Effects of Seed-Pretreatments on the Promotion of Germination in Papaya, Carica papaya L.

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Effects of Seed-Pretreatments on the Promotion of Germination in Papaya, *Carica papaya* L.

Masaki YAHIRO
(*Laboratory of Tropical Crop*)
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Introduction

Papaya, *Carica papaya* L., is originated in Mexico and now cultivated all over the tropics and sub-tropics. The propagation is practiced only by seed, but no fresh seeds are to be germinated even after 20 days. In this respect, the following structure of the seed is assumed to have some relations to the delaying of germination. The true seed is wrapped with aril which consists of gelatinous covering, containing a transparent liquid. Mosqueda[3] in Mexico reported that sun drying of papaya seeds was favorable in promoting germination and that the treatment was even more effective when the aril was removed. Experiments were conducted for the purpose of determining the effects of air drying and temperature pretreatments in promoting the germination in relation to the removal of the seed aril. Viability of dried seeds was also studied.

Materials and Methods

Exp. 1. Promotion of germination by air drying of seed

1-1. Seeds without removal of aril

Papaya fruits on the trees of 2 lines, A and B growing in the hot glass house in Kagoshima city were harvested on May 10 and July 1 in 1977. A_1, A_2 and A_3 seeds in Table 1 were from fully ripened fruits of spindle type and their seed coats were black in color, in contrast to B_1, B_2 seeds coming from unripe fruits of pear type and left to be somewhat whitish in color on the seed coat. Both seeds were taken out from the fruits on the harvesting day, and were sterilized immediately for 30 minutes in 3% solution of hydrogen peroxide and washed completely with tap water. After that, they were dried in the room for 10, 20, and 40 days, and the treated seeds and untreated seeds (control) were planted in germination beds 1cm deep after being imbibed with water for 20 hours. Seed beds were made from river-sand and were put in plastic pots (15cm diameter × 15cm high). The number of seeds per pot was 50 or 100. All pots were watered and placed in a dark room at a constant temperature (30° C). The germination was counted six times at intervals of five days.

1-2. Seeds with removal of aril

Ripe fruits were harvested on May 17 and June 17, 1977 and the seeds were taken out immediately from the fruits. The seeds were manually removed of aril from testa, sterilized, and washed with water. The number of days for the air drying of seeds was 10 and 25, and the germination test followed the same procedure as described in Exp. 1-1.

Exp. 2 Promotion of germination by low temperature pretreatments

2-1. Pretreatments at 15°C with and without removal of aril

From a large ripe fruit of spindle type harvested on May 8, 1976, 1082 seeds were obtained, and divided into two groups, one consisting of 600 seeds and the other of 482. The seed aril of the former group was removed but that of the latter was not. Seeds of both groups were washed with water after the sterilization, soaked in water for 17 hours, and placed on filter paper moistured with water of 10 ml in petri dishes (15cm diameter × 3cm high). Each dish had 100 seeds, except one dish with less than 100 seeds, and kept in a dark room maintained at 15°C for 10, 20, 30, 40, and 50 days. Treated seeds and non-treated seeds were transferred into a dark germinator at 30°C to test the germination. The tests were continued for 2 weeks.

2-2. Temperature pretreatments at 5°C and 25°C, of seeds removed of the arils

Seeds obtained from a fruit were removed of the arils, sterilized and washed with water and soaked in water for 20 hours. Temperature treatments of seeds were done in a dark room regulated at 5°C and 25°C for 10, 20, 30, and 40 days, respectively. The seed-beds for 5°C treatment were petri dishes measuring 15cm diameter × 3cm high with a filter paper containing 10 ml of water. 100 seeds were planted per petri dish. For 25°C treatment, 100 seeds were sown in a pot filled with river-sand at a depth of 1cm. After the completion of the treatments, seeds in the petri dishes were transferred to the sand pots (at 5°C treatment). All pots and non-treated control pots were placed in a dark germinator of 30°C and germination was recorded for a month.

Exp. 3. Promotion of germination by high temperature pretreatments (Aril was removed from the seeds)

Seeds from a fruit were revomed of the arils, sterilized, and washed with water. Half of these seeds were placed immediately into stoppered glass tubes and the other half were dried at room temperature for a week and then placed in the tubes. Each tube had 100 seeds. These tubes were placed in the incubator at 40°C and 50°C of 1, 2, 3, and 4 days. After the completion of treatments, the seeds were sown in river-sand pots and the germination was tested in the dark incubator at 30°C.

Exp. 4. Viability of dried seeds (Aril was not removed from the seeds)

Seeds used were from ripe fruits, harvested at 4 different dates: May 27, June 10, and June 12 in 1974 and July 1 of the following year. Each fruit was opened and the seeds were immediately separated from the placenta, dried at room temperature for 50–72 days and stored in a desiccator for 644–1048 days. The desiccator with a desiccating agent of silicagel was placed in the laboratory.

Results

Exp. 1-1. When the aril was not removed from the seed, the undried control plot showed almost no germination during the month, as shown in Table 1, regardless of the derivation of the seeds, whether from ripe fruits or from immature ones. Although air drying of the seed for 10 days had apparently little effect on the germination of immature seeds (B_1, B_2), a 20-day-drying increased the germination rate effectively to 46% after 30 days. On the contrary, the similar effect was found in ripe seeds (A_1, A_2, A_3) by a 10-day-drying, and the effect was more distinguishable when the treatment period was expanded to 20 days, resulting in a higher germination percentage of 70%. But in immature seeds, the increase of germination, even by a 40-day-drying period, was not so high.

Table 1. Promotion of germination of seeds dried in room temperature, and incubated at 30°C (Seed aril was not removed)

Line and ripeness	Date of sampling (1977)	No. of seeds used	Period of drying (days)	Days after sowing and germination percentage (%) (Temperature of incubator, 30°C)					
				5 days	10	15	20	25	30
A_1(Ripe)	May 10	50	0	0 %	0	0	0	0	0
	May 10	50	10	0	0	4	38	44	44
	May 10	50	20	0	0	0	0	68	70
A_2(Ripe)	July 1	100	10	1	3	36	38	38	38
A_3(Ripe)	July 1	100	10	0	5	27	35	35	35
B_1(Immature)	May 10	50	0	0	0	0	2	2	2
	May 10	50	10	0	0	0	8	8	8
	May 10	50	20	0	0	2	2	8	46
	May 10	50	40	0	0	10	30	32	46
B_2(Immature)	May 10	50	0	0	0	0	0	0	0
	May 10	50	10	0	0	0	4	8	8
	May 10	50	20	0	0	6	8	30	46
	May 10	50	40	0	0	26	32	32	56

Exp. 1–2. As shown in Table 2, in ripe seeds the great increases of germination without drying, such as 48%(I) and 39%(II), were found when the arils were removed, and this enhancement of the germination was the same as that of the 10–day air-drying of seeds with aril attached. Furthermore, the effect of the 10–day air-drying on promoting germination was very considerable in seeds with the arils removed and the germination percentage (89%) was apparently higher than that of the same period of drying applied to seeds with aril.

Table 2. Promotion of germination of seeds dried in room temperature, and incubated at 30°C (Seed aril was removed)

Experimental number	Date of sampling (1977)	No. of seeds used	Period of drying (days)	Days after sowing and germination percentage (%) (Temperature of incubator, 30°C)					
				5 days	10	15	20	25	30
I	May 17	50	0	0%	20	48	48	48	48
		50	25	24	24	66	70	82	82
II	June 17	100	0	0	0	2	4	18	39
		100	10	32	58	71	72	83	89

Exp. 2–1. The low temperature pretreatment at 15°C was ineffective on promoting germination in seeds attached with the arils, while in seeds removed of the arils, 50%, 89% and 95% of germination rates were recorded by 10–30–day, 40–day and 50–day treatments, respectively, in comparison with only a 5% germination of the untreated control (Table 3).

Exp. 2–2. In seeds removed of the arils, lower temperature treatments at 5°C showed slightly higher germination percentages, namely those in 10, 20, 30, and 40 day treatments were 34%, 29%, 37% and 45%, though 27% in the control plot. The temperature treatment at 25°C was more favorable for enhancing germination than the treatment at 5°C, and the germination rates were 44%, 59% ,55%and 58% in 10, 20, 30 and 40 day treatments, respectively. Germination percentages of 5 days after sowing were 25%, 31%, 14% and 17% in the treated plots but 0% in the control plot, indicating that 25°C treatment was especially effective in increasing germination (Table 4).

Table 3. Promotion of germination of seeds pre-treated with low temperature at 15°C, and incubated at 30°C

Period of pre-treatment (days) (1976)	Days after sowing and germination percentage (%) (Temperature of incubator, 30°C)					
	Seed aril was not removed			Seed aril was removed		
	7 days	14	Total	7 days	14	Total
0	—	—	—	5	0	5
10	1%	4	5	38	2	40
20	2	3	5	59	0	59
30	1	2	3	42	0	42
40	1	7	8	86	3	89
50	8	10	18	95	0	95

Table 4. Promotion of germination of seeds pre-treated with temperatures at 5°C and 25°C, and incubated at 30°C (Seed aril was removed)

Temperature of pre-treatment and period (days)		No. of seeds used	Days after sowing and germination percentage (%) (Temperature of incubator, 30°C)					
			5 days	10	15	20	25	30
30°C	Control	100	0%	18	18	24	24	27
5°C	10 days	100	1	1	2	17	20	34
	20	100	0	7	7	22	22	29
	30	100	4	23	27	31	37	37
	40	100	0	33	38	38	45	45
25°C	10	100	25	29	32	40	40	44
	20	100	31	46	51	54	55	59
	30	100	14	30	38	48	55	55
	40	100	17	29	42	50	58	58

Table 5. Promotion of germination of seeds pre-treated with high temperatures at 40°C and 50°C, and incubated at 30°C (Seed aril was removed)

Period of drying (days)	High temperature pre-treatment and period (days)		No. of seeds used	Days after sowing and germination percentage (%) (Temperature of incubator, 30°C)					
				5 days	10	15	20	25	30
0	30°C (Control)	1	100	0%	0	9	27	27	28
		2	100	0	3	21	35	35	35
		3	100	0	1	2	22	22	22
		4	100	2	6	28	28	34	34
0	40°C	1	100	0	13	15	29	29	30
		2	100	0	2	5	24	24	25
		3	100	0	1	2	27	28	28
		4	100	0	7	23	23	33	33
7	40°C	1	100	0	8	12	13	13	16
		2	100	0	2	12	16	16	16
		3	100	0	20	22	23	24	24
		4	100	0	14	15	18	18	21
0	50°C	1	100	0	0	3	3	3	3
		2	100	0	0	0	0	0	0
		3	100	0	0	0	0	0	0
		4	100	0	0	0	0	1	2
7	50°C	1	100	0	8	12	18	18	21
		2	100	11	11	12	16	16	16
		3	100	0	4	14	19	19	19
		4	100	0	4	4	10	15	15

Exp. 3. In fresh seeds, 40° C treatment[1] showed no effect on promoting germination and 50° C treatment[2,4] severely depressed germination, presumably resulting in the death of the seeds. In dried seeds, both temperature treatments resulted in less germination percentage than that of the control plot (Table 5).

Exp. 4. Table 6 shows that loss of viability of papaya seeds was comparatively small during 3 years under the desiccated storage at room temperature.

Table 6. Viability of seeds stored in desiccator for long periods after drying at room temperature (Seed aril was not removed)

Date of sampling	Period of drying (days)	Period of storing (days)	No. of seeds used	Days after sowing and germination percentage (%) (Temperature of incubator, 30°C)					
				5 days	10	15	20	25	30
27. V. 1974	72	1048	100	0%	5	43	69	72	81
10. VI. 1974	58	1022	100	0	46	60	65	67	67
12. VI. 1974	56	738	50	14	94	94	96	96	96
1. VII. 1975	50	644	100	7	23	47	62	62	67

Discussion

The results of Exp. 1 generally agree with the work of Mosqueda[3], indicating that an air-drying pretreatment of the papaya seed tried by the author is effective as well as sun drying, and, further, the aril of seed plays an important role to prevent germination or to induce seed dormancy. The latter point is also confirmed by Exp. 2. It has been noticed in the cereals, outer covering of the seed such as rice seed hull has a similar function in relation to seed dormancy, as dormant seeds start germination rapidly when the hull is removed. Therefore, it has been assumed, although not conclusive, that the hull contains a germination inhibitor or prevents the infiltration of oxygen into the seed. This assumption is probably accepted in the papaya seed because the removal of the aril apparently enhances the germination as seen in Table 2 and the effects of drying and especially low temperature treatments on the promotion of germination were smaller in the seed attached with aril than in case of the naked seed (Table 2 and 3). However, in papaya seed, it seems difficult to explain by above assumption alone the fact that the germination of the seed enclosed with the aril was enhanced by the dryness, but not by 15° C treatment. Although the drying could evaporate the liquid in the aril, 15° C treatment could not. Therefore, the mechanical pressure produced by the liquid enclosed within the aril would be one of the inhibiting factor of germination. The low temperature effects on the increasing of germination of seeds removed of the arils suggest the existence of germination inhibiting substances in the seeds. It is very noticeable that in papaya, a 15° C temperature treatment enhanced germination considerably, or broke dormancy, but the 5° C treatment had small effect. In contrast, in a temperate region the dormancy of tree buds is broken by a low temperature, such as 5° C – 10° C[5,6] is not broken by a 15° C treatment. The viability of the seed was kept 3 years in the experiment, but it will be enlarged if the desiccated seeds are stored under lower temperature. The relationship between the aril and viability of the seed is a problem left to the future study.

Summary

The promoting effects of germination by the pretreatments of the removal of aril

(gelatinous covering), air drying, low temperature, and high temperature were studied in papaya seeds, and also the viability of seeds stored in the desiccator was determined at room temperature.

1) Fresh seeds having aril were incapable of germinating for about 30 days after sowing, but when the seeds were dried for 20 days at room temperature before sowing, the germination percentage was increased to 50–70%, indicating the promoting effect of the drying treatment on the germination.

2) Even fresh seeds, provided the aril was removed, germinated rapidly with a germination percentage of 40–50%. When those seeds were dried for 10–25 days at room temperature, the promoting effect of germination was more conspicuous and the germination percentage was above 80%.

3) In the seeds removed of the arils, considerable promoting effects were presented by low temperature pretreatment of 15°C for 10–30 days and for 50 days, and germination percentages were 50% and 95%, respectively. Thus 15°C treatment was superior to air-drying on promoting the effect of germination when the aril was removed, but adversely it was greatly inferior to it when the aril was not removed.

4) The promoting effect on the germination of seeds was not obtained by high temperature pre-treatments at 40°C and 50°C.

5) It is interesting that the papaya showed a similarity to plants in temperate zone in breaking the dormancy of seeds, but the optimum temperature for termination of dormancy was 15°C, which is higher than 5–10°C observable in temperate-plants.

6) The viability of seeds were stored in the desiccator after drying under room temperature could be maintained for about three years.

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