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Improving Papaya Seedling Emergence by Matriconditioning and Gibberellin Treatment

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Abstract. **Papaya *(Carica papaya* L.) seeds germinated poorly at 25C in the presence of gibberellin (GA_{4+7}) or following matriconditioning at 25C for 4 days. However, a combined treatment of matriconditioning and GA_{4+7} for 4 days synergistically promoted germination and seedling emergence. Drying the seeds after conditioning reduced the percentage of seedling emergence in the combined treatment involving 400 µM GA_{4+7} only. Combining matriconditioning with 100 or 200 µM GA_{4+7} could effectively reduce germination time and improve seedling emergence and is recommended as a standard procedure for testing papaya seed germination.**

Papaya is cultivated in many tropical and subtropical regions. Papaya is propagated commercially by seed. The seed is enclosed in a gelatinous sarcotesta (aril or outer seedcoat), which is formed from the outer integument. Papaya seed germination frequently is slow, erratic, and incomplete (Chacko and Singh, 1966; Lange, 1961; Ramirez, 1961; Yahiro, 1979). While the sarcotesta can delay germination, dormancy also is observed in seeds from which the aril has been removed (Lange, 1961; Yahiro, 1979; Yahiro and Oryoji, 1980).

Several attempts have been made to overcome dormancy and improve papaya seed germination. Treatments such as removing sarcotesta, presoaking in water, or water leaching promote *Carica* spp. germination (Chow and Lin, 1991; Riley, 1981). Gibberellin (GA_3) treatments may (Lange, 196 1; Riley, 1981; Yahiro and Oryoji, 1980) or may not (Chacko and Singh, 1966; Ramirez, 1961) increase germination percentage, even though germination time may be reduced (Chacko and Singh, 1966; Lange, 1961; Seth, 1961; Yahiro and Oryoji, 1980). Based on previous studies, Yahiro (1979) suggested that 30 or 20/30C (16 h/8 h) was a suitable germination temperature. Also, if a combination of aril removal and a subsequent presoak for 30 to 42 days with 500 ppm GA_3 failed to promote germination, then a prechill treatment should be considered (a presoak at 15C for 40 to 50 days promoted germination in one case). However, even with these treatments, papaya seedling emergence is slow and erratic. Watkins and Cantliffe (1983) reported that GA_{4+7} was more effective than GA_3 in stimulating germination rate of pepper *(Capsicum annuum* L.) seeds.

Preplant seed conditioning or priming has been used to reduce germination time, synchronize emergence, and improve stand size of several crops (Khan, 1992). One preplant conditioning procedure, matriconditioning, uses moist solid carriers to improve seed performance. Matriconditioning has been highly effective in improving emergence and stand of many crops (Khan et al., 1990, 1992a, 1992b; Madakadze et al., 1992).

We were interested in determining if matriconditioning alone or combined with GA_{4+7} would break papaya seed dormancy, shorten seedling emergence time, and improve emergence percentage.

Two lots of hybrid 'Tainung no. 1' and 'Tainung no. 2' papaya seeds supplied by Known You Seed Co., Kaohsiung, Taiwan, were used to test matriconditioning and GA treatments. Two experiments were conducted. Expt. 1 treatments consisted of seed matriconditioning with Micro-Cel E (a synthetic silicate produced by hydrothermal reaction of diatomaceous silica, hydrated lime, and water; Manville Products Corp., Denver) as a solid carrier moistened with water or GA_{4+7} solution at 100, 200, or 400 µM in 0.47-liter glass jars, loosely capped for 1 to 5 days. Matriconditioning occurred at 25C in fluorescent light (16 $\mu mol \cdot m^{-2} \cdot s^{-1}$). A ratio (by weight in grams) of 2 seed : 0.6 Micro-Cel E :3.75 water or GA_{4+7} solution was used for conditioning. After conditioning, seeds were washed in running water, wiped on paper towels, and germinated (three replications of 50 seeds each) in 9-cm petri plates on two Whatman no. 1 filter paper disks soaked in 5 ml water or 200 µM GA_{4+7} solution. Seeds also were soaked for 24 h in 200 µM GA_{4+7} without Micro-Cel E, wiped on paper towels, and germinated in water as above. Seedling emergence was evaluated by planting seeds in a 1 peat : 1 vermiculite mix in 30 × 24 × 10-cm plastic boxes at the rate of 25 seeds per row per box (four replications). The boxes were covered with a lid to prevent evaporative cooling and moisture loss and transferred to 25C in continuous fluorescent light (16 $\mu mol \cdot m^{-2} \cdot s^{-1}$). Expt. 2 consisted of the same treatments as Expt. 1, except that, after conditioning, seeds were dried to their original weight by forced air at 25C for ≈24 h before being planted directly in a peat–vermiculite mix. Emergence was recorded every 2 days.

Nontreated papaya seed germination was only 6% (Table 1). Matriconditioning or GA_{4+7} treatment slightly promoted germination. Adding GA_{4+7} during matriconditioning synergistically enhanced the germination percentage. In peat-lite mix, only 10% of matriconditioned seeds emerged in 10 days compared to 5% in 14 days for nontreated seeds (Fig. 1A). However, when conditioning was combined with 400 µM GA_{4+7}, seedling emergence reached 70% and 90% in 4 and 5 days, respectively.

Although germination rate was slightly reduced (Fig. 1B), final emergence was not adversely affected when papaya seeds conditioned in the presence of 100 or 200 µM GA_{4+7} were dried to their original weight. In contrast, drying seemed to affect adversely the seeds treated with 400 µM GA_{4+7} during conditioning, as indicated by reduced final percent emergence. The time for 50% of final emergence (T_{50}) was 6.0, 7.0, and 7.8 days for seeds treated with 200, 100, and 400 µM GA_{4+7}, respectively. Seedling emergence in nontreated and dried matriconditioned seeds was ≤6%, even after 20 days.

Conditioning duration in the presence of GA_{4+7} influenced emergence time. The T_{50} was reduced from 12 to 6 days as the conditioning treatment was extended from 1 to 5 days (Fig. 2). However, conditioning duration did not significantly affect emergence percentage.

Table 1. Effect of matriconditioning, with or without GA_{4+7}, on hybrid papaya seed germination.

	Cultivar			
	Tainung no. 1		Tainung no. 2	
	Time after seeding (days)			
Treatment	6	12	6	12
	Germination (%)			
Nontreated	0 c[z]	6 c	0 b	0 c
GA_{4+7}[y]	10 b	25 b	0 b	12 b
MC[x]	6 bc	10 c	0 b	4 c
MC + GA_{4+7}[x]	74 a	88 a	42 a	52 a

[z]Mean separation within columns by LSD at $P < 0.05$.
[y]Seeds were soaked in 200 µM GA_{4+7} for 24 h, wiped on paper towels, and transferred to petri plates for germination.
[x]MC = matriconditioned. Seeds were conditioned for 4 days with or without 200 µM GA_{4+7}.

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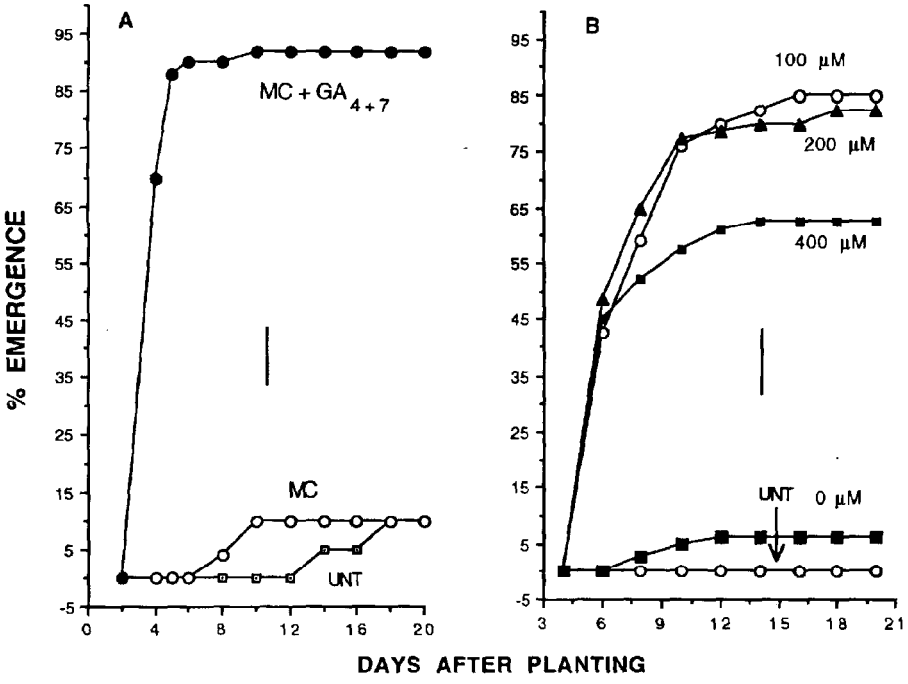

Fig. 1. (**A**) Enhancing emergence of 'Tainung no. 1' papaya seed by combined matriconditioning and 400 µM GA_{4+7} treatment for 4 days. Seeds were planted without drying to original weight. (**B**) The combined effect of matriconditioning and GA_{4+7} (100, 200, and 400 µM) for 4 days on 'Tainung no. 1' papaya seedling emergence after drying to original weight before planting. MC = matriconditioned seeds, MC + GA_{4+7} = matriconditioned in presence of GA_{4+7}, UNT = nontreated seeds. Vertical bars = $LSD_{0.05}$.

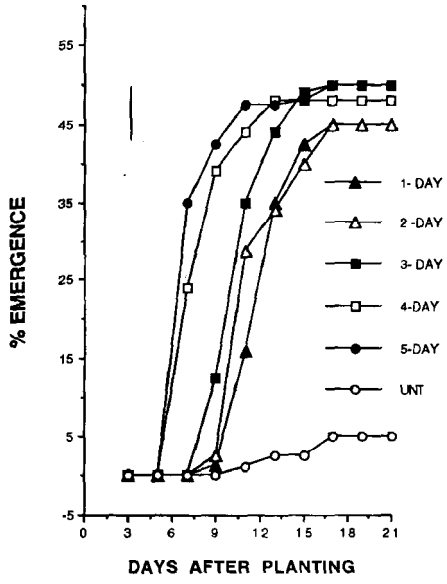

Fig. 2. The combined effect of 200 µM GA_{4+7} and matriconditioning (1 to 5 days) on 'Tainung no. 2' papaya seed emergence. Seeds were treated and planted after drying to original weight. UNT = nontreated seeds. Vertical bar = $LSD_{0.05}$.

Germination inhibitors isolated from papaya seeds interfere with germination (Chow and Lin, 1991; Wolf and Spencer, 1984). GA action in seeds can he blocked by the presence of an inhibitor; removing the inhibitor or its effect by an antagonist permits GA action (Khan, 1971). Our results also indicate that the promotive action of GA_{4+7} may be blocked by inhibitory factors in the seed when the seeds are soaked directly in GA solution. It seems that the inhibitor is rendered ineffective during conditioning, thus permitting GA_{4+7} to influence germination or emergence.

Alternatively, inhibitors present in papaya seeds may have properties permitting them to be selectively exchanged with Micro-Cel E, which adsorbs various types of organic and inorganic chemicals. (Khan, 1992). In tomato *(Lycopersicon esculentum* L.) and pepper seeds, GA promotes mannanase activity, which is implicated in the digestion of the endosperm, thereby removing the mechanical constraint on embryo growth (Groot and Karssen, 1987; Watkins and Cantliffe, 1984). A similar mechanism may be operative in papaya, in the absence of inhibitors, during conditioning. Thus, matriconditioning papaya seeds in the presence of GA_{4+7} is a highly practical means of reducing germination time and improving seedling stand.

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