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EFFECT OF SEED PRIMING ON MAIZE (*Zea mays* L.) SEEDLING EMERGENCE UNDER DIFFERENT SOWING DATES

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Abstract

The experiment was carried out at the research field of Regional Agricultural Research Station, Jessore during 2009-10 and 2010-2011 to find out the effect of priming and ambient temperatures due to different sowing dates on emergence of maize seedlings. The experiment consisted of two priming methods viz., i) Priming, ii) Non-priming, and ten sowing dates viz., i) 15 November, ii) 30 November, iii) 15 December iv) 30 December v) 14 January vi) 29 January vii) 13 February viii) 28 February, ix) 15 March, and x) 30 March. The experiment was laid out in a randomized complete block design with three replications. Results showed that germination percentage, germination index, mean germination time and dry matter/plant were influenced significantly by priming. The highest germination percentage, germination index, dry matter/plant and lowest mean germination time were recorded from primed seed sown in March followed by February and November sowings but those were very poor in December and January sowings. So, primed seeds should be sown in November and February for better stand establishment of maize.

Keywords: Seed priming, maize (*Zea mays* L.), sowing date, seedling emergence.

Introduction

Maize (*Zea mays* L.) is one of the most important food grains of the world. In Bangladesh, maize ranks third of total acreage after rice and wheat but ranks first in respect of average yield which is 5.30 t/ha for Maize (BBS, 2010). Maize is the most popular and palatable feed for all kinds of livestock and poultry birds all over the world (Hossain and Shahjahan, 2007). Good seedling establishment is an important prerequisite for successful crop production (Harris *et al*., 1999) and this is particularly true for crops, such as maize which do not have the capacity to adjust to sub-optimal stand by tillering (Finch Savage *et al*., 2004). Constraints to good establishment of crops include low seed quality, lack of soil moisture, temperature extremities, soil salinity, poor seed bed preparation, weed competition, extreme disease pressure, etc. (Townend *et al*., 1996). When seeds are sown, they have to absorb water from the soil which take a long time before they germinate. If this time could be reduced by soaking the seeds before they are sown, germination happens more quickly resulting in a healthier crop. Seed

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priming can be a simple solution towards expected stand establishment (Harris *et al*., 2001). Seed priming is a process in which seeds are imbibed in water or osmotic solutions followed by drying before radicle emergence (McDonald, 2000). Seed priming has been reported to improve germination, reduce seedling germination time, and improve stand establishment, increase emergence, earlier flowering, earlier maturing and higher grain yield (Harris *et al*., 1999). Hydropriming involves allowing seeds to absorb sufficient water to initiate metabolic process but insufficient water to allow completion of germination. When seeds are imbibed, the lag period before radicle emergence is considerably reduced and improved the rate and uniformity of germination. Singh (1995) and Shivankar *et al*. (2003) observed that hydropriming practically ensured rapid and uniform germination accompanied with low abnormal seedling percentage. Hydropriming of maize seeds showed rapid seedling emergence and improved field stand (Nagar *et al*., 1998).

Pre-sowing seed invigoration treatments have beneficial effect on field emergence, crop stand and seedling growth of Maize under low and sub-optimal temperatures (Rashid *et al*., 2002). Emergence performance of maize seeds varies with sowing dates due to variation in ambient temperature. Farooq *et al*. (2008) and Basu *et al*. (2005) found that primed seed sown at higher temperature showed higher emergence performance and dry matter compared to low temperature. Medany *et al*. (2007) stated that optimum temperature for maize growing is between 25 and 30^{o} C. Maize being a crop of tropical origin requires optimum temperature of 25^{0}C for proper growth and development (Basu, 1999) and the prevailing sub-optimum temperatures affect the field emergence and early vegetative phase of the crop.

Maize can be produced successfully by priming seed at low moisture content of soil after harvesting transplant Aman rice. However, the priming technique of this crop is not well established in Bangladesh. Although quite a good number of works have been done on seed priming of Maize in abroad but under Bangladesh condition, such works are a few. Therefore, the present experiment was undertaken to find out the effect of priming and ambient temperature due to different sowing dates on emergence of Maize seedling.

Materials and Method

The experiment was conducted in two consecutive years at the research field of Regional Agricultural Research Station, Jessore during 2009-10 and 2010-2011. The experimental site belongs to the High Ganges River Floodplain soil. The soil is characterized by sandy loam to silty clay loam with pH value of 7.0-8.0. Organic matter, total N, and K of the soil were 1.68%, 0.087%, and 0.20

meq/100g soil, and P, S, Zn, and B were 5.09, 20.20, 2.80, and 0.32 µg/g soil. The maximum and minimum average temperatures were 35 and 16 ^{0}C in the month of April and December, during 2009-10 and 2010-11. The total rainfalls were 1222.60 and 827.70 mm in 2009-10 and 2010-11. There was no rainfall in the month of November to January during 2009-10 to 2010-11. Monthly average relative humidity ranged from 88.62 to 95.87% in 2009-10 and 90.27 to 95.63% in 2010-11. The treatments of the experiment consisted of two priming methods viz., i) Hydropriming ii) Non priming, and ten sowing dates viz., i) 15 November, ii) 30 November, iii) 15 December, iv) 30 December, v) 14 January, vi) 29 January, vii) 13 February, viii) 28 February, ix) 15 March, and x) 30 March. The experiment was laid out in a randomized complete block design with three replications. Maize (var. BARI Hybrid Maize 5) seeds were taken in plastic bowls and submerged with distilled water for 18 hours. Then seeds were washed under tap water for several times and surface dried for two hours under shade. Seeds were sown in well prepared plots at 2 cm depth in soil maintaining 75 cm × 20 cm spacing. Fertilizers were applied at the rate of 230-48-90-43-3.5-1 kg/ha in the form of N-P-K-S-Zn, and B (BARI, 2006). One-third of Urea and all other fertilizers were applied as basal during final land preparation. One hand weeding was done at 20 days after sowing (DAS) for minimizing weed competition and one irrigation was applied after weeding. The experiment continued up to 30 days. Data on different parameters were recorded following the procedures as below-

Germination percentage: The seedlings were counted daily until complete emergence. Germination was calculated in percentage using the following formula:

$$\% \text{ Germination} = \frac{\text{Number of seeds germinated}}{\text{Number of seeds sown}} \times 100$$

Germination index: The germination index (GI) was calculated by following formula (AOSA, 1983):

$$\text{GI} = \frac{\text{Number of germinated seeds}}{\text{Days of first count}} + \text{-----} + \frac{\text{Number of germinated seeds}}{\text{Days of final count}}$$

Mean germination time: The mean germination time (days) was calculated according to the following formula (Scott *et al*., 1984):

$$\text{MGT (days)} = \frac{\Sigma \text{ Ti Ni}}{\text{S}}$$

Where, Ti = Number of days after beginning of experiment
Ni = Number of seeds germination on day i
S = Total number of seeds germination

Dry matter/plant: Plant dry matter at 30 DAS (days after sowing) was recorded after drying plant samples in an oven at 70 ^{o}C for 72 hours.

Data were subjected to statistical analysis using ANOVA technique through computer based statistical package programme MSTATC. Square root transformations of percentage data were done before the analysis (Gomez and Gomez, 1984). Mean comparison was done by Duncun's Multiple Range Test (DMRT) at 5% level.

Results

Germination percentage

Germination of maize seed was influenced significantly by priming methods and dates of sowing in 2009-10 and 2010-11. Primed seeds showed higher germination (83%) than that of (75%) non-primed seeds (Fig. 1). In both the years, germination was highest at 30 March sowing followed by that at 15 March, 15 November, 30 November sowings and it was the lowest on 30 December. The highest (82%) germination was obtained from 30 March, which was statistically identical with 15 March (81%), 15 November (81%) and the lowest (77%) from 30 December sowing (Fig. 2).

Germination of maize was influenced significantly by the interaction of priming and sowing date in 2009-10 and 2010-11 (Table 1). The highest germination was recorded when primed seeds were sown on 30 March followed by 15 March, 15 November and the lowest germination was noticed from non-primed seed sown on 30 December.

Germination index

Germination index of maize seed varied significantly due to priming and dates of sowing in both the years (Fig. 3). Average germination index was higher (12.29) from primed seeds than the non-primed seeds (9.74). In both the years, germination index from seed sown on 30 March was the highest followed by sowing on 15 March, 15 November and the lowest from 30 December sowing. Average germination index of both the years was highest (14.31) from 30 March sowing followed by 15 March (13.56), 15 November (13.20) and the lowest (6.97) from sowing on 30 December (Figure 4).

Germination index of maize was influenced significantly by the interaction of priming and sowing date in both the years (Table 1). The highest (15.68) mean germination index was obtained from primed seeds when it was sown on 30

March followed by sowing on 15 March (15.41), 15 November (14.80) and the lowest from non-primed seeds sown on 30 December (6.15).

Mean germination time

The mean germination time (MGT) varied significantly due to priming and dates of sowing in both the years (Fig. 5). Average mean germination time was lower (7.39 day) in primed seeds than that of non- primed seeds (8.48 day). MGT from 30 March sowing was the lowest followed by sowing on 15 March, 28 February, 15 November and the highest from 30 December. Average MGT of both the trials was the lowest (5.18 day) from 30 March sowing followed by sowing on 15 March (5.98 day), 28 February (6.09 day), 15 November (6.34 day) and the highest (11.69 day) from 30 December sowing (Fig. 6).

MGT was influenced significantly by the interaction of seed priming and sowing date in both the years (Table 1). The lowest MGT was obtained from primed seeds when sown on 30 March followed by 15 March, 28 February, 15 November and it was the highest from non-primed seeds sown on 30 December. Average MGT of both the years was the lowest (4.47 day) from hydroprimed seeds sown on 30 March followed by seeds sown on 15 March (5.39 day), 28 February (5.54 day), 15 November (5.76 day) and the highest (12.15 day) from non-primed seeds sown on 30 December.

Dry matter

Dry matter (DM) per plant of maize showed significant variation due to priming and dates of sowing (Fig. 7). Average dry matter of both the years was higher (4.89 g) from primed seed than that of non-priming (3.88 g). DM/plant of Maize sown on 30 March was the highest followed by that sown on 15 March, 15 November, 28 February and the lowest from 30 December. Average dry matter/plant was the highest (9.78 g) from 30 March sowing followed by 15 March (9.24 g), 15 November (7.95 g) and the lowest (0.66 g) from 30 December, which was statistically identical with 30 December (0.67 g) and 15 December (0.70 g) (Fig. 8).

DM/plant of maize showed significant variation due to interaction of priming and sowing date in both the years (Table 1). The highest average DM (10.80 g) was obtained from primed seeds when sown on 30 March followed by 15 March (10.18 g), 15 November (8.64 g) and the lowest from non-primed seeds sown on 30 December (0.62 g).

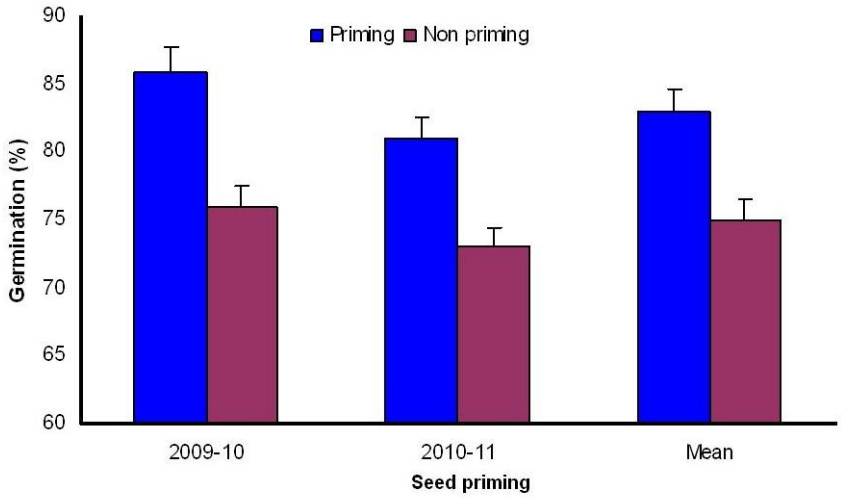

Fig. 1. Effect of priming on the germination percentage of maize seed in 2009-10 and 2010-11 (Vertical bars represent standard error of means).

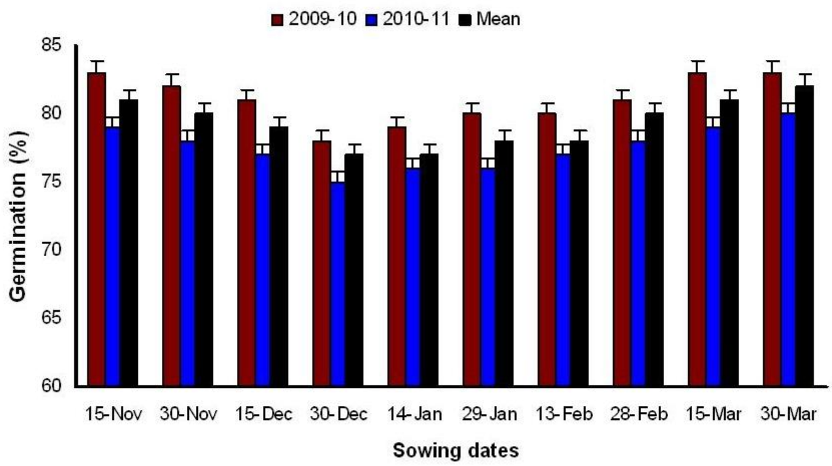

Fig. 2. Effect of sowing dates on the germination percentage of maize seed in 2009-10 and 2010-11(Vertical bars represent standard error of means).

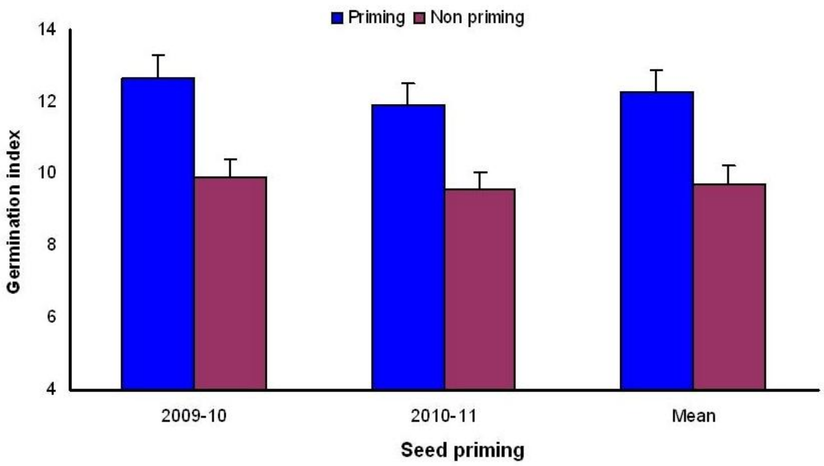

Fig. 3. Effect of priming on the germination index of maize seed in 2009-10 and 2010-11 (Vertical bars represent standard error of means).

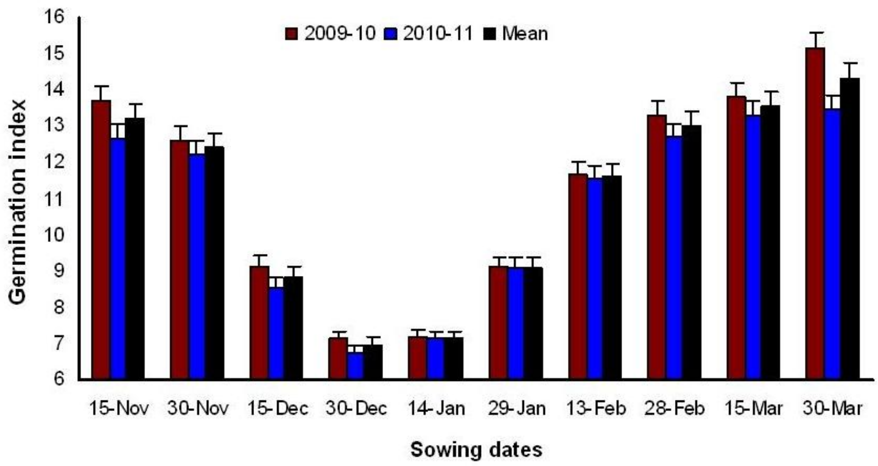

Fig. 4. Effect of sowing dates on the germination index of maize seeds in 2009-10 and 2010-11 (Vertical bars represent standard error of means).

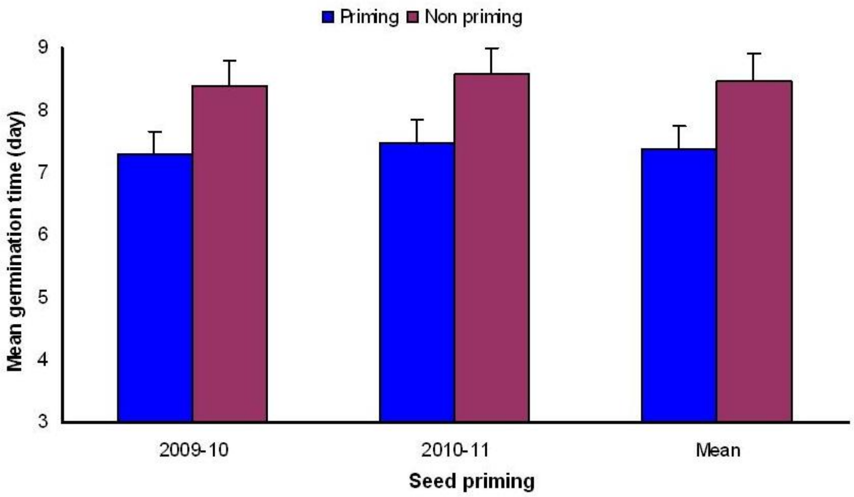

Fig. 5. Effect of priming on the mean germination time of maize seed in 2009-10 and 2010-11 (Vertical bars represent standard error of means).

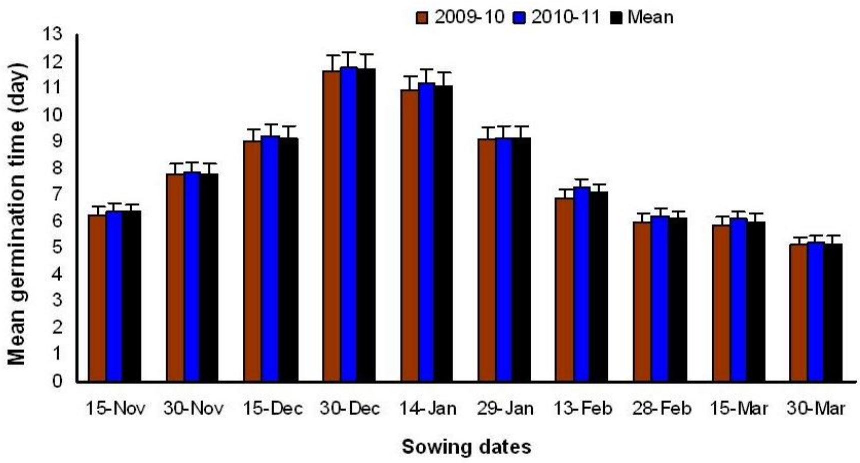

Fig. 6. Effect of sowing dates on the mean germination time of maize seed in 2009-10 and 2010-11 (Vertical bars represent standard error of means).

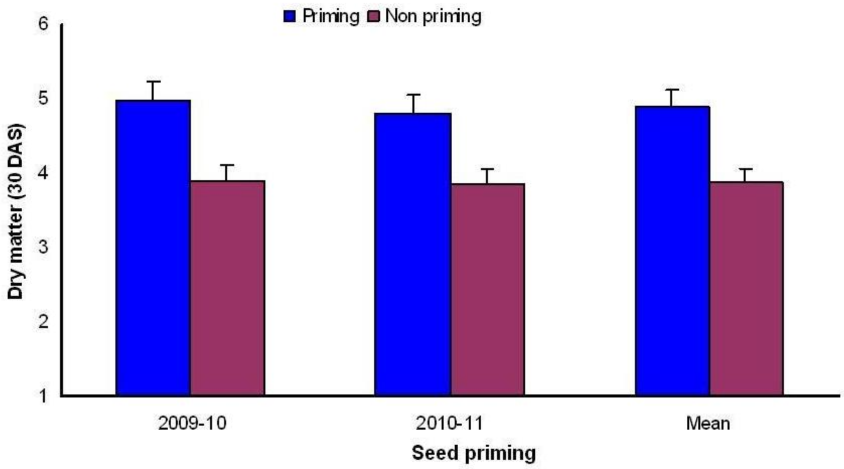

Fig. 7. Effect of priming on the dry matter of maize seedling at 30 DAS in 2009-10 and 2010-11 (Vertical bars represent standard error of means).

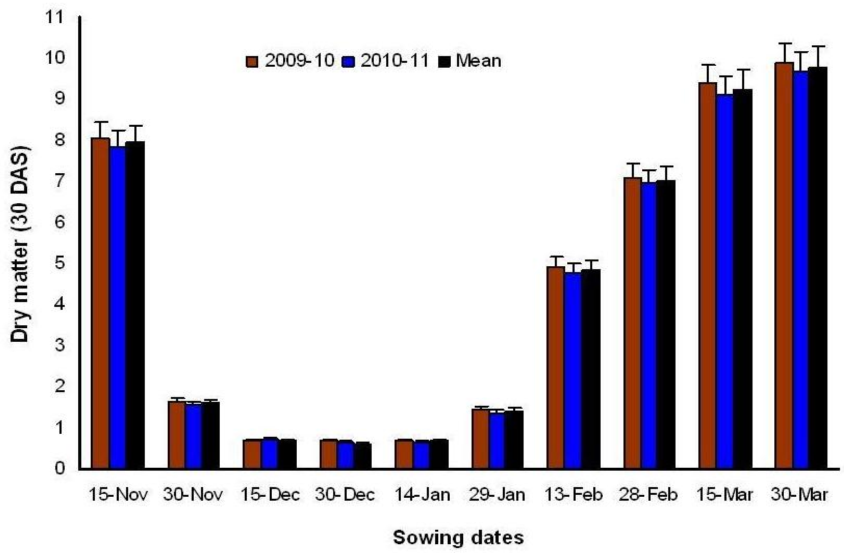

Fig. 8. Effect of sowing dates on the dry matter of maize seedling at 30 DAS in 2009-10 and 2010-11 (Vertical bars represent standard error of means).

Table 1. Interaction effect of seed priming and sowing date on germination percentage, germination index, mean germination time and dry matter of maize during 2009-10 and 2010-11.

Interaction (D x P)	Germination percentage			Germination index			Mean germination time (day)			Dry matter/plant (g) (30 DAS)		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
$D_1 \times P_1$	87 (9.33)b	82 (9.09)	85 (9.21)b	15.49bc	14.17c	14.80b	5.66o	5.85o	5.76o	8.75c	8.54d	8.64cd
$D_2 \times P_1$	86 (9.27)b	81 (9.04)	84 (9.15)c	14.49d	13.17d	13.83c	7.27j	7.38j	7.33j	1.79i	1.69j	1.74j
$D_3 \times P_1$	85 (9.22)c	80 (8.98)	83 (9.10)d	10.69h	10.24ij	10.47g	8.73g	8.86g	8.80g	0.77l	0.77m	0.77m
$D_4 \times P_1$	84 (9.17)c	78 (8.87)	81 (9.02)e	8.13j	7.43l	7.78j	11.12c	11.31c	11.22c	0.73l	0.73m	0.73m
$D_5 \times P_1$	84 (9.17)c	79 (8.92)	82 (9.04)de	7.66jk	7.63l	7.65j	10.54d	10.73d	10.64d	0.74l	0.73m	0.73m
$D_6 \times P_1$	85 (9.22)c	79 (8.90)	82 (9.06)de	10.05i	10.04j	10.05h	8.16i	8.32h	8.25h	1.71i	1.55jk	1.62j
$D_7 \times P_1$	85 (9.22)c	80 (8.98)	83 (9.10)d	12.76f	12.66e	12.72d	6.46m	6.62m	6.54m	5.27g	5.05h	5.16h
$D_8 \times P_1$	87 (9.33)b	82 (9.06)	84 (9.19)bc	15.00c	14.11c	14.59b	5.46p	5.61p	5.54p	8.65c	8.43d	8.54d
$D_9 \times P_1$	88 (9.38)a	84 (9.17)	86 (9.27)a	15.74b	14.75b	15.41a	5.25q	5.53q	5.39q	10.30b	10.05b	10.18b
$D_{10} \times P_1$	88 (9.40)a	85 (9.22)	87 (9.31)a	16.59a	15.08a	15.68a	4.41r	4.53r	4.47r	11.07a	10.54a	10.80a
$D_1 \times P_2$	78 (8.83)d	75 (8.66)	76 (8.75)f	11.93g	11.28gh	11.61e	6.86k	6.95k	6.91k	7.33e	7.16f	7.25f
$D_2 \times P_2$	78 (8.83)d	74 (8.62)	76 (8.73)f	10.77h	11.29gh	11.03f	8.27h	8.30h	8.29h	1.46j	1.41k	1.43k
$D_3 \times P_2$	77 (8.77)e	73 (8.56)	75 (8.67)gh	7.60k	6.88m	7.24k	9.31f	9.50f	9.41f	0.63l	0.65m	0.64 m
$D_4 \times P_2$	73 (8.54)h	71 (8.43)	72 (8.49)k	6.22l	6.09n	6.15m	12.18a	12.12a	12.15a	0.62l	0.61m	0.62m
$D_5 \times P_2$	74 (8.60)g	71 (8.45)	73 (8.52)jk	6.63l	6.62m	6.63l	11.28b	11.64b	11.46b	0.63l	0.62m	0.62m
$D_6 \times P_2$	74 (8.60)g	72 (8.49)	73 (8.54)j	8.17j	8.13k	8.15i	9.95e	9.99e	9.97e	1.21k	1.21l	1.22l
$D_7 \times P_2$	75 (8.66)f	73 (8.54)	74 (8.60)I	10.55h	10.48i	10.52g	7.25j	7.88i	7.57i	4.57h	4.45i	4.51i

Table 1. Cont'd.

Interaction (D x P)	Germination percentage			Germination index			Mean germination time (day)			Dry matter/plant (g) (30 DAS)		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
$D_8 \times P_2$	76 (8.72)e	73 (8.58)	75 (8.65)hi	11.59g	11.23h	11.42e	6.55l	6.74l	6.64l	5.50f	5.47g	5.48g
$D_9 \times P_2$	77 (8.77)e	74 (8.64)	76 (8.71)fg	11.86g	11.57g	11.72e	6.46m	6.66lm	6.56m	8.46d	8.17e	8.31e
$D_{10} \times P_2$	77 (8.77)e	76 (8.72)	77 (8.75)f	13.75e	12.12f	12.94d	5.84n	5.92n	5.88n	8.68c	8.83c	8.75c
$S_{\bar{x}}$	0.018	0.022	0.018	0.174	0.105	0.115	0.028	0.016	0.016	0.058	0.052	0.051
Level of signif.	**	NS	**	**	**	**	**	**	**	**	**	**
CV (%)	0.34	0.43	0.35	2.67	1.69	1.81	0.61	0.35	0.36	2.25	2.08	2.02

Figures in parentheses are the square root transformed values for germination percentage.

Figures with similar letter(s) letter within the column do not differ significantly whereas figures with dissimilar letter(s) differ significantly at 0.05 level of probability by DMRT, ** = Significant at 0.01 level of probability, NS = Not significant, D_1 = 15 November, D_2 = 30 November, D_3 = 15 December, D_4 = 30 December, D_5 = 14 January, D_6 = 29 January, D_7 = 13 February, D_8 = 28 February, D_9 = 15 March, D_{10} = 30 March, P_1 = priming and P_2 = Non-priming.

Discussion

Different factors, such as soil moisture stress, temperature extremities, soil salinity, poor seed bed preparation, weed competition, low seed quality, and extreme disease pressure adversely affect the emergence of maize seed. Seed priming could be used as a viable technology to improve seedling establishment. Rapid and uniform emergence has been achieved by seed priming in some field crops (Murungu *et al.*, 2004).

In this study, emergence performance of maize seeds varied with sowing dates. This difference was mainly related to variation in ambient temperature. Maize seed sown in the month of December and January showed very poor emergence but those sown in March showed the highest emergence. Optimum temperature for maize production is between 25 and 30^{o} C, if the temperature is lower than that then germination of maize is delayed. Therefore, lower germination was observed in December and January sowing due to lower temperature. This result is at par with the findings of Sikder *et al*. (2009). Farooq *et al*. (2008) also found that primed seeds sown at higher temperature showed higher emergence performance and dry matter compared to low temperature. Medany *et al*. (2007) stated that optimum temperature for maize growing is between 25 and 30^{o} C. Ambient mean temperature during germination period in this study of both the years were 15 to16 ^{o}C, 17 to18 ^{o}C, 19 to 21 ^{o}C, 19 to 25 ^{o}C and 27 to 30 ^{o}C when sown in December, January, November, February and March, respectively. Therefore, it was evident from the study that emergence was lower in December and January due to lower temperature than those in November, February, and March.

Higher emergence performance in this study was obtained from sowing of primed seeds at any date compared to non-primed seeds. Seed priming plays a vital role for increasing emergence and stand establishment. So, primed seeds improved seedling emergence for any date of sowing. This result is in line with the findings of Afzal *et al*. (2008). Primed maize seeds sown in the month of November and February showed higher germination percentage and lower mean germination time compared to hydroprimed seeds sown in December and January. Primed seeds sown on 15 November showed 4% higher germination and mean germination time reduced by 5.46 days compared to primed seeds sown on 30 December. Similarly February sowing showed higher germination and reduced mean germination time. Though the variation of germination percentage was narrower but it took longer period for completion of germination and as a result dry matter of maize seedling at 30 DAS reduced more (Table 1). So, primed seeds sown in December and January could not achieve the required emergence as compared to primed seeds sown on 15 November and February.

In Bangladesh, the optimum sowing time of maize is October to November in rabi season and mid February to March in kharif season (BARI, 2006). In the study, maize seeds sown in December and January showed very poor emergence whereas November and February sowing showed better emergence.

Conclusion

Primed seeds sown in March showed highest emergence of maize whereas it was very poor when sown in December and January. Primed maize seeds sown in the month of November and February showed higher germination percentage, germination index, dry matter and lower mean germination time compared to primed seeds sown in December and January. So, it may be concluded that primed seeds could be sown in November and February for better production of maize in Bangladesh.

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