graduate 150 to 200 students a year and most of them go into the ornamental horticulture industries of California.

While we claim to be educating students for middle managemnt positions, it is rewarding to see them climb the ladder of success. Many of them become owners or managers of businesses. They are active in their trade associations as is evidenced by the number of our graduates who have been presidents of the California Association of Nurserymen. We also have an active alumni association. A new graduate taking a job in the industry can be sure that there are O.H. graduates in the area to give him a helping hand. Suport for our program is evidenced by the fact that our students receive $35,000 to $40,000 a year in scholarships.

A number of alumni have remarked to me that it was interest in plant propagation that took them the college route but it was the support courses such as accounting, business law, labor relations, computer science, and public speaking that enabled them to advance in the business world.

SEED GERMINATION STUDIES WITH KENTIA PALMS *(HOWEA FORSTERANA)*

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Abstract. Seed of the kentia palm (*Howea forsterana*) was subjected to presowing treatents before planting in peat:perlite (50:50) at incubation temperatures in the range 20 to 40°C. Four percent of freshly harvested seed was found to be non-viable. Air drying the seed at 20 to 25°C for two weeks prior to sowing hastened decomposition of the outer husk. After 12 months there was nil germination of dried seed incubated at 20°C compared with 1.3, 5.4, 7.9, and 11.0 percent at temperatures of 25°, 30°, 35°, and 40°C, respectively. None of the undried seed had germinated after 12 months irrespective of substrate temperature. Chipping of part of the outer husk resulted in 6% germination compared with nil for unchipped seed, while soaking chipped seed in gibberellic acid (250 to 1000 mg L^{-1}) further improved germination. Gibberellic acid at greater than 250 mg L^{-1} produced no increase in germination and, at 750 mg L^{-1} germination was inexplicably decreased. A relationship between substrate temperature and seed decay appeared to exist for dried seed with maximum decay (ca.20%) occurring at 35°C. Fungi have been isolated from decayed seed and their pathogenicity and control are currently being investigated. Seed stored at 5°C for periods of up to 24 weeks had not germinated after 12 months.

REVIEW OF LITERATURE

The kentia palm, *Howea forsterana* (previously *H. forsteriana*), is one of the most familiar and widely grown ornamental palms in the world. For more than a century this elegant slow-

growing palm has adorned the hallways and drawing rooms of wealthy Europeans (5). There is currently a strong world demand for kentia palms as indoor plants.

Kentia palms are endemic to the lowlands of Lord Howe, Island, a small island off the coast of New South Wales. The island climate is temperate with a mean annual temperature of 19°C (maximum and minimum recorded temepratures are 31.5°C and 6.0°C, respectively) with a winter dominant rainfall averaging 1676 mm annually (7). The harvesting and sale of seed from the natural stands of kentia palm has been an important source of income to Lord Howe Island for more than 100 years. Recently a nursery has been established on the island where seed is germinated and the young sprouts are exported to mainland Australia and to other parts of the world.

Most palms possess a single meristem hence the principal means of propagation is from seed. Some palms produce suckers and thus may also be propagated vegetatively by division or aerial layering (5). More recently, *in vitro* methods of propagation have been developed (9). For economically significant palms, such as the oil palm (*Elaeis guineensis*), extensive studies have identified the optimum conditions for seed germination (4, 8). For the majority of palms, however, these conditions are unknown. The time required for the germination of palm seed varies greatly and may take several days for some species or up to 3 years for others (5, 10).

There is a dearth of information on the optimum conditions for the germination of kentia palm seed. This paper describes experiments investigating the effects of pre-sowing seed treatments and substrate temperature of the germination of kentia palm.

MATERIALS AND METHODS

Seed for all experiments was harvested on 30 March, 1984, from a single, mature palm growing in a well-watered garden on Lord Howe Island. The seed was plump and of a light green/yellow colour. Seed was planted in a medium of German peat moss and perlite (50:50) in shallow trays and placed on gravel over electric heating cables. Planting medium was maintained in a moist but not wet state at all times. In all experiments counts of germinated and decayed seed were made after 12 months.

Prior to conducting the germination experiments a sample of 100 seeds were cut open and examined for healthy embryos.

Experiment 1: The effects of air drying seed prior to sowing and of substrate temperature on germination.

Samples of 150 seeds were either planted fresh or air-dried in a greenhouse at 20 to 25°C for two weeks prior to planting. The planting media were maintained at temperatures of 20, 25, 35 and 40°C.

Experiment 2: The effect on germination of chipping the outer husk of the seed and soaking in gibberellic acid.

The outer seed husk was removed from the embryo end of the seed using secateurs. Samples of 100 seeds were then soaked for 48 hours in aqueous solutions containing 0, 250, 500, 750, and 1000 mg L^{-1} GA_3. Seed was planted and maintained at 25°C.

Experiment 3: The effect of low temperature storage on germination.

Samples of 200 seeds were stored in moist peat:perlite (50:50) at 5°C for 0, 2 weeks, 4 weeks, 8 weeks and 24 weeks. Seeds were then planted and maintained at 25°C.

RESULTS

Four percent of the fresh seed examined soon after harvest was found to have a dead embryo.

Experiment 1: Within two months of planting, the outer husk of dried seed had decomposed sufficiently to separate from the seed. By contrast the outer husk of undried seed did not reach this stage of decomposition until 6 to 8 months after planting.

None of the undried seed had germinated after 12 months irrespective of substrate temperature. Germination of dried seed showed a linear increase with increasing temperature ($P < 0.05$, $r_2 = 0.98$). At 20°C no seed germinated compared with 11% at 40°C (Table 1). For dried seed there appeared to be a relationship between substrate temperature and the percentage of decayed seed, with a peak occurring at 35°C (Table 1). For undried seed there was no trend except that the highest percentage of decayed seed also occurred at 35°C.

Table 1. The effects of substrate temperature and seed drying on germination and decay of kentia palm seed 12 months after sowing.

Substrate Temperature °C	No. Seeds	Undried Seed		Dried Seed	
		% germ.	% decayed	% germ.	% decayed
20	150	0	4.8	0	<1
25	150	0	2.6	1.3	3.3
30	150	0	1.4	5.4	5.3
35	150	0	18.9	7.9	19.9
40	150	0	2.0	11.0	8.8

Experiment 2: Chipping and soaking the seed in gibberel-

lic acid improved germination (Table 2). After 12 months an average of 13% of seed chipped and soaked in GA_3 (250-1000 mg L^{-1}) had germinated compared with 6% for the chipped control, and 0% for the unchipped control. A higher percentage of chipped seed decayed compared with unchipped seed.

Table 2. The effects of chipping the outer husk and gibberellic acid concentration on the germination and decay of kentia palm seed 12 months after sowing. Substrate temperature 25°C.

Treatment	No. Seeds	% Germinated Seed	Percent Decayed
Unchipped	100	0	3
Chipped (C) + O mg $L^{-1}GA_3$	100	6	10
C + 250 mg $L^{-1}GA_3$	100	18	14
C + 500 mg $L^{-1}GA_3$	100	15	13
C + 750 mg $L^{-1}GA_3$	100	3	8
C + 1000 mg $L^{-1}GA_3$	100	17	17

Experiment 3: None of the seed stored for varying periods at 5°C had germinated after 12 months (Table 3).

Table 3. The effects of storage at 5°C on germination and decay of kentia palm seed.

Period of Low Temperature Storage	No. Seeds	Percent Germinated Seed[1]	Percent Decayed Seed
2 weeks	200	0	6.9
4 weeks	200	0	10.8
8 weeks	200	0	16.1
24 weeks	200	0	4.5

[1] 12 months after the commencement of storage. Substrate temperature 25°C

DISCUSSION

The germination of kentia palm seed is reported to take 6 months to 3 years (5). The observations reported here were made 12 months after sowing and thus must be interpreted as provisional.

Air drying of the seed hastened decomposition of the outer husk and, at 25°C or higher, improved germination compared with undried seed. Jones (5) reported that the viability of seed of many tropical palm species was reduced if seed was allowed to dry. The kentia palm, however, is from a temperate climate and, in native stands, mature seed would fall and undergo natural drying on the soil surface at a mean temperature of approximately 20°C and relative humidity of about 70% (7). In Experiment 1 seed was dried for two weeks under similar conditions.

In both dried and undried seed the percentage of decayed seed increased with increasing temperature, reaching a maxi-

mum at 35° C. Fungi have been isolated from these decaying seeds and their pathogenicity and control is currently being investigated. It is possible that 35°C is the optimum temperature for such organisms.

The increased germination at higher temperatures recorded in this experiment confirms findings for other palm seeds. The optimum seed germination temperature for the tropical oil palm (*Elaeis guineensis*), for example, was found to be 42.0°C dry heat for 60 days (8). A temperature of 44.5°C was however, found to be fatal. The optimum temperature for germination of kentia palm seed has not been reported in the literature, but commercial growers in Australia provide a bottom heat of 25°C in germination beds.

Chipping of the outer husk of palm seed has been reported to hasten germination of some species (3). Experiment 2 confirmed this with kentia palm and the soaking of chipped seed in gibberellic acid further enhanced germination. The reason for the low percentage germination for seed soaked in 750 mg $L^{-1}GA_3$ compared with the other concentrations is not known. Gibberellic acid has been reported to stimulate germination of seeds which are physiologically dormant (1, 2). Nicholls (6), however, found that excised embryos of *Howea forsterana* seed germinated rapidly *in vitro* and concluded that the embryo was not physiologically dormant.

The effects of low temperature storage on germination of kentia palm are not yet apparent. Sixteen percent of seed stored for 8 weeks subsequently decayed. Only 4.5% of seed stored for 24 weeks decayed but detection was difficult because the outer husk had not fully decomposed. Low temperature may cause embryo death in some species of palm (5).

The overall seed germination percentage after 12 months was surprisingly low. Data gathered from the Lord Howe Island Board nursery for undried seed collected and sown in April, 1984, showed an average 15 to 20% germination after 12 months (C. Weale, pers. comm.). Such seed was collected from many trees and planted in a friable medium with no temperature control (year-round temperature in the range of 15 to 30°C). In the experiments reported here none of the undried seed had germinated after 12 months. The reason for this discrepancy is unknown but may be a genetic effect.

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TAXUS PRODUCTION IN THE U.S.A.

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The genus *Taxus* is probably one of the finest narrow-leaved evergreens for use in the landscape. The literature tells us that *Taxus* fossils have been found between layers of sandstone and shale originating about 150,000 years ago. (1) The genus has long been associated with religion and most of the Christian churches were built in yew groves throughout England. In the United States, the genus appeared in horticulture in the mid-1800's and much of the early popularity was due to the work of T. D. Hatfield, who was the head gardener at the Hunnewell Estate at Wellesley, Massachusetts (2).

There has been quite a bit of controversy as to exactly how many species of *Taxus* truly do exist. There are at least 3 species relatively universally accepted - *Taxus baccata* (English yew), *T. canadensis* (Canadian yew), *T. cuspidata* (Japanese yew). In the United States the English yew is only hardy in certain areas of the country. This species is not hardy in my state of Michigan.

The Canadian yew is a native species ranging from Virginia to the Great Lake Forests in the U.S.A. This plant, unfortunately, only thrives well in the shade and cannot tolerate full