seed at the end of 13 weeks was 40% as compared to 3% for the control. The pulpy material around the seed apparently inhibited germination.

Soaking the seeds in 100 ppm kinetin for 48 or 72 hr increased germination rate and percentage. There was a rapid increase in germination between the 6th and 10th weeks. The germination percentages at the end of 13 weeks were 87% for the 48 hr soak and 83% for the 72 hr soak. Germination was only 20% for the 24 hr kinetin treatment.

The response of 2000 ppm KNO_3 was similar to 100 ppm kinetin.

The 500 ppm GA treatment resulted in germination trends similar to those produced by kinetin and KNO_3 with the most effective treatments being the 48 and 72 hr soaks (Table 1). The 1000 ppm GA increased the effectiveness of the shorter soaking periods. Germination increased very rapidly between the 6th and 8th weeks for the 1000 ppm GA 48 hr soak and resulted in 97% germination after 13 weeks. The 72 hr soak was less effective (70% germination).

This study indicates that the germination rates and percentage of *Alyxia olivaeformis* Gaud. seeds can be substantially improved by removal of the fleshy seed coat and by preconditioning with kinetin, KNO_3, or GA.

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Accelerating Palm Seed Germination with Gibberellic Acid, Scarification, and Bottom Heat[1]

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Additional index words. Alexandra palm (*Archontophoenix alexandrae*), Macarthur palm (*Ptychosperma macarthurii*)

Abstract. **Scarification and pre-soak treatments with water or 1000 ppm gibberellic acid (GA) accelerated seed germination of Alexandra palm [*Archontophoenix alexandrae* (F. J. Muell.) H. Wendl. & Drude]. Macarthur palm [*Ptychosperma macarthurii* (H. Wendl.) Nichols] germination was accelerated following scarification or pre-soaking in 1000 ppm GA, however, in both species greatest acceleration was obtained when the scarification and GA treatments were combined. Germination time of Macarthur palm was also reduced by 6 weeks when sown in beds heated to 27° ± 1°C.**

Propagation of palms is often hampered by a slow rate of seed germination (1). In some instances germination may extend over several years (1) and may require elaborate seed treatment procedures (7). In the propagation of the oil palm, for example, seeds are soaked in water for 7 days, transferred to a 39°C germinating chamber for 80 days, re-soaked in water for 7 days and planted at ambient temperature (7). Germination is evident 3 weeks later. Bottom heat (8, 9, 12), pre-soaking in water (9), and scarification (5) are some practices recommended for accelerating palm germination.

Hodel (4) has also obtained rapid shoot growth in palms by growing excised embryos in tissue culture. Recently we demonstrated that pre-soak treatment with GA accelerated germination of Alexandra palm (6). This study was conducted to assess the effect of GA, scarification, and bottom heat on germination of 2 landscape species, Alexandra and Macarthur palm.

Mature fruits of Alexandra and Macarthur palm were harvested from trees near Hilo, Hawaii in February 1978 and the exocarps removed. Seeds were rinsed for 5 min in tap water, dipped in 5% sodium hypochlorite for 5 min, re-rinsed in water and air dried for 24 hr. Seeds were mechanically scarified or left unscarified and treated in the following manner: a) pre-soaked for 72 hr in distilled water, b) pre-soaked for 72 hr in an aqueous 1000 ppm GA (Gibberellic X, potassium salt) solution, c) untreated. Mechanical scarification was achieved by abrading the lateral surface of the seed with a file until the endosperm was visible. Seeds were sown in No. 2 vermiculite and maintained in the laboratory with an average maximum and minimum temperature of 26° and 20°C. Macarthur palms were also sown in beds supplied with bottom heat provided by electrical resistance coils. Temperature of medium was maintained at 27° ± 1°C.

Germination (shoot visible) percentage was determined weekly. Experimental design was randomized complete block with 20 seeds per treatment, replicated 5 times for Alexandra palm and 25 seeds per treatment, replicated 3 times for Macarthur palm.

Germination of Alexandra palm was most rapid when seeds were pre-treated with 1000 ppm GA (Table 1). Scarification enhanced the GA effect, thus indicating that the effectiveness of GA was related to its ability to penetrate the seedcoat. Germination rate at 7 weeks showed that pre-soaking with water for 72 hr and scarification also accelerated germination when compared to untreated seeds. The scarified/GA treatment produced the greatest acceleration, however, final germination percentage taken at 12 weeks was lower than in other treatments.

Results with Macarthur palm, a slower germinating species, showed that bottom heat greatly accelerated germination (Table 2 and 3) and were consistent with reports that seed germi-

Table 1. Effect of GA, scarification and pre-soaking with water on seed germination of Alexandra palm.

Treatment[z]	Germination (%)				
	4 wk	5 wk	6 wk	7 wk	12 wk
Control	0.0 a[y]	0.0 a	12.0 a	57.0 a	96.0 b
Scarified	0.0 a	7.0 a	46.0 bc	85.0 b	98.0 b
Unscarified, water pre-soak	0.0 a	2.0 a	27.0 ab	78.0 b	96.0 b
Scarified, water pre-soak	0.0 a	2.0 a	29.0 ab	72.0 b	95.0 b
Unscarified, 1000 ppm GA pre-soak	0.0 a	21.0 b	65.0 cd	84.0 b	94.0 b
Scarified, 1000 ppm GA pre-soak	6.0 b	53.0 c	69.0 d	77.0 b	83.0 a

[z]Duration of pre-soak treatment in water and 1000 ppm GA was 72 hr.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

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Table 2. Effect of GA, scarification and pre-soaking with water on seed germination of Macarthur palm planted in heated beds.

Treatment[z]	Germination (%) 7 wk	9 wk	11 wk	16 wk
Control	0.0 a[y]	4.0 a	32.0 a	81.3 bc
Scarified	0.0 a	44.0 b	72.0 b	74.7 ab
Unscarified, water pre-soak	0.0 a	12.0 a	62.7 b	88.0 bc
Scarified, water pre-soak	0.0 a	9.3 a	44.0 a	65.3 a
Unscarified, 1000 ppm GA pre-soak	0.0 a	17.3 a	70.7 b	89.3 c
Scarified, 1000 ppm GA pre-soak	8.0 b	50.7 b	73.3 b	78.7 bc

[z]Duration of pre-soak treatment in water and 1000 ppm GA was 72 hr.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

Table 3. Effect of GA, scarification and pre-soaking with water on seed germination of Macarthur palm planted in unheated beds.

Treatment[z]	Germination (%) 12 wk	15 wk	20 wk	26 wk
Control	0.0 a[y]	4.0 a	61.3 c	92.0 c
Scarified	2.0 a	14.7 a	33.3 ab	65.3 ab
Unscarified, water pre-soak	0.0 a	8.0 a	54.7 bc	81.3 bc
Scarified, water pre-soak	0.0 a	6.7 a	28.0 a	46.7 a
Unscarified, 1000 ppm GA pre-soak	0.0 a	5.3 a	54.7 bc	92.0 c
Scarified, 1000 ppm GA pre-soak	6.7 b	45.3 b	52.0 bc	54.7 a

[z]Duration of pre-soak treatment in water and 1000 ppm GA was 72 hr.
[y]Mean separation in columns by Duncan's multiple range test, 5% level.

nation is usually more rapid at higher temperatures (3). Germination of control seeds occurred at 9 weeks in beds supplied with bottom heat, and at 15 weeks in the unheated beds. Within heated and unheated beds greatest acceleration was again obtianed with scarified seeds pre-soaked in GA. Data from heated beds at 11 weeks also indicated that, with the exception of the scarified/water pre-soak treatment, all treatments accelerated germination over control. This trend was not evident in the unheated treatments. Final germination rates in treatments with scarified seeds were generally reduced in both the heated and unheated beds.

Our results suggest that two factors may contribute to the slow germination of palm seeds: a) a mechanism responsive to GA, b) an impervious seedcoat. Hodel (4) found that embryos of *Pritchardia kaalae* Rock and *Veitchia joannis* H. Wendl., grown *in vitro*, develop shoots within 14-21 days, whereas germination time was 35-40 days. He proposed that dormancy in palms may be due to a thick endocarp or chemical inhibitors within the seed. Although chemical inhibitors have not been identified in palm seeds, the ability of GA to stimulate germination of dormant seeds is well documented (10) and is often attributed to its ability to overcome inhibitors such ABA (2, 11).

A general reduction in final germination percentage occurred in the scarification treatment and was especially evident in Macarthur palms sown in unheated beds. This may have been due to the entrance of microbial contaminants into the scarified seed during the long incubation period. It is unlikely that the embryo was directly injured by scarification since the lateral surface of the seed was scarified while the embryo is found at the distal end.

The work described above shows that GA, scarification, and bottom heat accelerate palm seed germination. A combination of bottom heat, scarification and pre-soaking in GA produces the greatest affect. The effectiveness of GA is limited by its ability to penetrate the seed coat.

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Influence of Light and Fertilizer Levels on Production and Acclimatization of *Pittosporum* spp.[1]

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Additional index words. tissue analyses

Abstract. Pittosporum tobira **(Thunb.) Ait. and** *Pittosporum tobira* **(Thunb.) Ait. cv. Variegata were grown under various light and nutritional levels and then placed in an interior environment under 2 light levels. As production light levels decreased, plant height and width and leaf size increased for both cultivars. Fertilizer had no effect on plant height or leaf size and slightly increased width of green pittosporum. A decrease in production light intensity greatly improved plant color and grade while increased fertilizer slightly improved leaf color of both cultivars and plant grade of variegated pittosporum. Treatment effects were essentially the same after 6 months indoors.**

Previous research by Conover et al. (2, 3, 4, 5), Vlahos and Boodley (10) and others (7, 9) has shown the necessity of conditioning or acclimatizing sun-grown plants prior to movement to an interior environment. Results of this research has shown acceptable plants could be produced under reduced light levels and these plants performed better indoors than sun-grown plants.

Pittosporum is used primarily as an outdoor landscape plant in the south, but is also used to a small extent as an interior accent plant. Unlike most foliage plants, pittosporum will tolerate full sun and light freezing temperatures. The objectives of this study were to evaluate growth of green and variegated

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