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Effect of osmopriming on rice seed germination and seedling growth

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Abstract

The experiment was conducted in the Agronomy Laboratory of Agrotechnology Discipline, Khulna University, Khulna from 29th August to 17th September, 2009. The experiment was laid out in a Completely Randomized Design (CRD) with two factors and three replications. The aim of the experiment was to study the efficacy of three osmopriming agents viz ., NaCl, KC1 and CaCb with control on seed germination and seedling growth of three T. aman rice varities viz., BRRI dhan40, BRRI dhan41 and BINA dhan7. Among the chemicals CaCb showed best as osmopriming agents and it enhanced all germination parameters. BRRI dhan41 showed the best performance. Better root length and shoot length were observed in control. Seeds of BRRI dhan41 when treated with NaCl showed the highest germination percentage (98.67%), germination energy (88%), germination speed (96.83%), but vigor index (10.63) was found highest in BRRI dhan40 when it was treated with KC1. BRRI dhan41 produced the largest root (8.56 cm) when seeds were treated with NaCl. BRRI dhan40 (10.51 cm) and BINA dhan7 (10.53 cm) produced the highest shoot length at controlled condition and CaCl2 treated seed, respectively.

Keywords: Osmopriming, Rice, Germination, Seedling growth

Introduction

Rice (*Oryza sativa L.*) is the most important and extensively cultivated cereal crops in Bangladesh. Rice has been considered as staple food of the Bangladeshi people about 80% of the total cultivated lands in Bangladesh are used for rice cultivation and its total production is 31.98 million metric tons (BBS, 2011).Rice supplies more than 70% of calories (Khush, 2008) and more than 50% proteins (Islam, 2009) as well as contributes 95% of the cereals consumed in Bangladesh.

Good seed germination behavior is very important for field crops. Uneven or poor germination and subsequently uneven seedling growth can lead to great financial losses, by reducing crop production or lower prices of uneven plant batches (Ghiyasi *et al*., 2008a). But seed priming can increase speed and uniformity of germination (Ghiyasi *et al*., 2008b). Seed priming treatments can lead to better germination and establishment in many crops such as maize, wheat, rice, canola (Basra *et al*., 2005; Ghiyasi *et al*., 2008a, b). In another way seed priming could be defined as controlling the hydration level within seeds so that the metabolic activity necessary for germination can occur but radical emergence is prevented. Different physiological activities within the seed occur at different moisture levels (Taylor, 2007). The last physiological activity in the germination process is radical emergence. The initiation of radical emergence requires high seed water content.

Once sown, seeds spend significant amounts of time just absorbing water from the soil. By reducing this time to a minimum seeds can be made to germinate and seedlings emerge. The quicker to do this is to soak seeds in water before sowing. It has been reported that primed crop seeds emerged faster and grew more vigorously. They also flowered earlier very important in drought-prone areas, matured earlier and gave higher yields. Priming has, therefore, become very popular and it is simple and cheap yet extremely effective (Broud *et al*., 2006).

Several different priming methods have been reported to be used commercially. Among them, liquid or osmotic priming is a very common practice. It is well established that seed soaking in chemical improve the crop performance over control, particularly under adverse conditions. Many workers have studied the effect of seed treatment with different chemicals and found that crops yield can be increased through pre-sowing treatments with chemicals (Mehortra *et al*., 2005). One of the primary benefits of priming has been the extension of the temperature range at which a seed can germinate (Valdes and Bradford, 1987).

From a practical standpoint, priming enables seeds of several species to germinate and emerge at supra-optimal temperatures. Priming has also alleviated secondary dormancy mechanisms that can be imposed if exposure to supra-optimal temperatures lasts too long (Valdes *et al*., 1985). The other benefit of priming has been to increase the rate of germination at any particular temperature. On a practical level, primed seeds emerge from the soil faster and often more uniformly than non-primed seeds because of limited adverse environmental exposure. Priming accomplishes this important development by shortening the lag or metabolic phase or phase II in the triphasic water uptake pattern (Bewley and Black, 1978) in the germination process. The metabolic phase occurs just ater seeds are fully imbibed and just prior to radical emergence. Since seeds have already gone through this phase during priming, germination times in the field can be reduced by approximately 50% upon subsequent rehydration. Moreover priming has been commercially used to eliminate or greatly reduce the amount of seed-borne fungi and bacteria. Organisms such as *Xanthomonas campestris* in *Brassica* seeds and *Septoria* clearly have been shown to be eliminated within seed lots as a by-product of priming (Bachman, 1989). In the case of *Xanthomonas campestris* in *Brassica* sp., zero infection in 50,000 seeds is commonly reported (Goustine, 2004). So. considering above, the experiment was conducted with the following objectives:

To observe the efficiency of different chemicals as osmopriming materials on rice seed germination and seedling growth. To observe the varietal response against different osmopriming agents.

Materials and Methods

The experiment was conducted in the Agronomy Laboratory of Agrotechnology Discipline, Khulna University, Khulna from 29th August to 17th September, 2009. The materials used in the study and methodologies followed presented in this chapter in systematic ways.

Treatments

There are two factors -

Factor A- Salt solutions	Factor B- Rice varieties
S_1=control (water) S2=16.4g/L NaCl S3=20.74 g/L KC1 S4=22.2 g/L CaCl2	Aman rice vaities-3 V1=BRRI dhan40 V2=BRRIdhan41 V3=BINA dhan7

The expeiment was laid out in a Completely Randomized Design (CRD) with two factors and four replications.

Total number of petridishes were=3 (Vaities) ×4 (Solutions) x 4(Replication) = 48

Three different concentration of NaCl, KC1 and CaCl2 were used in the study as osmopiming agent Solution of 16.4 g NaCl, 20.74 g KC1 and 22.2 g CaCl2 were taken respectively in each of a 1000 ml Volumetric flask and filled up to a mark with distilled water. Then, a weighed quantity of seed (250 g) each of three varieties were soaked in solution having 16.4 g/1 NaCl, 20.74 g/1 KC1, 22.2 g/1 CaCl2 and with distilled water respectively for 24 hours at 25±2 °C. The ratio of seed weight to solution volume was 1:5. (Bashra *et al*., 2004; Farooq *et al.,* 2004).

Germination Test

The germination test was conducted using the Petridish method. Two pieces of blotting papers were used in each Petridis as substrate. Twenty five seeds of BRRI dhan 40, BRRI dhan 41and BINA dhan 7 were placed in each medium size Petridish. Each treatment was replicated four times. The solutions were used for germination of seeds and distilled water was used in control. The petridishes were observed every day.

Data collection

Germination Parameters: The petidishes were observed every day and the numbers of germinated seeds were recorded. After one dav of seed setting in petidishes, few of the seeds were terminated. Within 4 davs after seed setting in petridishes maximum number of seeds were germinated. A seed was considered to be germinated as seed coat ruptured, plumule and radicle came out and were >2mm long. Germination count was expressed in percentage. The germination percentage was calculated using the following formula-

$$\text{Germination}(\%) = \frac{\text{Number of seed germinated}}{\text{Total number of seeds set for test}} \times 100$$

The speed of germination (%) was calculated using the following formula (Krishnaswamy and Seshu, 1990).

$$\text{Speed of germination}(\%) = \frac{\text{Number of seed germinated at } 72\,\text{h}}{\text{Number of seeds germinated at } 168\,\text{h}}$$

Germination energy = Percentage of seeds germinated at 72 h (Bam *et al*., 2006).

Vigor Index = No. of germinated seeds / days of first count +……+ No. of germinated seeds/days at final count.

Measurement of Root and Shoot Length

Randomly selected five seedlings were taken from each petridish to measure root and shoot length. It was measured with a measuring scale and expressed in centimeters. Root and shoot length of the seedlings were measured after 17 days of seed setting (kouio, 2003).

Measurement of Fresh Weight and Dry Weight of the Seedling

After 17 days of seed setting 15 seedlings of each petisdish were wrapped with brown paper and weighed the fresh weight first and then they were died in oven at 70° C for 48 hours and weighed the dry weight. These were measured by four digit balance and expressed in gram.

Statistical Analysis

All the data were analyzed by using MSTAT-C (Statistical analysis software) computer package program. The differences between the treatment means were determined by using Duncan's Multiple Range (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Effect of Rice varieties: All the germination parameters of three rice varieties BRRI dhan40, BRRI dhan41 and BINA dhan7 were presented in Table 1. Among the varieties germination percentage, germination energy (%) and germination speed (%) varied widely. The highest germination percentage, termination energy (%) and germination speed was found from BRRI dhan41 and it was 93.67%, 78%and 83.72% respectively. Significant difference was seen in fresh weight of varieties.

Table 1. Varietal differences related to germination parameters among three T. ama rice varieties as affected by seed priming

Varieties	Germination (%)	Germination energy (%)	Germination speed (%)	Germination index
BRRI dhan40	92.33 ab	75.33 c	80.64 c	9.52
BRRI dhan41	93.67 a	78.00 a	83.72 a	9.18
BINA dhan7	87.33 c	76.67 b	82.44 b	9.06
CV (%)	1.88	4.13	5.54	2.06
Level of significance	0.01	0.01	0.01	NS

Figures in a column with similar letter (s) do not differ significantly
CV= Co-efficient of variation

Interaction effect of varieties and osmopriming agents: Seed germination parameters eg. germination percentage, germination energy (%), germination speed (%) greatly varied due to interaction of rice varieties and osmopriming agents (Table 2). The highest germination (98.67%) was found in the treatment V_1S_1 i.e BRRI dhan40 in control condition which was statistically similar with V_1S_2, V_1S_3, V_2S_2,V_2S_3 ,V_3S_4 and V_2S_4. In case of germination energy (%) and germination speed (%), BRRI dhan41 performed better in NaCl treated seeds. It was due to salt tolerant ability of BRRI dhan41 (K. Bashar, 2008).

Table 2. Interaction effect of variety and different osmopriming agents on germination of three T.aman rice varieties

Variety	Salt Conc. g/L	Germination	Germination Energy (%)	Germination Speed (%)	Vigor Index
BRRI dhan 40	Control (water)	98.67 a	84.00 ab	69.55d	7.86d
BRRI dhan 40	S2=16.4g/L NaCl	94.67 ab	56.00 c	89.23bc	10.06b
BRRI dhan 40	S3=20.74 g/L KC1	98.67 a	86.67a	76.73cd	10.63a
BRRI dhan 40	S4=22.2 g/L CaCl2	82.67 de	74.67b	75.67cd	9.32bc
BRRI dhan 41	Control (water)	77.33 c	63.33cb	85.61abc	7.69d
BRRI dhan 41	S2=16.4g/L NaCl	98.67 a	88.00a	96.83a	9.91bc
BRRI dhan 41	S3=20.74 g/L KC1	97.33 ab	82.67ab	85.00bc	9.83bc
BRRI dhan 41	S4=22.2 g/L CaCl2	96.00 ab	78.67ab	81.86bc	9.28bc
BINA dhan 7	Control (water)	77.33 e	58.66c	75.96cd	7.70d
BINA dhan 7	S2=16.4g/L NaCl	92.00 be	64.67c	89.00ab	9.33bc
BINA dhan 7	S3=20.74 g/L KC1	86.67 cd	84.00ab	88.77ab	9.98bc
BINA dhan 7	S4=22.2 g/L CaCl2	93.33 ab	84.00ab	74.21cd	9.20c
CV (%)		4.45	6.54	7.53	0.72
Level of significance		0.01	0.01	0.01	0.01

Figures in a column with similar letter (s) do not differ significantly Interaction of varieties and osmopriming agents on root growth, shoot growth, fresh weight and dry weight was presented in Table 3. The highest root length was measured in BRRI dhan41 (8.56 cm) seeds treated with NaCl solution. This is statistically similar with treatment V_3S_3. Shoot length of BRRI dhan40 showed better response to all osmopriming agents. Higher shoot length was observed in BINA dhan7 seedling where seed treated with CaCl2 solution which was followed by V_3S_3 ,V_3S_1, V_2S_2 and V_3S_2. The highest fresh and dry weight was recorded in the treatment V_3S_1 i.e. BINA dhan7 in control condition.

Table 3. Interaction effect of variety and different osmopriming agents on root length, shoot length, fresh weight and dry weight of three T.aman rice varieties

Variety	Salt Conc. g/L	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
BRRI dhan 40	Control (water)	4.82cdef	10.51a	1.19d	0.11cdde
BRRI dhan 40	S2=16.4g/L NaCl	4.95def	10.07a	1.22d	0.18cde
BRRI dhan 40	S3=20.74 g/L KC1	5.28def	10.66a	1.26cd	0.19ab
BRRI dhan 40	S4=22.2 g/L CaCl2	5.94cde	10.00a	1.37bcd	0.15bcd
BRRI dhan 41	Control (water)	3.76f	4.66d	1.39bcd	0.077e
BRRI dhan 41	S2=16.4g/L NaCl	8.56a	8.55ab	1.48bc	0.15bcd
BRRI dhan 41	S3=20.74 g/L KC1	4.56ef	5.59cd	1.47bc	0.12cde
BRRI dhan 41	S4=22.2 g/L CaCl2	4.34f	7.53bc	1.49bc	0.16bc
BINA dhan 7	Control (water)	7.03bc	9.43ab	1.79a	0.24a
BINA dhan 7	S2=16.4g/L NaCl	5.15def	8.43ab	1.36bcd	0.14bcd
BINA dhan 7	S3=20.74 g/L KC1	7.44ab	9.53ab	1.34bcd	0.09de
BINA dhan 7	S4=22.2 g/L CaCl2	6.41bcd	10.53a	1.56b	0.16bc
CV (%)		14.34	13.50	9.16	14.36
Level of significance		0.01	0.01	0.01	0.01

Figures in a column with similar letter (s) do not differ significantly

Summary and Conclusion

Among the varieties germination percentage, germination energy (%) and germination speed (%) varied widely. The highest germination percentage, germination energy (%) and germination speed was found from BRRI dhan41 and it was 93.67%, 78% and 83.72% respectively.

From the findings of the present study it might be concluded that

- Among the osmopriming agents Calcium chloride (CaCl2) showed the best activity in regard to seed germination (%), germination energy (%), germination speed (%) and germination index.
- It was observed that BRRI dhan41 treated with NaCl gave the best germination (%), germination energy (%), germination speed (%) and root length.

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