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PRIMING PAPAYA SEEDS REDUCES SEED GERMINATION TIME

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ABSTRACT

Papaya seeds from four open pollinated papayas varieties 'Cariflora', 'Puerto Rico 6-65', 'Solo-64' and 'Waimanalo 162' were soaked for 5 days in water or -1 MPa solutions of $CaCl_2$, $Ca(NO_3)_2$, KCl or KNO_3. Following priming, treated seeds were rinsed and air dried for two days prior to planting. Untreated seeds were planted as controls. Seedling emergence was recorded daily. Priming reduced the mean time for seedling emergence for all salt treatments. The KNO_3 treatment resulted in the greatest seedling emergence in the shortest length of time. Pretreating papaya seeds with a salt solution can be used to enhance seed germination and plant emergence in a shorter length of time than untreated seed.

INTRODUCTION

Papaya seeds have been attributed with poor germination in the propagation of papaya (Chacko and Singh, 1966; Perez et al., 1980). Poor germination has been associated with growth inhibitors present in the sarcotesta, the gelatinous membrane surrounding the seed, as well as the seed coat itself (Lange, 1961; Reyes, et al., 1980). Seed priming is a system of soaking seeds in a solution for a given period of time prior to planting. Seed priming is commercially used to reduce germination time and increase the uniformity of the seedling stand (Samfield, et al., 1990; Wartidiningsih, et al., 1994). Uniform plant emergence allows for the full growth potential of every seedling. When seedlings emerge unevenly over a period of time, the first to emerge shade the latter emerging seedlings and develop ahead of the latter emerging seedlings.

Seed germination is divided into three phases: imbibition, lag phase and radicle emergence (Kozlowski, 1972). Imbibition is the physical uptake of water by a seed. Imbibition is not an indication of seed viability because even dead seeds will draw up water and swell. The lag phase is the time during which the cell membranes are repaired and the metabolic processes in the cell are reinitiated. Radicle emergence occurs when the root protrudes from the seed due to cell elongation and cell division. The purpose of seed priming is to allow the first two phases of seed germination, imbibition of water and restoration of cellular biochemical activity, but to inhibit the final phase, radicle emergence. Once the radicle has emerged, seeds are considered germinated and dehydration is lethal. Either salt solutions or water can be used for priming. When using water to prime seeds, priming should be terminated before radicle emergence. The osmotic potential is the key factor in developing salt solutions for seed priming. An osmotic potential of -1 MPa will allow proper seed priming and yet inhibit radicle emergence (Smith and Cobb, 1991). The objective of this study was to use K or Ca salt solutions to develop a system for reducing the time required for papaya seed germination and seedling emergence. Seedling emergence was determined when both the hypocotyl and the seed cotyledons broke through the potting mix surface.

MATERIALS AND METHODS

Seeds were collected from mature fruits of four open-pollinated papaya varieties, 'Cariflora', 'Puerto Rico Red', 'Solo 64' and 'Waimanalo 162'. Seeds were washed to remove the gelatinous sarcotesta and any floating seeds were discarded. Floating seeds often contain aborted embryos or under developed embryos that are nonviable. Cleaned seeds were air-dried and stored in a refrigerator at 5 °C until used. The priming solution treatments were developed to be -1 MPa as determined by a Decagon psychrometer. The salts chosen for priming solutions were: $CaCl_2$ (173 mM), $Ca(NO_3)_2$ (173 mM), KCl (232 mM) or KNO_3 (232 mM). Twenty-five seeds were placed in each half of 100 x 15 mm divided petri dishes to which 8 ml of priming solution was added. Each treatment was replicated four times. Seeds were primed for five days at room temperature (20 °C) with a change of fresh solution after 48 hr. After five days of priming, seeds were rinsed with distilled water and air dried 2 days prior to planting under greenhouse conditions in mid April at a 1 cm depth in 1:1 (v/v) Pro Mix : sand potting mix. Emergence was recorded when the hypocotyls forced the seed cotyledons above the potting mix surface.

RESULTS AND DISCUSSION

During imbibition the cell membranes have not yet been repaired from the damage incurred during dehydration of the mature ripening seed. The cells are therefor leaky and cell contents which dissolve with the uptake of water can be lost from the cell until the membrane is repaired. The loss of cell contents or electrolytes can be measured by conductivity. Conductivity readings provide an indication of the seeds passing from imbibition to the lag phase. The conductivity from all the priming solutions were the highest after the first two days and decreased by the fifth day of priming (data not presented). This indicated that the seeds were viable and able to repair the cell membranes upon imbibition of water. Dead seeds are unable to repair damaged membranes caused by dehydration and would have continuous electrolyte leakage over time. The conductivity readings indicate that the priming solutions did allow imbibition and activation of cellular membrane repair.

The effect of priming solution on total plant emergence over time was similar for all salt solution and significantly different from the control over time. The salt solutions used for seed priming provided better emergence over time than the water treatment or the control. While plant emergence began on the seventh day for all priming treatments, the start of plant emergence was delayed until the tenth day for the controls (Fig. 1). All priming treatments significantly reduced the average emergence time over the controls for all four varieties. Priming solutions containing either KNO_3 or $Ca(NO_3)_2$ had the greatest overall effect of reducing the average emergence time (Fig. 2).

The varieties selected did provide a range of response for plant emergence. Seedling emergence began on the seventh day and leveled off for 'Cariflora', 'Solo 64' and 'Waimanalo' by the twelfth day. Total plant emergence on the fifteenth day among these varieties ranged between 85% and 95% and was not significantly different. Total 'PR Red' emergence was lower at 70% but stabilized by day 15. The greatest total daily emergence for 'Cariflora', 'S-64' and 'Waimanalo' was on day 8, while 'PR Red' was similar for both day 10. The greatest average daily emergence for 'Cariflora', 'Solo 64', 'Waimanalo' and 'PR Red' was 31.4, 29.2, 26.4 and 17 respectively. These data presented are averages of the priming solution treatments without the control. Seed priming with one of the four salt solutions increased the total plant emergence for 'Cariflora', 'Waimanalo' and 'PR Red' than was possible with priming in water or no priming at all. The priming solutions had no effect on the total germination of 'Solo 64' (Fig. 3).

CONCLUSIONS

Seed priming was shown in this study to enhance the total seed germination and seedling stand establishment for slow germinating varieties or varieties with reduced viability. The benefit of seed priming was to reduce the average seedling emergence time and increase the uniformity of plant emergence. Priming papaya seeds in water or one of the four salt solutions examined benefited seedling stand establishment. One of the beneficial effects of seed priming may be to leach some of the plant growth inhibitors from the seed coat and internal seed tissues. Using a salt solution for seed priming of some papaya varieties can enhance the performance of seedling stand establishment over that obtained by water priming or unprimed seed. The uptake of the nutrient salt during priming may increase metabolic activity during the priming process which can stimulate low vigor seeds to germinate. Pretreating papaya seeds with a salt solution can be used to enhance seed germination and provide uniform plant emergence in a shorter length of time than untreated seed. Priming papaya seeds in a KNO_3 solution resulted in the greatest seedling emergence in the shortest length of time. Seed priming can be effectively used to promote better papaya seedling stand establishment.

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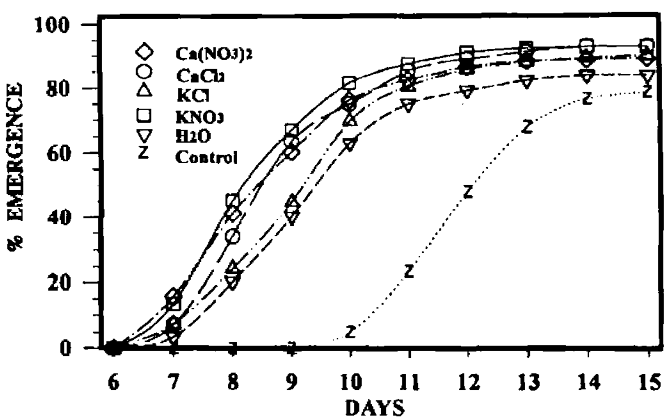

Fig. 1. Papaya plant emergence over time, combining 'Cariflora', 'S-64' and 'Waimanalo', as influenced by the salt solutions used in seed priming.

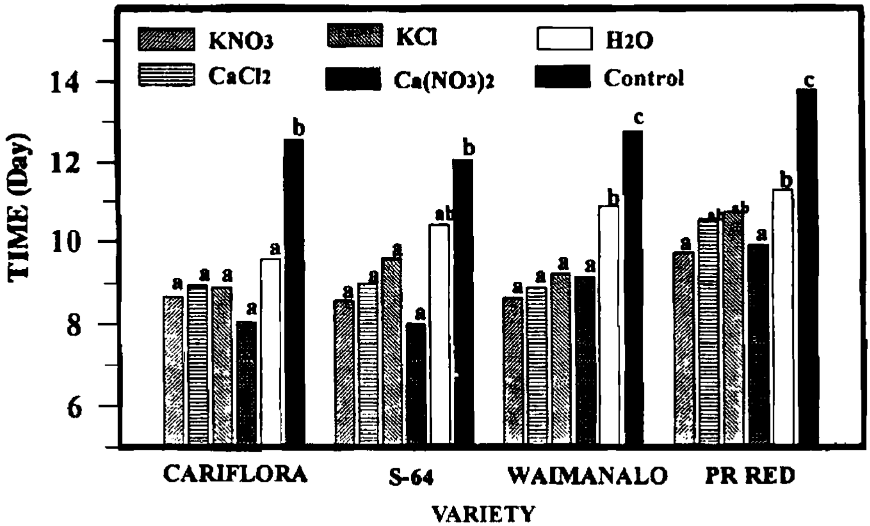

Fig. 2. Average plant emergence as influenced by papaya variety and seed priming treatment. Different letters indicate significant differences between treatments within a variety. Mean separation test based on LSD P = 0.05.

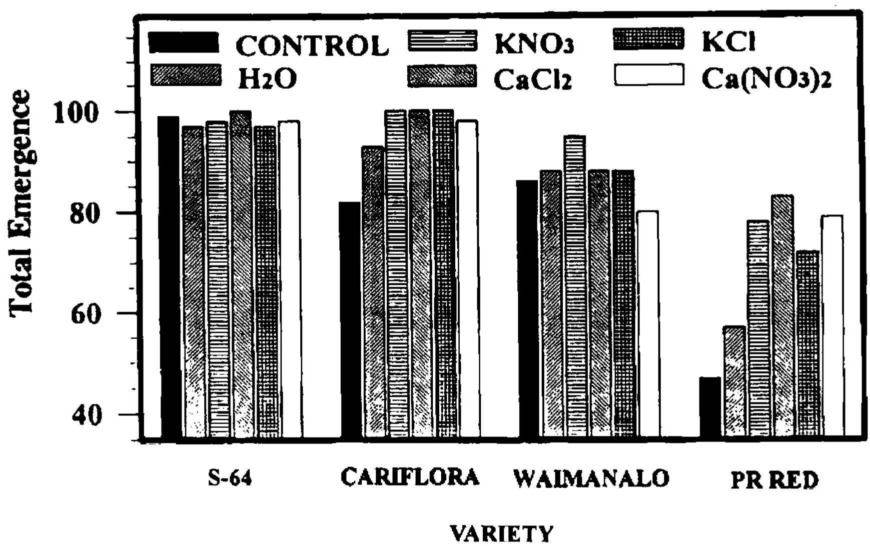

Fig. 3. Total papaya plant emergence by variety fifteen days after planting as influenced by seed priming treatment.