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Effect of Seed Priming on Seed Germination and Seedling Growth of Modern Rice (*Oryza sativa* L.) Varieties

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Abstract

The experiment was carried out in the Seed Laboratory of Bangladesh Agricultural Development Corporation (BADC), Gazipur during June to July 2014 to investigate the effects of different priming methods on seed germination and the seedling growth of some rice (*Oryza sativa* L.) varieties. Four rice varieties: 1) Nerica, 2) BRRI dhan51, 3) BRRI dhan41 and 4) BRRI dhan49; and six priming treatments: 1) On-farm Priming, 2) Hardening, 3) Hydro-priming, 4) Osmo-hardening, 5) Vitamin C Priming and 6) Control were used in the experiment. The experiment was laid out in a completely randomized design (CRD). The treatments were replicated three times. The germination percentage and seedling growth parameters differed significantly among the priming treatments. For germination, Nerica variety showed poor performance, whereas the other varieties were found superior. Among the priming treatments, Vitamin C priming and Osmo-hardening were found superior. In case of interaction, germination was increased with Vitamin C priming and Osmo-hardening in Nerica. For seedling growth parameters, particularly vigor index, shoot and root lengths, BRRI dhan41 and BRRI dhan51 were found superior. The priming treatment Vitamin C and Osmo-hardening performed better than others. Seedling vigor index was increased with Vitamin C priming and Osmo-hardening in Nerica variety. Shoot length at 15th day was influenced by hydro-priming in Nerica. Root length at 10th day was significantly increased with hardening in BRRI dhan41. Vitamin C priming and Osmo-hardening could therefore, be used for improving germination and seedling growth of Nerica.

Keywords: Priming, Variety, Germination, Seedling growth parameters.

1. Introduction

Seed priming is one of the techniques to obtain higher yield of rice by producing quality seedlings. Priming is a method that might improve seed performance under the stress conditions such as drought or freshly harvested or aged seeds which might fail to germinate (Binang *et al.,* 2012).

Good seed germination is very important for rice (*Oryza sativa* L.). Uneven or poor germination and subsequently uneven seedling growth can lead to great financial losses by reducing crop, though seed priming can increase speed and uniformity of germination (Ghiyasi *et al.*, 2008). Seed priming treatments can lead to better germination and establishment in many field

crops, such as maize, wheat, and rice. 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 *et al*., 1998). 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 for absorbing water from the soil. By reducing this time to a minimum, seeds can be made to germinate and seedlings emerge within shorter time.

It has been reported that primed crop seeds emerged faster and grew more vigorously. They also flowered earlier, matured earlier and gave higher yields, which is very important for drought-prone areas. 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 improves 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. One of the primary benefits of priming has been the extension of the temperature range at which a seed can germinate. In upland rice, Harris *et al.* (1999) demonstrated that on-farm seed priming markedly improved establishment and early vigor of seedlings, resulting in faster development, earlier flowering and maturity and higher yields, while Farooq *et al*. (2006) observed improved emergence, yield and quality of direct-seeded rice. Mondal *et al*. (2011) postulated that the positive effect of rice seed priming was associated with an increase in endospermic amylase activity resulting from the increase insoluble sugar content of the primed seed. Invariably, the best priming method would depend on the type of stress the seed is exposed to (Yadav *et al*., 2011), as well as the genotype (Berchie *et al*., 2010).

The other benefit of priming is 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 in the germination process. The metabolic phase occurs just after 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. In this framework, we have mentioned the following priming techniques- On-farm priming, Hardening, Hydro-priming, Osmo-hardening, Vitamin C (Ascorbate) priming and Control.

However, methods for priming suitable for rice have not yet been developed in Bangladesh. Moreover, there is a limited study in the country on seed priming of high yielding modern rice varieties. The present study was therefore, undertaken to examine the efficiency of different priming methods on rice seed germination, seedling growth and to determine the varietal response of rice to seed germination and seedling growth against different priming agents.

2. Materials and Methods

The details of materials used and methods employed during the experimental period have been presented in this chapter.

2.1. Design and treatments of the experiment

The experiment was conducted with two factors following completely randomized design.

Treatments were as follows:
Factor A: Priming treatments:

a) On-farm Priming (Seeds will be soaked overnight in water before sowing) (Harries *et al*.,1999)
b) Hardening (Alternate soaking of seeds with tap water for 24 hours and dying before sowing in the field) (Basra *et al*., 2003)
c) Hydro-priming (Seeds will be soaked with distilled water for 48 hours and dried under shade before sowing in the field)
d) Osmo-hardening (Similar to hardening with 1 mole NaCl solution`)
e) Vitamin C Priming (Seeds will be soaked with 10 ppm Ascorbic acid solution for 48 hr then dried 24 hours under shade) (Basra *et al*., 2006)
f) Control (Farmer Practice)

Factor B: Rice varieties:
a) Nerica
b) BRRI dhan41
c) BRRI dhan51
d) BRRI dhan49

2.2. Preparation of chemical solution
Chemical solutions, NaCl 58.44 gm and Ascorbic acid 0.01 gm of chemicals were added with 1000 ml water.

2.3. Preparation of germination media
Wet tissue was used as germination media and Petridis was used as container. The moisture content of the media was maintained at 80% of the field capacity.

2.4. Seed quality parameters
The following seed quality parameters were measured:

2.5. Germination
Germination test is most commonly used to determine seed viability. The germination test was conducted at 25^{o}C temperature in germination room of Seed Laboratory, Bangladesh Agricultural Development Corporation (BADC), Gazipur. One hundred seeds were taken from each pot and placed in the Petridish. The daily record of germinated seed was taken up to 7th day from set up of the test. The germination percentage was calculated as follows:

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

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

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

2.7. Germination energy
Germination energy was expressed as percentage of seeds germinated at 72 hours (Bam *et al.*, 2006).

2.8. Vigor index
Seed vigor index is the sum total of all attributes of seeds which indicates the potential level and activity of seed during germination and seedling emergence. Daily count of germination of seed was taken to calculate data on vigor index. It can be calculated by the following formula (Maguire, 1962).

$$\text{Vigor Index} = \frac{x1}{n1} + \frac{x2}{n2} + \ldots\ldots\ldots\ldots\ldots + \frac{xn}{nn}$$

Where,
x_1 = number of seedlings at first count
n_1 = number of days at first count
x_2 = number of seedlings at second count
n_2 = number of days at second count
x_n = number of seedlings at final count
n_n = number of days at final count

2.9. Seedlings shoot and root length
Randomly selected 10 normal seedlings from each petridish were taken to record data on shoot and root length. It was recorded at 10 and 15th day.

2.10. Seedlings shoot and root dry weight
The seedlings for shoot and root length measurements were dried in an electric oven at

72°C for 48 hours. After drying the dry weight of shoot and root were recorded by an electric balance.

2.11. Data analysis

The data obtained from different yield components were statistically analyzed to find out the significance of the difference among the treatments. The analysis of variance (ANOVA) was performed by MSTAT-C and means of the parameters were compared using DMRT-Duncan's new Multiple Range Test (Gomez and Gomez, 1984).

3. Results and Discussion

3.1. Rice seed germination parameters as influenced by variety and seed priming

There was significant effect of treatments and their interactions on seed germination parameters (Table 3). Maximum germination was occurred on 3rd day. The seed germination (%), speed of germination (%) and germination energy (%) of different tested rice varieties were ranged from 45.1 to 99.7, 86.5 to 100.0, 53.7 to 99.7 percentages, respectively depending of priming treatments and crop varieties (Table 1, 2 and 3).

3.2. Rice seed germination parameters as influenced by variety

All the germination parameters due to effect of four rice varieties were presented in Table 1. Among the varieties germination percentage on 3rd and 7thday, speed of germination (%) and germination energy (%) varied widely. The highest germination percentage on 3rd and 7th day, speed of germination (%) and germination energy (%) was found in BRRI dhan49 and it was 90.9, 98.0, 98.3 and 96.3%, respectively that was also statistically similar to BRRI dhan41 and BRRI dhan51 compare to Nerica.

3.3. Rice seed germination parameters as influenced by seed priming

All the germination parameters due to effect of five priming treatments and control were presented in Table 2. Due to priming treatments, germination percentage at 3rd and 7thday, speed of germination (%) and germination energy (%) varied widely. The highest germination percentage on 3rd and 7th day, speed of germination (%) and germination energy (%) was found in Vitamin C priming and it was 91.9 %, 97.7 % 98.2 % and 96.0% respectively and followed by Osmo-hardening (NaCl). Other priming treatments performed similar to the control.

3.4. Rice seed germination parameters as influenced by interaction effect of variety and seed priming

All the germination parameters due to interaction effect of variety and priming are presented in Table 3. There was a significant effect of treatments and their interaction on seed germination parameters. In case of germination (%), maximum germination was occurred at 3rd day. Statistically, the highest germination (%) was found in Nerica variety with Vitamin C priming (88.4%) and followed by Osmo-hardening priming (71.1%). On-farm priming (49.7%), Hardening (47.8%) and Hydro-priming (45.11%) had similar value compared to control. Germination percentages on 3rd day of BRRI dhan51, BRRI dhan41 and BRRI dhan49 varieties were also maximum with Osmo-hardening and Vitamin C priming but, there were no statistical difference compared to control. In a laboratory study, it was revealed that priming with Ascorbate at various (10–50 ppm) concentrations improved the germination and early seedling growth in both coarse and fine rice varieties, although priming with 10 ppm was the most effective (Basra *et al*., 2006).

Germination percentage on 7th day for different treatments were followed similar pattern of 3rd day irrespective of priming treatment. In speed of germination, the highest speed of germination was found in BRRI dhan41 (100.0%), BRRI dhan51 (100.0%) with Vitamin C priming and also BRRI Dhan41 (100.0%), BRRI dhan49 (100.0%) with Osmo-hardening priming. In germination energy, statistically, the highest germination energy (%) was found in Nerica variety with Vitamin C priming (92.7%) and

followed by Osmo-hardening priming (87.0%). On-farm priming (49.7%), Hardening (47.8%) and Hydro-priming (45.1%) carried same value compared to control. Germination energy of BRRI dhan51, BRRI dhan41 and BRRI dhan49 varieties were found the highest with Osmo-hardening and Vitamin C priming. But, in that case, there was no statistical difference compared to control. According to Mohammadi (2009) seeds primed with sodium chloride (NaCl) showed the highest values for germination percentage, germination energy, seedling dry weight, and height under both field and laboratory studies.

Germination ability of seed is not only genetically controlled character, but it may be affected by the different type of factors, such as moisture, temperature, light etc. So, there were large scope to vary the result by applying same treatment in time. In few cases control treatment was also performed well probably due to high quality seed, developed from almost same parent materials and proper management etc. If we consider the total effect of seed priming on germination, the results of the present study clearly showed that treatment Vitamin C priming and Osmo-hardening performed very well for germination percentages on 3rd & 7th days and germination energy of Nerica variety. This result is in agreement with the statement of Basra *et al*. (2005) and Ghiyasi *et al*. (2008) who found Vitamin C priming can increase the speed and uniformity of germination and that lead to better germination and establishment in many field crops including rice.

Table 1. Effect of variety on rice seed germination parameters

Variety	Germination (%) on		Speed of germination (%)	Germination energy (%)
	3rd day	7th day		
Nerica	59.167 b	73.44 b	91.2 b	67.27 b
BRRI dhan51	88.72 a	94.83 a	98.4 a	93.33 a
BRRI dhan41	90.57 a	97.27 a	99 a	96.27 a
BRRI dhan49	90.90 a	98 a	98.3 a	96.33 a
Level of significance	**	**	**	**
CV%	5.14	4.03	3.13	4.69

Table 2. Effect of priming on rice seed germination parameters

Priming	Germination (%) on		Speed of germination (%)	Germination energy (%)
	3rd day	7th day		
Control	81.8 bc	89.3 b	96.9 c	87.0 b
On-farm priming	77.9 c	85.5 c	97.3 bc	83.6 bc
Hardening	79.7 c	89.7 b	96.3 d	86.9 b
Hydro-priming	75.4 c	86.08 c	94.0 e	81.6 c
Osmo-hardening (NaCl)	87.3 ab	97.08 a	97.6 b	94.8 a
Vitamin C priming (Ascorbic Acid)	91.9 a	97.8 a	98.2 a	96.0 a
Level of significance	**	**	**	**
CV%	5.14	4.03	3.13	4.69

=Significant at 1% level. Means followed by common letter(s) in a column do not differ significantly by DMRT.**

Table 3. Interaction effect of seed priming and variety on seed germination parameters of rice

Interaction of treatment		Germination (%) on		Speed of germination (%)	Germination energy (%)
Seed priming	Variety	3rd day	7th day		
Control	Nerica	52.9 e	62.3 c	90.9	56.7 e
	BRRI dhan51	90.1 a-c	97.7 a	99.3	97.0 a-c
	BRRI dhan41	91.2 a-c	98.7 a	98.6	97.3 a-c
	BRRI dhan49	91.1 a-c	98.7 a	98.6	97.3 a-c
On-farm priming	Nerica	49. 7 e	59.7 c	92.7	55.3 e
	BRRI dhan51	80.3 cd	87.3 b	98.9	86.3 d
	BRRI dhan41	90.7 a-c	97.3 ab	99.3	96.7 a-c
	BRRI dhan49	90.9 a-c	97.7 a	98.3	96.0 a-c
Hardening	Nerica	47.8 e	66.67 c	88.2	58.33 e
	BRRI dhan51	89.4 a-c	95.3 ab	99.6	95.0 a-c
	BRRI dhan41	92.6 ab	99.3 a	98.7	98.0 ab
	BRRI dhan49	89.1 a-c	97.3 ab	98.6	96.0 a-c
Hydro-priming	Nerica	45.1 e	62.0 c	86.5	53.7 e
	BRRI dhan51	82.3 bc	92.0 ab	94.8	87.3 d
	BRRI dhan41	86.7 a-c	94.3 ab	97.2	91.7 cd
	BRRI dhan49	87.6 a-c	96.0 ab	97.6	92.7 b-d
Osmo-hardening	Nerica	71.1 d	93.7 ab	92.8	87.0 d
(NaCl)	BRRI dhan51	91.2 a-c	97.3 ab	97.6	95.0 a-c
	BRRI dhan41	90.0 a-c	97.7 a	100.0	97.7 a-c
	BRRI dhan49	97.0 a	99.7 a	100.0	99.7 a
Vitamin C	Nerica	88.4 a-c	96.3 ab	96.1	92.7 b-d
priming (Ascorbic	BRRI dhan51	97.1 a	99.3 a	100.0	99.3 ab
Acid)	BRRI dhan41	92.3 ab	96.3 ab	100.0	96.3 a-c
	BRRI dhan49	89.8 a-c	99.0 a	96.6	95.7 a-c
Level of significance		**	**	NS	**
CV%		5.14	4.03	3.13	4.69

**=Significant at 1% level and NS= Non significant level. Means followed by common letter(s) in a column do not differ significantly by DMRT.

3.5. Rice seedling growth parameters as influenced by variety and seed priming

There were significant effects of treatments and their interaction on seedling growth parameters (Table 6).The vigor index, shoot and root length and dry weight of seedlings of different tested rice varieties were ranged from 12.2 to 25.08, 2.9 to 11.1, 3.5 to 6.8 cm and 200 to 373 mg, respectively, depending of priming treatments and crop varieties (Table 4, 5 and 6).

3.6. Rice seedling growth parameters as influenced by variety

All the seedling growth parameters due to effect of four rice varieties were presented in Table 4. Among the varieties, the highest vigor index was found in BRRI dhan51 (23.04), BRRI dhan41 (23.5) and BRRI dhan49 (23.6). The highest shoot length was found in Nerica variety (9.8 cm) on 15th day and highest root length was found in BRRI dhan41 (5.9 cm) on 10th day and BRRI dhan51 (5.9 cm) on 15th day.

3.6. Rice seedling growth parameters as influenced by seed priming

All the seedling growth parameters due to effect of five priming treatments and control were presented in Table 5. The highest vigor index was found in Vitamin C priming (23.9) which is statistically almost similar to Osmo-hardening (22.6). In shoot length, the highest shoot length was observed in Vitamin C priming and Osmo-hardening on 10th day and also again Vitamin C priming for shoot length on 15th Day. The maximum dry weight was found in Hardening (319 mg) and Hydro-priming (330 mg).

3.7. Rice seedling growth parameters as influenced by interaction effect of variety and seed priming

All the seedling growth parameters due to interaction effect of variety and priming are presented in Table 6 There was significant effect of treatments and their interaction on seedling growth parameters. Statistically, the highest vigor index was found in Nerica variety with Vitamin C priming (23.08) and followed by Osmo-hardening priming (18.5). On-farm priming (13.07), Hardening (12.7) and Hydro-priming (12.2) were carried same value compare to control.

Table 4. Effect of variety on rice seedling growth parameters

Variety	Vigor index	Shoot length (cm) on		Root length (cm) on		Seedling dry weight(mg) on 15th day
		10th day	15th day	10th day	15th day	
Nerica	15.6 b	5.8	9.8 a	4.9 b	4.9 b	282
BRRI dhan51	23.04 a	5.05	8.3 bc	5.2 ab	5.9 a	284
BRRI dhan41	23.5 a	6.2	9.5 ab	5.9 a	5.4 ab	287
BRRI dhan49	23.6 a	6.4	8.02 c	4.8 b	5.2 ab	274
Level of significance	**	NS	**	**	**	NS
CV%	4.67	29.74	7.37	16.75	13.7	25.51

**=Significant at 1% level and NS= Non significant level. Means followed by common letter(s) in a column do not differ significantly by DMRT.

Table 5. Effect of priming on rice seedling growth parameters

Priming	Vigor index	Shoot length (cm) on		Root length (cm) on		Seedling dry weight (mg) on 15th day
		10th day	15th day	10th day	15th day	
Control	21.2 bc	4.01 b	8.6 bc	4.6	5.6 ab	239 b
On-farm priming	20.2 c	5.04 ab	8.3 c	4.8	4.9 ab	293 ab
Hardening	20.8 c	5.7 ab	8.3 c	5.4	4.8 b	319 a
Hydro-priming	19.8 c	5.7 ab	8.8 bc	5.09	5.7 a	330 a
Osmo-hardening (NaCl)	22.6 ab	7.2 a	9.6 ab	5.5	5.6 ab	253 ab
Vitamin C priming (Ascorbic Acid)	23.9 a	7.5 a	10.02 a	5.5	5.4 ab	256 ab
Level of significance	**	**	**	NS	*	**
CV%	4.67	29.74	7.37	16.75	13.7	25.51

**=Significant at 1% level and NS= Non significant level. Means followed by common letter(s) in a column do not differ significantly by DMRT.

Table 6. Interaction effect of seed priming and variety on seedling growth parameters of rice

Interaction of treatment		Vigor index	Shoot length (cm) on		Root length (cm) on		Seedling dry weight (mg) on15th day
Seed priming	Variety		10th day	15th day	10th day	15th day	
Control	V_1	13.9 e	2.9	9.5 a-e	3.5 e	4.9	203
	V_2	23.8 ab	4.0	7.9 e-i	5.1 b-e	6.8	270
	V_3	23.5 ab	4.0	9.1 b-h	5.5 b-d	5.3	257
	V_4	23.6 ab	5.1	7.6 f-i	4.3 c-e	5.3	227
On-farm	V_1	13.07 e	5.5	9.8 a-d	5.2 b-e	4.65	263
priming	V_2	20.8 cd	4.3	7.4 hi	4.7 b-e	4.9	287
	V_3	23.5 a-c	5.3	8.5 d-i	4.9 b-e	5.5	317
	V_4	23.6 ab	5.0	7.4 hi	4.4 c-e	4.8	307
Hardening	V_1	12.7 e	6.0	9.5 a-f	4.9 b-e	4.3	353
	V_2	23.2 a-c	3.7	7.5 g-i	4.8 b-e	5.8	260
	V_3	23.9 ab	7.3	9.0 c-h	7.7 a	4.7	357
	V_4	23.2 a-c	5.7	7.03 i	4.05 de	4.4	307
Hydro-	V_1	12.2 e	6.3	8.1 d-i	5.3 b-e	5.3	330
priming	V_2	21.6 bc	6.0	8.2 d-i	4.6 b-e	5.7	357
	V_3	22.6 a-c	4.5	9.9 a-d	5.3 b-e	6.0	260
	V_4	22.7 a-c	6.0	9.07 c-h	5.2 b-e	5.8	373
Osmo-	V_1	18.5 d	6.9	11.1 a	5.4 b-d	5.3	260
hardening	V_2	23.8 ab	6.0	9.6 a-e	5.6 b-d	6.5	293
(Nacl)	V_3	23.2 a-c	7.7	9.6 a-e	6.2 b	5.5	227
	V_4	25.07 a	8.3	7.9 ab	4.9 b-e	5.01	230
Vitamin C	V_1	23.08 a-c	7.3	10.7 a-c	4.7 b-e	4.7	250
priming	V_2	25.08 a	6.3	9.3 b-g	6.09 bc	5.9	237
(Ascorbic	V_3	23.9 ab	8.3	10.9 ab	5.7 b-d	5.4	307
Acid)	V_4	23.5 a-c	8.0	9.1 b-h	5.5 b-d	5.5	200
Level of significance		**	NS	**	*	NS	NS
CV%		4.67	29.74	7.37	16.75	13.70	25.51

*= Significant at 5% level, **=Significant at 1% level and NS= Non significant level. Means followed by common letter(s) in a column do not differ significantly by DMRT.
Where, V_1= Nerica, V_2= BRRI dhan51, V_3=BRRI dhan41, V_4= BRRI dhan49

Vigor index of BRRI dhan51, BRRI dhan41 and BRRI dhan49 varieties were also observed maximum with Osmo-hardening and Vitamin C priming but, there were no statistical difference with that of control. In shoot length, the highest shoot length was found in Nerica variety with Osmo-hardening priming and followed by Nerica variety with Vitamin C priming and it was 11.1 cm, 10.4 cm respectively. Burgeieres *et al.* (2007) and Barh *et al.* (2008) reported that Ascorbic acid stimulated the germination percentage, coleoptile percentage, radical length and vigor index of tomato and pea seeds in distilled water medium. These results were in agreement with our findings. In root length, the highest root length was found in BRRI dhan41 with Hardening and followed by BRRI dhan41 with Osmo-hardening and it was 7.8 cm, 6.2 cm, respectively. Our result is in agreement with Ramesh and Singh (2006) who did seed priming in rice with K_2SO_4 and ascorbic acid with four rice genotypes (Pusa Basmati-1, Basmati-385, Saket-4 and IR-36) and found seed priming with ascorbic acid was effective in enhancing root and

shoot length. In dry weight, numerically the highest dry weight was found in BRRI dhan49 (373mg) with Hydro-priming followed by BRRI dhan51 (357 mg) with Hydro-priming and BRRI dhan41 (357 mg) with Hardening. According to Farooq *et al*. (2007), Hydro-priming for 48 h improved the growth and dry weight of rice seedlings. If we consider the total effect of seed priming on seedling growth parameters, the results of the present study clearly showed that treatment Vitamin C priming performed very well for Nerica variety. The increase of vigor index might be related to reduction of imbibitions lag time for priming treatment (Bradford, 1986).

Priming also causes physiological and bio-chemical changes in seed during the seed treatments and metabolic activities increases alpha-amylase activity, thus indicating higher vigor index and well developed shoot and root (Lee and Kim, 2000). Vigor index of seedling is related to germination ability of seeds and nutritional level and those are affected by the many factors, such as moisture, temperature, light, nutrition, pathogen etc. So, there was also large scope to vary the result by applying same treatment in time. Our findings are in agreement with the statement of Mukherjee and Hossin, (2012), Guan *et al*. (2009) and Rahimi (2013) who found Vitamin C priming can increase growth parameters of seedling.

4. Conclusions

It may be concluded that there was significant effect of seed priming on different rice varieties. However, the priming effect differed with rice varieties. The variety Nerica showed poor performance; whereas the other varieties were found superior. Vitamin C priming and Osmo-hardening were found superior compared to others priming treatments. Seed germination and seedling growth parameters particularly germination percentages, germination energy, vigor index, shoot and root lengths were increased by the treatments with Vitamin C priming and Osmo-hardening for Nerica. Further investigation may be undertaken to confirm this result and make recommendations on seed priming.

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