The Palawan Scientist ISSN No. 1656-4707
Vol. 1, No. 1. pp. 13-20, 2004

Reinvigorative Pre-Sowing Treatment for Aged Rice Seeds (*Oryza sativa* L.) using Seawater

George A. Hamora and Anselmo Q. De la Cruz
WPU-Research & Extension Department
Aborlan, Palawan

ABSTRACT

The study was conducted to evaluate the efficiency of seawater as reinvigorative presowing treatment for aged rice seeds. The seawater concentrations used were: 0, 25.0, 50.0, 75.0 and 100.0%. Results revealed that among the treatments used, 50% seawater solution is the most efficient in restoring the germination capacity of aged lowland rice seeds. Seawater pre-treatment significantly improved the final germination capacity, final emergence capacity, and mean daily emergence rate of aged rice seeds. Further, seedlings from reinvigorated seeds were noted to be heavier (whether fresh or dry), taller, with more expanded leaf, and have longer shoots and roots.

Keywords: aged rice seeds, Oryza sativa, presowing, seawater

INTRODUCTION

Seed availability has been a persistent problem of the Philippine Rice Industry (Lara *et al.,* 1991). Seed growers nationwide can produce only around 35% of the total requirements in key grain areas. This problem is aggravated by the uneven distribution of seed growers in the country (Javier and Malabanan, 1997). Since farmers have limited access to good quality seeds, they resort to the to the use low of quality seeds available in the locality (e.g. aged rice seeds).

The poor germination of rice seeds is mainly due to viability deterioration after long storage. Rice seeds storability can only be maintained up to six months under ordinary room condition. However, under ideal storage conditions (i.e. in air-conditioned rooms), the viability and vigor of seeds could be maintained for three to five years (PhilRice, 1997).

Seeds of high vigor are highly desirable in the establishment of most crops. Rapid germination and uniform stand are among the properties of vigorous seeds but both decline in deteriorated seeds (Heydecker, 1972). Seed priming or other prehydration treatments accelerate the rate of germination of seeds in many crop species (Bradford, 1986). It is in this context that vigor restoration of aged rice seeds using seawater as pre-sowing treatment was studied.

METHODOLOGY

The experiment was laid out in Completely Randomized Design with 5 treatments and 8 replications. Treatments used were the following: T_1 = control (without seawater), T_2 = 25% seawater solution, T_3 = 50% seawater solution, T_4 = 75% seawater solution, and T_5 = 100% seawater.

The study made use of PSB Rc 58, an irrigated lowland rice variety stored for 9 months. This rice variety is high yielding, resistant to bacterial leaf blight, with high milling potentials and good sensory qualities.

Seed sterilization. Prior to reinvigoration, the seeds were washed in 5% solutions of zonrox for 30 seconds then rinsed two times with distilled water. The seeds were then surface dried on a clean cloth.

Reinvigoration. Priming the seeds was done after sterilization by soaking it in 15 ml seawater solution for 36h at 20-25°C temperature.

Germination tests. Germinability of reinvigorated seeds was observed for 5 days under laboratory condition. The germination test was carried out using transparent lunch boxes supported by glass platforms. One hundred seeds were sown on moist tissue paper in each of the boxes. The tissue paper was kept moist via paper wicks from a reservoir of distilled water at the bottom of the boxes. Germinants at radicle protrusion were counted at 24h interval. Counted germinants were discarded.

Emergence tests. Rice shoot emergence was observed for thirty (30) days in a greenhouse. The emergence test was carried out using galvanized iron plain sheet seed box filled with 15 cm soil media composed of fully decomposed rice straw, fine sand, and topsoil in 1:1:1 proportion. One hundred (100) seeds were sown on the seed box. Water was maintained at saturation point throughout the duration of the study. Emergents at hypocotyl protrusion were marked and recorded at 24h interval and were allowed to grow for 30 days.

Data gathered. In the germination test the following data were gathered and calculated: germination percentage, mean daily germination rate and number of abnormal seeds germinated. In the emergence test, emergence percentage, mean daily emergence rate, shoot length, root length fresh weight, dry weight, seedling height and number of expanded leaves were gathered and calculated. Except for the emergence percentage which was taken at 24-h interval, the rest of the data were taken at the end of the 30 day observation period.

RESULTS AND DISCUSSION

Germination Test

During the first day of observation, there was a significantly higher germination percentage of seeds at 0% seawater (control) compared to the reinvigorated ones (Fig. 1). This is because seeds primed in solutions with low osmotic potentials slowly imbibe water to a level that permits pregerminative metabolism to proceed, but prevents actual radicle emergence even for several days or weeks (Khan *et al.,* 1978). On the second day, reinvigorated aged seeds had already increased germination, with exception of those soaked in 75% seawater which had significantly lower germination rate. However, results showed that from day 3 to day 6, aged rice seeds soaked in different seawater concentrations improve their germination capacity. It was observed that seeds soaked in 50%, 75% and 100% seawater had significantly high germination and mean germination rate than those in 25% and control (Table 1). The germination capacity and daily germination rate increased by 18-22% and 3.50-4.2%, respectively. This findings confirmed the findings of Benedetto (1990), which stated that presowing treatment with sodium hypochlorite (NaOCl) solution increased the percentage of germination but contradicted the report of Pressman *et al.* (1977), that increasing concentration of seawater used to pretreat the seeds of two celery varieties inhibited seed germination.

The reported inhibitory effect of pure seawater in celery (Pressman, *et al.,* 1977) may be due to the penetration and accumulation of toxic ions causing deleterious effects (Brocklehurst and Dearman, 1984; Bliss *et al.* 1986a; Greenway and Munns, 1980; Nerson and Govers, 1986). However, this was not observed in this study. The effective action of salt as osmotica is to regulate osmotic pressure of the solution sufficient enough to prevent germination while permitting seed hydration to support enzymatic activities (Ells, 1963; Hadas, 1976). The presence of Ca^{2+} in conjunction with Mg^{2+} and $SO_4^{=}$ ions in seawater might have reduced cell membrane permeability thus, reducing the penetration and accumulation of Na^+ into catastrophic level (Toledo, 1997). The high Na^+ and Cl^- concentrations did not damage seeds before they reached the hydration threshold level (Bliss *et al.*, 1986b). According to Corchete and Guerra (1986), as cited by Toledo (1997), it is possible that these ions may be involved in the cellular osmotic adjustment of the seeds during priming that increased soluble sugars such as sucrose, galactose and mannose in the embryonic axes

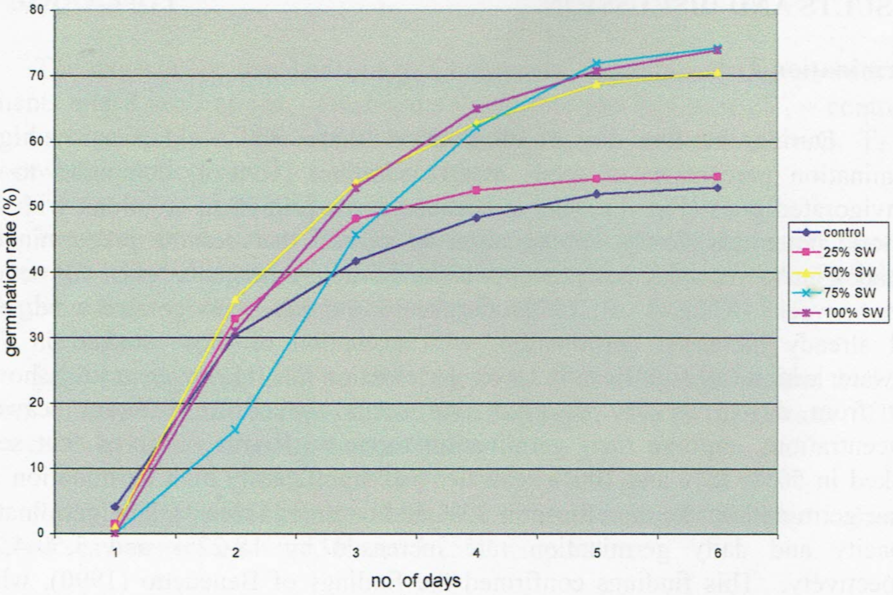

Figure 1. Mean germination rate of aged PSB Rc 58 rice seeds reinvigorated with different concentration of seawater.

Table 1. Mean daily germination and mean abnormal germination rate of aged PSB Rc 58 rice seeds treated with varying levels of seawater.

Treatment	daily germination rate	Abnormal germination rate
Control	10.575[b]	19.500[c]
25% seawater	10.925[b]	16.250[c]
50% seawater	14.100[a]	30.000[c]
75% seawater	14.775[a]	35.500[ab]
100% seawater	14.800[a]	40.750[a]

Note: Means with the same letter superscripts are not significantly different at 0.01 level.

On abnormal germination, results showed that 75% and 100% seawater reinvigoration has the highest abnormal germination showing stunted growth, distorted cotyledon with necrotic areas, and albinism. Seawater concentration of 25% and the control exhibits the lowest abnormal germination (Table 1).

Villiers (1974) and, Villiers and Edcumbe (1975) stated that seedlings grown from seeds with low viability manifested abnormalities like growth stunting, cotyledon distortion with necrotic areas, subdivided first leaves, and root swelling with necrotic radicle meristem that increase with time. Another characteristic of abnormally grown plants is albinism. Aging causes heritable specific gene mutation like albinism in barley and peas (Dourado and Roberts, 1984). These characteristics were observed in the present experiment both in the laboratory germination and greenhouse emergence.

The result revealed that high rates of seawater presowing treatments significantly increased the frequency of morphologically abnormal seedlings of aged rice seeds. Such results suggest that repair processes were activated but due to the deleterious effects of aging, the embryos were not able to grow normally.

Emergence Test

The final emergence capacity of rice seeds reinvigorated with different levels of seawater has remarkably improved. Seawater treatments greatly restored the emergence capacity of aged rice seeds with an increase of 7.75-10%. Among the different treatments, the seeds soaked in 25% and 50% seawater had significantly higher emergence rate than those in 75%, and 100% (Figure 2).

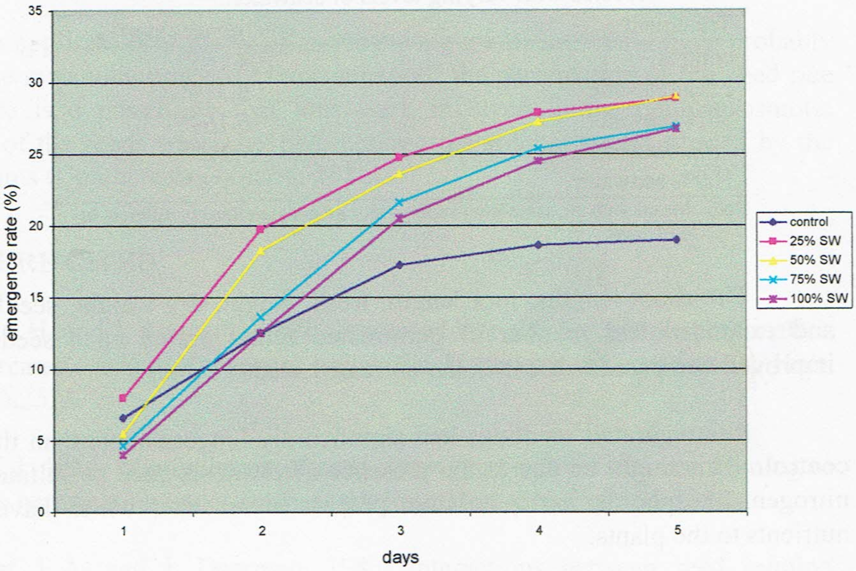

Figure 2. Mean daily emergence capacity of PSB Rc aged rice seeds as a result of different levels of reinvigorative seawater presowing treatment.

The positive response of the aged rice seeds to seawater presowing treatment on the emergence capacity might be due to the effective action of salt as osmotica which regulate osmotic pressure of the solution sufficient enough to prevent germination while permitting seed hydration to support enzymatic activities (Ells, 1963; Hadas, 1976). It might be possible that the presence of elements such as sulfate, calcium, nitrogen, phosphorus, and potassium in seawater, have provided nutrients while simultaneously reducing water uptake. Consequently, this improvement increased plant weight, height, leaf number, and root length.

Likewise, mean daily emergence rate of aged seeds primed with seawater improved. The seeds reinvigorated in 25% and 50% seawater had higher mean daily emergence rate than those seeds in control but had similar performance with those in 75% and 100% (Table 2).

The remarkable response on the daily emergence rate of aged seeds in higher concentration of seawater might be due to the lower incidence of fungus compared to the control. Many pathogen such as field and storage fungi are associated with most crop seed species (Christensen, 1972; Neergaard, 1977), such pathogens initiate deterioration and accelerate the aging process of seeds.

Table 2. Mean daily emergence rate of aged PSB Rc 58 rice seeds Treated with varying levels of seawater.

Treatment	emergence rate
control	4.165[b]
25% seawater	6.319[a]
50% seawater	6.169[a]
75% seawater	5.550[ab]
100% seawater	5.350[ab]

Note: Means with the same letter superscripts are not significantly different at 0.01 level.

The shoot lengths, root length, fresh weight, dry weight, seedling height and expanded leaf number of germinated reinvigorated aged seeds likewise improved compared to those in the untreated seeds (Table3).

Reinvigorated seedlings had significantly longer shoots than those in the control. This might be due to the presence of elements such as sulfate, calcium, nitrogen, phosphorus, and potassium present in seawater which have provided nutrients to the plants.

Table 3. Mean observed values for various characteristics of aged PSB Rc 58 rice seeds primed with seawater.

Treatment	Shoot Length	Root Length	Fresh Weight	Dry Weight	Seedling Height	No. Expanded Leaf
control	33.362[b]	7.200[b]	4.613[b]	0.930[b]	40.550[b]	5.150[b]
25% sw	38.600[a]	8.675[a]	7.588[a]	1.643[a]	47.287[a]	5.900[a]
50% sw	39.763[a]	8.913[a]	8.663[a]	1.750[a]	48.575[a]	6.000[a]
75% sw	39.163[a]	8.438[ab]	7.538[a]	1.492[a]	47.613[a]	5.575[ab]
100% sw	40.862[a]	9.588[a]	9.300[a]	1.852[a]	50.313[a]	6.100[a]

Note: Means with the same letter superscripts are not significantly different at 0.01 level.

In terms of root length, rice seeds primed with seawater produced longer roots compared to those in the control. However, no significant difference in the mean root length was observed between the control and those primed in 75% seawater.

The same trend was observed on the fresh weight, dry weight and height of rice seedlings (Table 3). Those reinvigorated with seawater did not vary from each other but were significantly higher compared to those in the control.

However, in terms of expanded leaf number, seeds soaked in 75% seawater had significantly lower number of expanded leaf compared to those in the other treatments.

The observed increase in seedling dry weight of primed aged PSB Rc 58 rice seeds conform to the observations of Cantliffe, *et al.* (1992) in celery; Furutani *et al.* (1986) in onion; Fieldhouse and Sasser (1975), Ichan and Passam (1992), and Smith and Cobb (1987) in pepper; Durant *et al.* (1983) in table beet; and Ells (1963) and Mitra and Basu (1979) in tomato primed with NaCl or NaOCl.

The application of seawater as presowing treatment would have probably activated the metabolic processes thus, enhanced the germination of the aged rice seeds. There is a possibility that ions were involved in the cellular osmotic adjustment of the seeds which helped increase the soluble sugars needed by the growing plants (Corchete and Guerra, 1986).

LITERATURE CITED

Benedetto, A.H. and J. Tognetti. 1990. Increased rate and percentage germination in pre-treated seeds of *Asparagus officinalis.* I. Laboratory experiments. Hort. Abst. 60:2528.

Bradford, K.J. 1986. Manipulation of seed water relations via osmotic priming to improve germination under stress conditions. Hort. Sci. 21:1105-1112.

Brocklehurst, P.A. and J. Dearman. 1983. Interactions between seed priming treatments and nine seedlots of carrot, celery and onion. I. Laboratory germination. Ann. Appl. Biol. 102:577-584.

Christensen, C.M. 1972. Microflora and seed deterioration. In: E.H. Roberts (ed.). Viability of Seeds. London: Chapman and Hall Ltd. pp.59-93.

Ells, J.E. 1963. The influence of treating tomato seed with nutrient solutions on emergence rate and seedling growth. J. Amer. Soc. Hort. Sci. 83:684-687.

Heydecker, W. 1972. Vigor. In: E.H. Roberts (ed.), Viability of Seeds. London: Chapman and Hall Ltd. pp.209-252.

Javier, L.C., and F.M. Malabanan. 1997. The Municipal Rice Seed Production Project. Philippine Rice R&D Highlights for 1997. 173 p.

Khan, A.A., K.L. Tao, B. Borkowska and L.E. Powell. 1978. Osmoconditioning of seeds: physiological and biochemical changes. Acta Hortic. 83:267-278.

Kran, E.M. and H.C. Passam. 1992. Sodium hypochlorite concentration, temperature, and seed age influenced germination of sweet pepper. Hort. Sci. 27:821-823.

Lara, R. J. , W.H. Libunao and D.P. Callo, Jr. 1991. Rice Seed Production Support Project for Non-Government Organizations in the Philippines NGO-SEEDPRO). PhilRice and UPLB. 157 p.

Neergaard, P. 1977. Seed Pathology. Vol.1. London: The McMillan Press Ltd. p. 426.

Pressman, E., M. Neobi, M. Sacus, and J.V. Jacobsen. 1977. Varietal differences in light requirements for germination of celery *(Apium graveolens* L.) seeds and the effects of thermal and solute stress. Aust. J. Plant Physiol. 4:821-831.

PhilRice, 1997. Seed Processing, Storage, and Distribution. Proceedings of the 10^{th} National Rice R&D Review and Planning Workshop. 33 p.

Toledo, P.E. 1997. Reinvigorative pre-sowing treatments for aged seed of asparagus *(Asparagus officinalis* L.). Unpublished Ph.D. Dissertation Benguet State Univ. La Trinidad, Benguet. pp.7-8.

Villiers, T.A. 1974. Seed ageing: chromosome stability and extended viability of seeds stored fully imbibed. Plant Physiol. 53:875-878.

Villiers, T.A. and D.J. Edgcumbe. 1975. On the cause of seed deterioration in dry storage. Seed Sci. & Technol. 3:671-774.