Sandal and Its Products

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Germination of Two Provenances of *Santalum austrocaledonicum* var. *austrocaledonicum*

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Abstract

During the germination phase of a *Santalum austrocaledonicum* progeny trial, important and unexpected differences occurred in the germination rates between two provenances. The 'Ile des Pins' provenance conformed with expectations, previous experimentations and routine germination (55% after two years' storage). By contrast, the unstudied 'Mare' provenance failed completely (one lot had a 19% germination rate; the others, nothing after 15 months' storage in identical conditions). Germination rate seems to correlate with mean seed-size of a provenance. This may be significant since the seeds of other *Santalum* species and varieties of the South Pacific look more like the Mare, even though the only large experiment was conducted on the Ile des Pins provenance. Present projects of genetic diversity conservation or species/provenance trials in South Pacific countries should be aware of that result, and test their seed lots regularly in order to minimise loss of costly material.

AN IMPORTANT PROGENY trial of *Santalum austrocaledonicum* has been initiated in New Caledonia in order to study some genetic characteristics of this species. Collections were conducted on 10 trees on the Ile des Pins (IdP), located 80 km southeast of the main island and 13 trees on Maré Island located 130 km east of the main island, in the Loyalty Islands archipelago.

All previous studies were carried out with the easiest provenance to collect: 'Nouméa'. Much information was also gathered with the most-used provenance for plantations: IdP, that behave like Nouméa in terms of conservation, germination and juvenile growth. The Loyalty provenances, including Maré, should be another variety due to major morphological differences with IdP; they have not been used for plantations, so their characteristics are unknown.

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Methodology

Fruits were collected ripe on the trees under the direct supervision of the officer in charge of the Forestry Seed Centre of New Caledonia, managed by CIRAD-Forêt. The fruits were immediately depulped with a potato peeler. Seeds were first tested by flotation, then dried under shade until transport to the Seed Centre where they were treated against fungus and stored in the dry cold-storage room at 1–3°C. All lots were stored together; they were:

- *Santalum austrocaledonicum* var. *austrocaledonicum* (doubtful denomination);
- 10 lots of more than 300 seeds each, collected 7–10 March 1995, each on a single tree on Ile des Pins; and
- 13 lots of more than 300 seeds each, collected 10 October 1995, each on a single tree on Maré.

After two years, on 3 March 1997, the seeds were withdrawn from the cold-storage room, scarified by removing the extremity of the hard coat, partially soaked overnight inside a fridge in a 0.1 g/L of a giberellic acid solution. The solution levelled in

order to have the top of each seed outside the solution. On 4 March 1997 they were sown on disinfected perlite (thoroughly watered with chloride, rinsed with treated tap water, then dried under the sun). The dried perlite was laid in boxes, then treated with a strong fungicide, *Terachlore*. One third to a half of each seed was left outside the germination medium. Bed heaters were not used because the germination was done during the hot season. Watering was by sprinkler at the rate of 1 mm every 10 minutes in order to keep the seeds humid but not wet. Every week, the seeds were treated with a fungicide (*Benlate*) solution. As soon as a seed germinates, it is withdrawn from the germination bed and sown in a second germination box (peat and sand) where it will grow until pricking out to the pots takes place.

Results

The differences between the two provenances are shown clearly in Table 1 and Figure 1.

Seed size

Unfortunately, since the Maré lots were unsuccessful, the individual germination record cards for each lot were not kept. We do not have the exact weight of the seeds for those lots, except for the lot that germinated poorly (35.5 g/100 nicked seeds). However, previous studies on the New Caledonian seeds (Bailly 1986; Kagy 1987; Nasi 1995) show that the average dry-seed weight of the lots vary around 40±0.6 g/100 whole seeds for Maré and 16.4±0.4 g for IdP. These values conform to the values measured here, considering that the latter were nicked seeds, which are slightly lighter than entire seeds. The Maré seeds are 2.4 times heavier than the IdP seeds.

Germination rates

The average germination rate of the IdP provenance is 55%, all 10 lots are between 38% and 70%, and the coefficient of variation is 19%; individual variation between progenies is important. By contrast, the 12 lots from Maré were completely unsuccessful (that is, virtually no germination), with the only one to germinate having a rate of 19%, half that of the worst IdP rate.

First germination

The IdP provenance has little variation and all the lots started to germinate the eighth or ninth day after sowing. The only Maré lot that germinated started on the 24th day after sowing.

Table 1. Germination results of two provenances of *S. austrocaledonicum*

Provenance	Characteristic	Provenance													
		1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
Ille des Pins	Germination rate (%)	49	38	52	54	60	67	44	57	70	45	–	–	–	55
	100 seed weight (g)	12.3	17	14.8	14.6	12.9	15	11.8	14.6	12.4	14.8	–	–	–	14.02
	Germination start (days)	9	8	9	9	8	9	8	9	9	9	–	–	–	8.7
Maré	Germination rate (%)	0	19	0	0	0	0	0	0	0	0	0	0	0	19
	100 seed weight (g)	?	35.5	?	?	?	?	?	?	?	?	?	?	?	35.5
	Germination start (days)	~	27	~	~	~	~	~	~	~	~	~	~	~	27

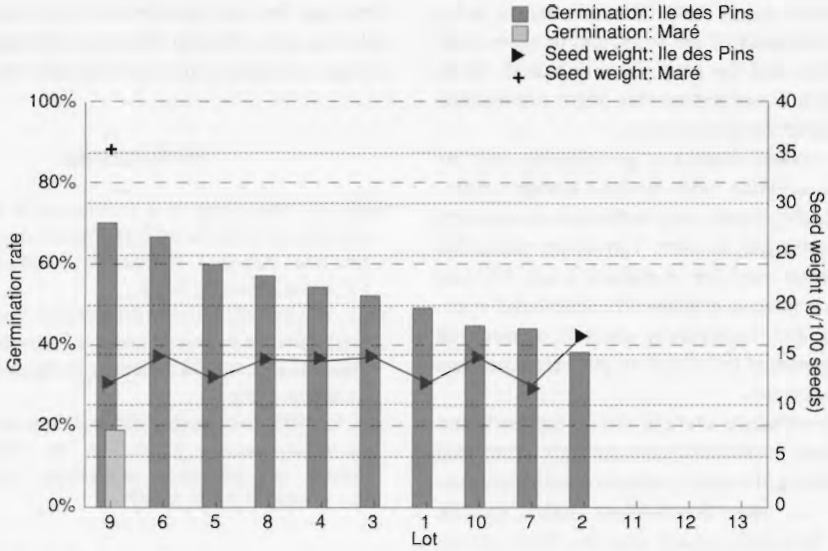

FIgure 1. Seed germination rates of progenies. Comparison between Ile des Pins and Maré.

Discussion

The behaviour of the two provenances concerning seed conservation and germination start is very different.

IdP

The germination rate of the IdP provenance was 54% after two years of dry cold storage conservation. This value is slightly under the germination rate (70–80%) in the large study in 1986 (Bailly 1986; Nasi 1995), but this latter was realised in laboratory conditions with the Main Island provenance, whose seeds are even smaller. Moreover, even if the cold storage room is dry, the experimental conditions of the 1986 study were air-tight boxes with silicagel that ensured a permanent and very low humidity level that is not reached in usual storage conditions. Given these remarks, we estimate that the observed germination rate of IdP seeds conforms to that expected.

However, the variation between progenies is high and must be further investigated. If the progeny trial shows sufficient genetic heritability, seed orchards of tested plus trees will be established. In order to ensure a regular and homogeneous quality seed supply, we will need to know the germination rate value and its evolution during storage. If these characteristics are linked to the seed bearer (either genetic or depending on physiological characteristics, their prediction will be possible and the management of the seed-lots collected will be far easier.

Maré

The Maré seeds were kept in the same conditions as the IdP ones. The storage length was only 15 months. Average germination rate was zero. (Only one lot among the 13 germinated, and the rate was low—19%.)

The conservation period for these Maré seeds is significantly shorter than the one for IdP, and we went beyond the limit of viability; so conservation for more than one year should not be considered.

Another factor that reinforced the low germination rate was the length of germination associated with the big size of the seeds. Until the beginning of the germination, the nicked seeds were exposed for longer. Even if sanitary precautions are enforced, they cannot completely protect the seeds from pathologic agents, mainly rot and fungus. The loss is therefore higher than for the IdP seeds.

Conclusion

Seed conservation of the Maré provenance seems to be very short. The present experience shows that the conservation period cannot exceed one year. In fact,

this conservation should only be conducted in order to break the dormancy of the seeds and to allow time between fruiting and the next planting period. More experimentation is needed on this Maré provenance in order to clarify that proposition.

We have already started a germination test vs length of conservation with several storage conditions. In fact, this factor may influence the present sandalwood program in New Caledonia since the main provenance used for plantation is the IdP one that has proved to have a better oil content and vegetative growth. But biodiversity must be considered too, so it is important to be able to produce seedlings of other provenances.

Since the provenance average size of the seeds and the conservation possibility seem strongly correlated in New Caledonia, the seed production and conservation strategy for other South-West Pacific species (e.g. *S. yasi* that looks much like the Maré provenance) or varieties (e.g. Vanuatu, the seed size of which is more like the Maré provenance), must be addressed and the viability evolution of the seeds identified in order to avoid any loss of seed. This is essential in case of an expected extended international program of species/provenance comparison or a genetic conservation one like that presently in process in some South Pacific Countries. Since the major part of the stands are depleted and the collection of seeds are few in quantity and very costly, the rare ones that are collected should not be kept too long in storage without a permanent viability test.

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