracted by sieving to remove scales.

Separation of sound seed. The variation in seed viability in any one year makes it necessary to have some method to separate sound from blind seed. Trials at Waipoua (6, 7) indicated that separation could be achieved by immersion of seed in cold water for between 24 and 48 hours, the sound seed sinking and empty seed remaining on the surface.

Our own experience using this method has been poor, and in glasshouse trials over 3 years (with various seed lots) there was a marked difference in length of time taken for all sound seed to settle out. In a recent experiment with freshly gathered seed (early March), 29 to 67% of sound seed sank in 48 hours, and 78 to 100% after 70 hours soaking — average temperature of the water baths at 7:30 a.m. was 21.1°C. In none of these "flotation" trials

[1] Samples taken from a recent collection of cones at Hunua (March, 1976) gave an average of 11 cones per kilogramme. (range 9-14/kg.) Cones were collected from about 15 trees, then all mixed together, and stored at room temperature for two days before sampling. From this total collection 34 samples (with ten cones per sample) were selected at random and weighed. One seed tree yielded above-average cones; these were weighed separately and gave an average figure of 8 cones per kilogramme. (125 grammes/cone.)

On the basis of these figures it seems that the information given in Morrison 1955[5] (i.e. 20 cones/kg.) is incorrect. Morrison's data appears to have been based on an earlier observation by McKinnon 1937 (N.Z. Jour. For. IV.) who stated that "between 9 and 10 cones weigh one pound."

Some variation in average cone weights is to be expected from year to year, due to differences in moisture content, cone size, and stage of ripening. However, on the evidence to date, a selection of Kauri cones (from a number of seed trees) should average in the range 90-110 grammes each. (9-11 cones/kg.)

did any sound seed ever settle out in 24 hours. In previous trials (where seed had been stored for about a month) it has taken 7 to 8 days for 90% of sound seed to sink in water.

There is a great variation in the rate of sinking of seed, both between lots from different trees, and between individual seeds. The method then is not very precise and can result in sound seed being discarded when "floaters" are removed, if insufficient time has been allowed in the water bath.

We have found the best means of separation to be by eye, and this method has also been used with accurate results in research (2). After a little practice, seed with well formed embryos can be recognised visually (Fig. 1) or by lightly pressing seed against the sorting table if doubt exists (2). A skilled person can sort through about 2,000 seeds per hour, — the rate of separation depending upon the number of sound seed present. This method of separating sound and empty seeds has consistently given 90 to 95% accuracy in germination tests.

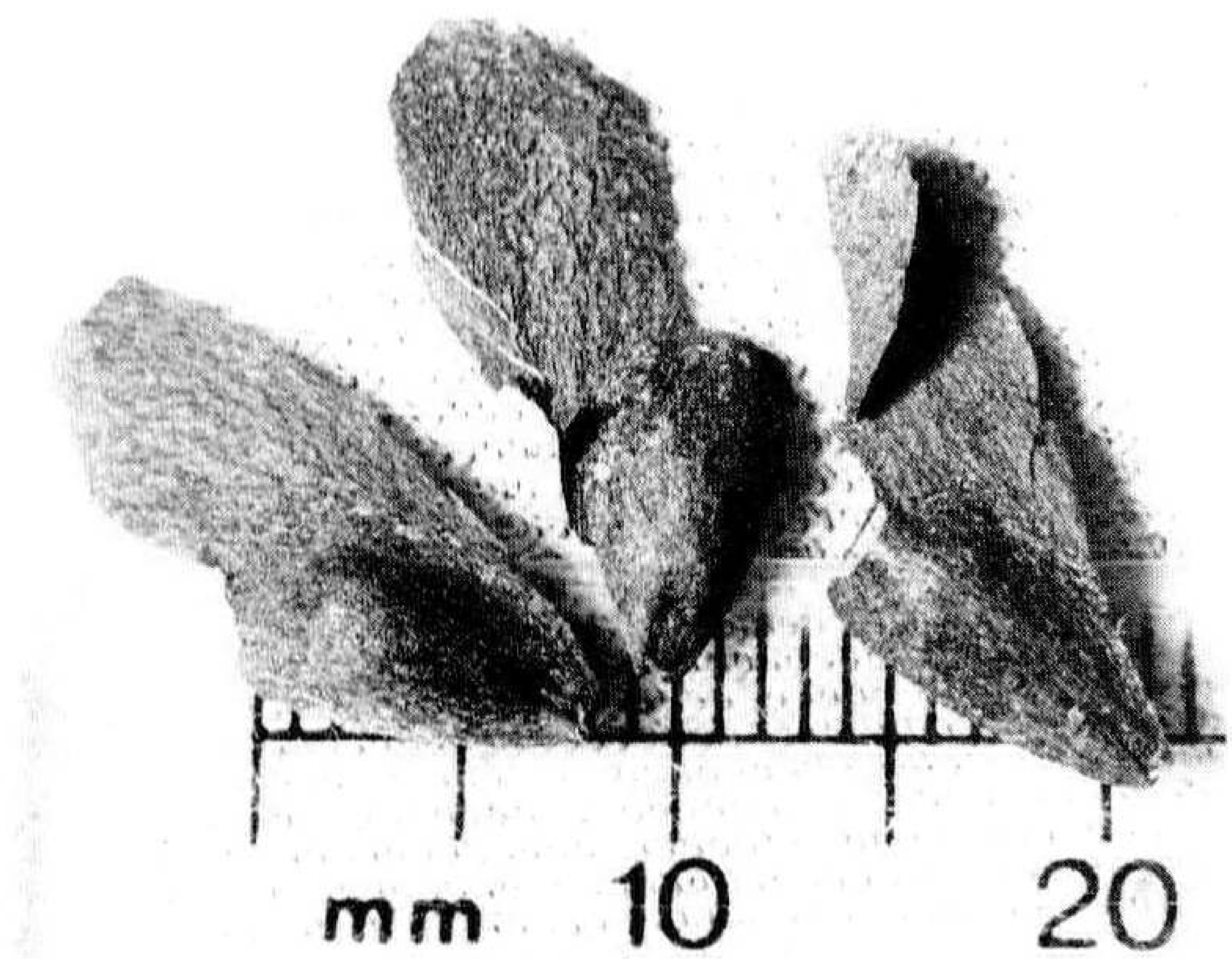

Figure 1. Viable Kauri seeds.

Seed storage. It has been known for many years that Kauri seed loses viability rapidly if stored under normal atmospheric conditions. Mirams (4) showed that there is a steady decline in germination from 100% at time of collection to only 5% by midwinter; the rate of decline varied between the two seed sources used in the experiment.

Standard nursery practice is to sow seed immediately after extraction (5, 7) and a good germination percentage is usually achieved.

Storage for a longer term may be of importance where a good quantity of special seed is collected, and not all is used in one year. It has been shown by Preest (see ref. 7) that if Kauri seed is stored at 5^0 to 10^0C with a moisture content of 6% then germination can still be 80% after four years storage. Drying the seed to a low moisture content seems to be the most important factor. We have found that storage of seed in plastic bags or tins, placed in an ordinary refrigerator (temperature 2^0 to 5^0C) is satisfactory for a few months. However, it is difficult to maintain a controlled environment and the seed gradually deteriorates.

Sowing and germination. A seedbox compost is used for sowing, composed of 2 parts soil (loam), 1 part scoria (or sand) and 1 part peat (parts by volume) and screened through a 1 cm sieve. To each cubic metre of this mix is added 2.1 kg superphosphate and 1.5 kg calcium carbonate. The compost is steam pasteurised before use.

Seeds are lightly dusted with Thiram fungicide and sown in wooden trays at 2.5 x 2.5 cm spacing, which gives about 120 per box. Seeds are covered lightly with a fine compost to 1 to 3 mm depth, watered thoroughly, and placed in a cool glasshouse for germination. (Mean monthly temperature 18^0 to 20^0C).

Probably the most important point at sowing is not to cover seeds too deeply; this is a common cause of failure in Kauri seed germination. Bieleski (2) in a small trial sowed seeds at: (a) soil surface, (b) 1 cm depth, and (c) 2 cm below soil surface. The germination percentage was: (a) 86% (b) 1.6% (c) 1.6%; the weak hypocotyl is unable to push the shoot tip through the soil from any great depth.

Kauri seed has a thin testa and imbibes available water very rapidly, hence the need for heavy watering at sowing. In an experiment (4) seeds were given varying amounts of water, and it was found that "those seeds which received a large proportion of their available water supply at the commencement (at sowing) had best germination."

The glasshouse is shaded, but additional shade cloth cover over boxes during germination aids in reducing evaporation.

First germination commences in 4 to 8 days, and is completed in a short time if conditions are favourable. Usually 90 to 95% of the selected sound seed germinates; most seed coats are shed and the cotyledons expanded in 30 to 40 days from sowing.. Buds break before winter, and two or four sets of "true" leaves are formed before the following spring.

At first potting, survival from sowing is 75 to 90%, with losses due to "damping-off" and the death of weak seedlings. Plants are culled fairly heavily, and only 60 to 70% are potted on.

CONCLUSION

The nursery method described produces good quality seedlings for artificial establishment at Hunua and has some advantages over production in open ground; i. e. seed sowing, germination, and early growth is less affected by climate, and disease and insect problems are reduced. The number of seedlings produced per unit area is increased, and growth in containers is less variable than in outside beds. In addition, staff generally have better working conditions.

There are still some areas in which improvements can be made (both in nursery technique and in plant growth) and we feel that investigation into the following should yield valuable results:

1) Direct sowing to individual propagation pots. (Seedlings are potted on in the small container thereby avoiding root damage).
2) Direct sowing and growth in a final container, in which the plant will be set out (acceptance of a smaller seedling at planting appears necessary to achieve this).
3) Better systems for hardening off and preparing plants for field conditions.
4) Improving seed selection. (Heavier seeds have been found to produce more vigorous seedlings — at least in early stages of growth) (5).
5) Development of a tree improvement programme for reproduction of superior trees. (This involves asexual propagation and some initial work has commenced on propagating from cuttings) (3).
6) Use of heated structures to improve the early growth of seedlings over winter.

If some (or all) of the foregoing can be developed and applied successfully, then prospects for reducing the length of time taken to grow a plantable seedling are very good.

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