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Effect of Hydropriming and Redrying on the Germination of Triploid Watermelon Seeds

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ABSTRACT

Two triploid watermelon cultivars 'Gold Prince' and 'Guangxi 5' were subjected to hydropriming by soaking in deionized water for 2 hrs with aeration following 24 and 48 hrs incubated at saturated relative humidity. Hydropriming had a promotive effect on germination performance in both cultivars but the overall seed germination percentages did not increase in 'Gold Prince'. Furthermore, hydrated seeds were redried under different conditions to low down the seed moisture content to 6-7 % and the two cultivars responded differently. The highest germination percentages and lowest mean germination time were obtained from medium drying (40%RH, 20°C) for 'Gold Prince' and quick drying (20%RH, 20°C) for 'Guangxi 5'.

Key words: triploid watermelon seed, hydropriming, seed germination

INTRODUCTION

Triploid watermelons [*Citrullus lanatus* (Thunb.) Matsum & Nakai] were first developed in the early 1950's at Kyoto University in Japan (Kihara, 1951). Besides the well known character of being seedless, triploid watermelon has its superior attributes, e.g. field resistance to Fusarium wilt (Kihara, 1951), watermelon fruit blotch (*Acidivorax avenae* subsp. *citruli*) (Garret *et al.*, 1995), long shelf life and high total soluble solid content (Rhodes and Zhang, 1999). Although triploid watermelons gained great market potential, the production remains low. Poor germination, slow growth at seedling stage, and high seed cost are main factors limiting the production.

Mechanical weakening of the seed coat structure such as scarification, seedcoat nicking, and seed coat lateral splitting has been reported to successfully enhanced germination performance of triploid watermelon seed (Duval and NeSmith, 1998; Grange and Leskovar, 2000). However, some drawback effects such as embryo injury and time involved are the negative effects usually associated with these treatments.Therefore, researchs are needed to detect a practical and easily handling method to improve the germination performance of triploid seeds aiming to promote triploid watermelon production.

Seed priming is a treatment that partially hydrates seeds so that germination process begins, but radicle emergence does not occur. Priming has been widely reported to enhance seed germination performance of various species of field crops, vegetables, and other plants (Welbaum *et al*., 1998). Short time hydration treatments, e.g. hydropriming, humidification (incubating seed at high relative humidity) have been widely used to increase seed vigour and extend seed longevity in many plant species (Burgass and Powell, 1984; Powell *et al*.,

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2000).

Redrying after priming is a critical step for maintaining seed quality.Rapid drying following priming can damage seeds resulting in the loss of advancement obtained during priming (Parera and Cantliffe,1992). Mechanical embryo damages have been reported in soybean, pine, and larch as a result of drying after osmotic priming (Armstrong and McDonald, 1992; Huang and Zou, 1989). On the contrary, primed pansy seeds increased longevity after fast drying (20°C, 40% RH) (Bruggink *et al*., 1999).

In cucurbits, priming has been proven successful to increase either germination rate or percentages in muskmelon (Bradford *et al.*, 1988; Nerson and Govers, 1986), diploid watermelon (Demir and Van de Venter, 1999; Sachs, 1977), and bitter gourd (Lin and Sung, 2000), etc. Unfortunately, few reports were documented on priming treatments of triploid watermelon seeds. In this work ,we attempt to assess the influence of hydropriming and redrying conditions on germination performance of triploid watermelon seeds.

MATERIALS AND METHODS

Seed materials: Seeds of two triploid watermelons, 'Gold Prince' and 'Guangxi 5', from the Vegetable & Flower Institute of Guangxi Academy of Agriculture Science, P.R. China, were employed in the experiment. The initial seed moisture contents of 'Gold Prince' and 'Guangxi 5' were 5.3% and 6.1%, respectively while the initial seed germination percentages were 83% and 67%, respectively.

Water uptake pattern: To determine the imbibition curve, seeds of 'Gold Prince' and 'Guangxi 5' were treated by seedcoat laterally split or not split (25 seeds per treatment), then soaked in deionized water for a period of 8 hours. Seeds were taken out from the water hourly and surface dried by blotter paper, weighed, and immediately put back to the water. The water uptake pattern was determined by measuring the water absorbed at every hour intervals related to the fresh weight (Le Deunff *et al.*,1989).

Hydration: The seeds of triploid watermelon were placed in glass columns (30 cm in height and 7 cm in diameter) containing 400 ml of deionized water and kept at 25°C under natural light for 2 hours. The duration of soaking was determined based on the water uptake pattern. Aeration was provided at 15 min/hr, 30 min/hr, and 45 min/hr, continuous, and non-aeration. After soaking, seeds were taken out from the water and put in a suspension of 0.2% Mancoseb for 10 minutes, in controlling fungus infection. Seeds were then rinsed off in running tap water for 10 minutes followed by surface drying with blotter paper and incubated in sealed plastic boxes under saturated humidity at 20±1°C for 24hrs or 48 hrs.

Germination tests were carried out immediately after incubation with 4 replicates of 25 seeds each in moist sand (1 liter deionized water per 10 kg sand). Seeds were carefully placed horizontally at 1 cm depth to prevent any orientation advantages (Maynard, 1989) in plastic boxes (7.5 × 11.5 cm). The boxes were covered with plastic lids to control evaporation and placed in germination chamber at 25°C. Seedlings were evaluated at 4^{th} and 14^{th} day after seeding and the mean normal seedlings, abnormal seedlings and dead seeds were calculated (ISTA, 1999), untreated seeds(original seeds) served as control. Mean germination time (MGT) was also obtained based on daily counting of normal seedlings using the following formula proposed by Alvarado and Hewitt (1987):

$$MGT = \sum Ti.Ni / \sum Ni$$

where Ni = number of newly germinated seeds at time Ti

Redrying: After the incubation process, the seeds were redried to lower seed moisture content to 6-7 % in a humidity controllable electronic dry cabinets (DRY-60, WEIFO) at different drying conditions: slow drying (60% RH, 20°C), medium

drying (40% RH, 20°C), and quick drying (20% RH, 20°C). Germination test was carried out immediately after the drying process as described above, compared to surface dried seeds and control. The seed moisture content was determined by hot air oven method at 103±1°C for 17 hours (ISTA, 1999). Two replications of 1 gram each were used for the test.

Statistical analysis: Data analyses were performed using the SAS statistical software (Version 6.12). Completely randomized design was used in this experiment. Mean separations were performed by Duncan's multiple range test (DMRT) at 5% level. The values in percentage were arcsine transformed before analysis.

RESULTS AND DISCUSSIONS

Hydration: The water uptake of triploid and diploid watermelon seeds showed a triphasic pattern, which is similar to the pattern of most of the seed kinds (Bewly and Black, 1994). However, there were no significant differences in water uptake between seed coat lateral splitting and non-splitting treatment especially in 'Guangxi' triploid watermelon (Figure 1). Therefore, water impermeability may not be a limiting factor to inhibit germination in both 'Gold Prince' and 'Guangxi 5'. The water uptake was attained rapidly during the first two hours, and continued to slowly increase with a steady rate in all treatments.

From the water uptake pattern, 2 hours duration was then chosen for soaking triploid watermelon seeds and found no significant differences on germination percentages among 2 hours soaking treatments in relation to aerating time (Figure 2). However, the highest germination percentages were obtained from primed seeds soaking in water for 2 hours with continuous aeration for 'Guangxi 5', and 45 min/hour aeration for 'Gold Prince'.

After 2 hours soaking with aeration (Figure

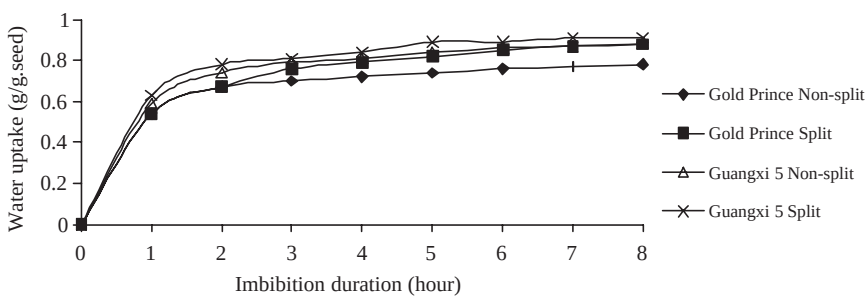

Figure 1 Water uptake pattern in watermelon seeds under 8 hours imbibition period.

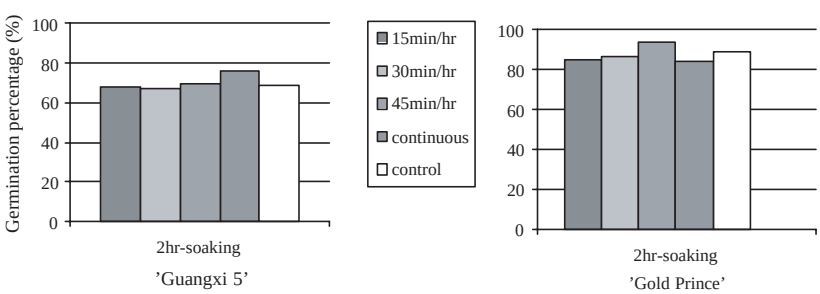

Figure 2 Germination of 'Guangxi 5' and 'Gold Prince' after hydropriming treatments at different aeration times.

2), primed seeds were further incubated for a period of 24 hrs or 48 hrs. The germination percentages of 'Gold Prince' were not significantly improved by both 24 or 48 hours incubation, but primed seeds from 48 hrs incubation dramatically increased the germination percentages of 'Guangxi 5'. However, MGT was significantly reduced by incubation time in both cultivars (Table 1) which indicate that the incubation treatment could enhance the speed of germination (Alvarado and Hewitt, 1987).

Redrying: When hydrated seeds (2 hrs soaking + 48 hrs incubation) were redried, all the seeds lost their moisture rapidly from approx.30% to 10% within one day (Figure 3). Under quick drying condition (20% RH, 20°C), both cultivars reached their equilibrium moisture content (5.09 % for 'Gold Prince' and 4.6 % for 'Guangxi 5') within two days. While medium drying (40% RH, 20°C) brought seeds to an equilibrium moisture content within 4 days of redrying (6.35% for 'Gold Prince' and 6.95% for 'Guangxi 5'). On the contrary, even after 4 days of drying under slow drying condition (60% RH, 20°C), the moisture contents were still high (9.63% for 'Gold Prince' and 8.42% for 'Guangxi 5'). The seeds of both cultivars in slow drying treatment were then transferred to medium drying condition and dried back to approx. 6~7% moisture content at the 5th day.

After redrying, the highest germination percentages and MGT were obtained from medium drying for 'Gold Prince' and quick drying for 'Guangxi 5' (Table 2). Since redrying after priming

Table 1 Germination percentages and mean germination time(MGT) of triploid watermelon seeds after soaking in water for 2 hours following 24 or 48 hours incubation.

Treatments	Gold Prince		Guangxi 5	
	Germination(%)	MGT(day)	Germination(%)	MGT(day)
48 hrs incubation	84.0a	4.11b	80.0a	4.08b
24 hrs incubation	80.5a	4.13b	67.0b	4.16b
Control	83.0a	4.38a	67.0b	4.63a
F-test	ns	**	*	**
C.V.(%)	5.92	2.33	8.49	3.76

Means within each column followed by the same letter are not significantly different at P<0.05 level by Duncan's multiple range test.

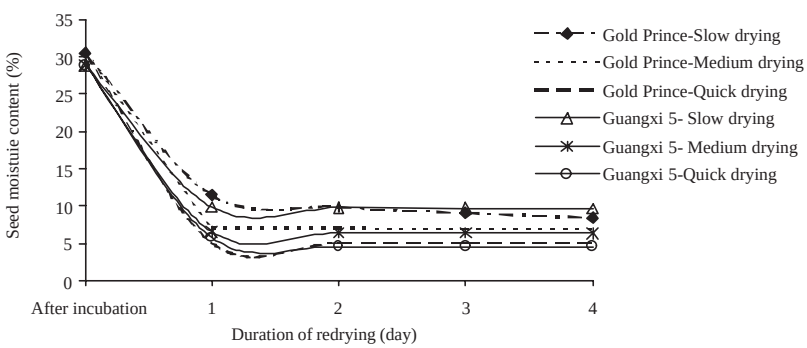

Figure 3 Changes in seed moisture content under different drying conditions of hydroprimed triploid watermelon seeds.

Table 2 Germination percentage and mean germination time (MGT) of hydroprimed triploid watermelon seeds after redrying.

Redrying conditions	Gold Prince		Guangxi 5	
	Germination (%)	MGT (days)	Germination (%)	MGT (days)
Surface drying	85 b	4.10b	76 bc	4.11 bc
Slow drying	80 b	4.20 ab	80 ab	4.52 a
Medium drying	92 a	4.06 b	82 ab	4.17 bc
Quick drying	84 b	4.29 ab	89 a	4.07 c
Control	83 b	4.36 a	67 c	4.41 a
F-test	*	*	**	*
C.V. %	4.48	2.12	6.20	3.64

Means within each column followed by the same letter are not significantly different at P<0.05 level by Duncan's multiple range test.

is critical step for maintaining seed quality, it could be explained that rapid drying might have altered the soluble carbohydrates content which in turn reduce desiccation tolerance and speed of germination (Bruggink *et al*., 1999). Further study is needed to investigate the relationship between redrying and seed longevity of primed seed.

CONCLUSSION

Hydropriming treatment can be successfully applied on triploid watermelon seeds to improve germination performance. A treatment combination of 2 hrs soaking in water following 48 hrs incubation at saturated relative humidity increased germination percentages and reduced mean germination time of both triploid watermelon cultivars 'Gold Prince' and 'Guangxi 5'. Hydrated seeds can be redried without the lost of physiological advancement obtained from hydration phase. However, the efficacy of priming treatments is also cultivar dependent.

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