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INFLUENCE OF PRIMING TECHNIQUES ON EMERGENCE AND SEEDLING GROWTH OF FORAGE SORGHUM (*Sorghum bicolor* L.)

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ABSTRACT

Seed priming is a technique which improves the germination and early growth under prevailing environmental conditions. However, the information on seed priming in sorghum is lacking in Pakistan. Therefore, this study was designed to evaluate the effects of different seed priming techniques, un-soaked seed (control), Hydro-priming (soaked with distill water), Halopriming with KNO_3 and $CaCl_2$ (1% solution), on seed emergence and seedling growth of three sorghum genotypes (Hegari, JS-263 and JS-2002). Experiment was conducted in wire house under natural climatic conditions during 2008. All the priming treatments significantly affected the fresh weight, shoot length, number of roots, root length, vigor index, time to start emergence, time to 50% emergence and energy of emergence of forage sorghum. The interactive effect of varieties and priming techniques were not significant for mean emergence time and coefficient of uniformity of emergence. It is concluded that seed priming may serve as an appropriate treatment for accelerating the emergence of sorghum genotypes studied.

Keywords: seed priming, emergence, seedling growth, sorghum.

INTRODUCTION

Although the soil and climatic conditions of Pakistan are favorable for sorghum production but it's per hectare average forage yield is very low (Bhatti, 1996). This is primarily due to substandard methods of cultivation, poor crop stand, malnutrition and lack of high yielding cultivars. The technology that enhances early emergence and stand establishment would enable the crop to capture more soil moisture, nutrient and solar radiation. Rapid and uniform field emergence is an essential pre-requisite to reach the yield potential, quality and ultimately profit in annual crops (Parera and Cantliffe, 1994). Priming repairs damage of aged seeds (Butler *et al*., 2009) or seeds exposed to abiotic stresses such as salinity (Ehsanfar *et al*., 2006), improving germination performance. Priming treatment consists of soaking seeds in an osmotica of low water potential to control the amount of water supply to the seed. At the cellular level, few processes have been described to act during priming some of these being: activation of cell cycle (De Castro *et al*., 2000) and mobilization of storage proteins (Gallardo *et al*., 2001).The priming-induced increase in the rate of seed germination has been associated with the initiation of germination-related processes(Soeda *et al*., 2005), repair processes (Sivritepe and Dourado, 1995) and increase in various free radical scavenging enzymes, such as superoxide dismutase, catalase and peroxidase have also been demonstrated (Gallardo *et al*., 2001). Halopriming is a pre-sowing soaking of seeds in salt solutions, which enhances germination and seedling emergence consistently under unfavorable environmental conditions. Seed priming treatment can lead to better germination and establishment in many crops such as maize , wheat , rice, canola (Basra *et al*., 2005). Many recent researchers suggested that seed priming of crop seeds might be a useful way for better germination, seedling growth, establishment and yield (Ghiyasi *et al*., 2008). Many researchers have taken this as evidence that the germination of seeds during priming depends not only on imbibitions rate (Bewley and Black, 1978) but also on genotype (Maiti and Moreno, 1995). Seeds of both marigold species primed with 50 mM $CaCl_2$for 24 h significantly reduced mean emergence time and days to 50% emergence, increased seedling emergence uniformity, final seedling emergence percentage and seedling growth (Afzal *et al*., 2009). Patane *et al*. (2009) reported that seed priming enhance germination and shortened the delay in germination time due to the increase in saline stress, at suboptimal temperatures only. Kader and Jutzi (2002), showed that imbibitions rates were higher in untreated than in primed seeds after more than 24 h of soaking and a rise in priming temperature increased imbibitions to a greater extent in the former. Priming treatments generally led to faster seedling emergence and greater seedling shoot fresh weight than was achieved with non-primed seeds (Pill *et al*., 2009). Priming significantly effects plant growth rate and grain yield in plants under high disease pressure (Dale *et al*., 2009). Ghassemi-Golezanik *et al*. (2008) reported that hydropriming significantly improved germination rate and root weight of lentil (*Lens culinaris* Medik.)

compared to other seed treatments. Pegah *et al*. (2008) evaluated the influence of seed priming techniques on germination and early growth of two maize inbred lines (B73 and MO17) and reported that priming techniques affected seed germination and early growth. Previous work on the priming of sorghum with NaCl and KNO_3 (Al-Mudaris and Jutzi, 1997) has shown positive responses to such treatments. The present study was, therefore, carried out with objective to evaluate the effects of seed priming treatments on emergence and seedling growth of sorghum in pot trial under wire house condition to find out the most promising technique.

MATERIALS AND METHODS

To assess the priming effects on emergence parameters, response of three sorghum genotypes seed soaked in water and different salts solutions were studied under wire house conditions. The study was conducted in the wire house of the Department of Agronomy, University of Agriculture, Faisalabad. Genotypes seed was obtained from Punjab seed corporation Faisalabad. Initial seed moisture content was 7.24%. Seeds of uniform size were used in the experiment. The experiment was laid out in completely randomized design with three replications. Seed were treated with the following seed-soaking media: (i) unsoaked seed (control); (ii) hydro-priming with distilled water for 10 h; (iii) halo-priming treatments with KNO_3 and $CaCl_2$ (1% solution) for 10 hours. After each treatment, seeds were given three surface washings with distilled water and dried closer to original moisture with forced air at room temperature. Fifteen seeds from each of the treatments were sown in pots having sand. Daily observation for emerging seedling continued for 14 days after sowing. The seedlings were evaluated as described in Seedling Evaluation Handbook (AOSA. 1991). Time taken to 50% emergence of seedlings (E_{50}) was calculated according to the following formulae of Coolbear *et al*. (1984) modified by Farooq *et al*. (2005):

$$E_{50} = t_i + \frac{\left(\frac{N}{2} - n_i\right)(t_j - t_i)}{n_j \quad n_i}$$

Where N is the final number of germinated seeds while n_j and n_i are the cumulative number of seeds germinated by adjacent counts at times t_j and t_i, respectively, where $n_i < N/2 < n_j$.

Mean emergence time (MET) was calculated according to the equation of Ellis and Roberts (1981) as follows:

$$MET = \frac{\sum Dn}{\sum n}$$

Where n is the number of seeds that had germinated on day D and D is the number of days counted from the beginning of germination.

Energy of emergence (EE) was determined on the 4th day of seed sowing (Ruan *et al*. 2002).

Coefficient of uniformity of emergence (CUE) was calculated using the formula of Bewley and Black (1985):

$$CUE = \frac{\sum n}{\sum \left|(\bar{t} - t)^2 \times n\right|}$$

where t is the time in days, starting from day 0, the day of sowing, n is the number of seeds completing emergence on day t and $\bar{t}$ is equal to MET.

VI = seedling length (cm) × emergence percentage
ER = Number of emerged seeds/number of emergence days

Numbers of roots and leaves, seedling shoot and root length were recorded of 10 randomly selected seedlings per replicate and averaged. Seedling fresh weight was determined immediately after removing from pots while dry weight was taken after drying at 70°C for 3 days.

Statistical Analysis: Data was analyzed by using Fisher's analysis of variance technique and the least significant difference test at 5% probability level was used to compare treatment means (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Priming treatment significantly affected emergence and growth of sorghum genotypes. The response of genotypes to different priming techniques approximately was similar. The control treatment shows maximum value of time to start emergence and E_{50} than all other priming treatments. Higher EE, ER and FEP were observed in seed treated with $CaCl_2$ for all genotypes. MET and CUE were non significant for genotype and significant for priming treatments. Interactive effect of seed treatment × genotypes was also non-significant for MET and CUE (Table 1). Maximum FW was noted in JS-2002 with $CaCl_2$ followed by KNO_3 than all other treatments. Hydropriming gave significantly higher NL compared to other treatments. Priming with $CaCl_2$ gave significantly higher NR than all other treatments and also gave maximum seedling length which was followed by KNO_3. Higher SL was measured in JS-2002 with KNO_3 which is statistically at par to Hegari with $CaCl_2$. Priming with $CaCl_2$ gave significantly maximum RL and higher VI as compared to other treatments (Table 2).

Table 1: Effect of seed priming on seedling emergence in sorghum

Traits / Treatments		Time to start emergence	E_{50}	EE (%)	ER	FEP (%)	MET	CUE
Varieties	priming							
Hegari	Dry	1.67[a]	1.33[a]	53.33[fgh]	2.31[g]	50.97[fg]	3.6533	0.8933
	Hydropriming	1.00[b]	0.77[b]	66.50[cde]	3.67[cde]	75.50[ab]	3.6367	0.8700
	$CaCl_2$	1.00b	0.61[bc]	73.30[abc]	4.67[b]	77.73[a]	3.1233	0.5833
	KNO_3	1.00[b]	0.72[bc]	69.83[bcd]	3.47[def]	59.87[e]	3.1267	0.6933
JS-263	Dry	1.67a	1.51[a]	48.87[gh]	2.68[efg]	62.20[cd]	3.5100	0.8267
	Hydropriming	1.33[ab]	0.55[bc]	59.97[ef]	4.39[bcd]	62.17[cd]	3.5500	0.8267
	$CaCl_2$	1.00[b]	0.52[c]	77.73[ab]	7.83[a]	77.63[a]	3.0167	0.5500
	KNO_3	1.00[b]	0.61[bc]	62.20[def]	4.50[bc]	68.63[bc]	3.0333	0.6800
JS-2002	Dry	1.67[a]	1.54[a]	44.43[h]	2.67[fg]	44.40[g]	3.5133	0.7800
	Hydropriming	1.00[b]	0.70[bc]	55.53[fg]	2.78[efg]	59.97[de]	3.6233	0.8700
	$CaCl_2$	1.00[b]	0.51[c]	79.97[a]	8.17[a]	82.20[a]	3.1167	0.5767
	KNO_3	1.00[b]	0.72[bc]	73.27[abc]	3.33[ef]	53.30[ef]	3.0100	0.6433
LSD at 0.05		0.63	0.2365	9.41	0.9867	7.13	n.s	n.s

Means sharing the same letter do not differ significantly at P= 0.05. E_{50}, time to 50% emergence; EE, energy of emergence; FEP, final emergence %age; ER, emergence rate; MET, mean emergence time; CUE, Coefficient of uniformity of emergence

Table 2: Effect of seed priming on seedling growth in sorghum

Traits / Treatments		FW	NL	NR	SL	RL	Seedling Length	VI
Varieties	priming							
Hegari	Dry	0.33 [h]	4.23[c]	3.87[f]	22.77[cd]	23.93[cd]	46.70[e]	2580.21[d]
	Hydropriming	0.56[c]	4.97[a]	4.92[b]	22.63[cd]	24.33[c]	46.96[e]	3545.48[bc]
	$CaCl_2$	0.54[d]	4.27[c]	5.00[b]	27.53[a]	26.17[ab]	53.7[a]	4174.10[a]
	KNO_3	0.51[e]	4.10[c]	4.[24de]	23.53[bc]	24.57[bc]	48.10[de]	2879.75[d]
JS-263	Dry	0.46[fg]	3.80[d]	3.87[f]	19.67[e]	22.30[de]	41.97[f]	2610.53[d]
	Hydropriming	0.53[de]	5.03[a]	4.60[c]	19.80[e]	23.93[cd]	43.73f	2718.69[d]
	$CaCl_2$	0.53[d]	4.27[c]	5.47[a]	21.77[d]	27.67 [a]	49.44[cd]	3838.03[ab]
	KNO_3	0.47[f]	4.13[c]	4.00[ef]	22.80[cd]	20.73[ef]	43.53[f]	2987.46[d]
JS-2002	Dry	0.45[g]	4.07[c]	3.97[ef]	22.70[cd]	19.43[f]	42.13[f]	1870.57[e]
	Hydropriming	0.57[c]	4.93[a]	4.00[ef]	24.43[b]	26.23[ab]	50.66[bc]	3038.08[cd]
	$CaCl_2$	0.74[a]	4.57[b]	4.50[cd]	23.10[bcd]	26.47[a]	49.57[cd]	4074.65[ab]
	KNO_3	0.71[b]	4.70[b]	4.17[ef]	27.97[a]	23.[57cd]	51.54[b]	2747.08[d]
LSD at 0.05		0.0221	0.2176	0.3145	1.4680	1.6786	1.8746	509.47

Means sharing the same letter do not differ significantly at P= 0.05. FW, fresh weight; NL, number of leaves; NR, number of roots; SL, shoot length; RL, root length; VI, vigor index

Seed priming improved germination and seedling growth of sorghum (Table 1 and 2). Improved seedling FW might be due to increased cell division within the apical meristem of seedling roots, which cause an increase in plant growth (Farooq *et al*., 2007). Leaf number and seedling length of plants derived from primed seed were higher than unprimed seed (Hassanpouraghdam *et al*., 2009). The increased shoot and root length with halopriming treatment may be due to the fact that, halopriming increased nuclear replication in shoot and root. These results are in accordance with Mavi *et al*. (2006) who reported that priming treatment increased seedling size. Priming significantly improved root length (Hassanpouraghdam *et al*., 2009). Farooq *et al*. (2005) concluded that seed priming with NaCl showed improved germination and seedling vigor by dormancy breakdown as compared to control. All the seed priming techniques reduce the time to start emergence, time to 50% emergence (E_{50}) and MET as compared to control. Early reserve breakdown and reserve mobilization might be the cause of significant reduction in E_{50}. Due to readily available food during germination (Farooq *et al*., 2006), primed seed are better able to complete the process of germination in shorter time. Improved EE %

and FEP % were due to efficient mobilization and utilization of seed reserves (Basra *et al*., 2005) and better genetic repair (Srivastava, 2002). Bose and Mishra (1992) reported faster ER after osmopriming due to an increased rate of cell division in the root tips of wheat.

Conclusion: The results of this experiment indicate that halopriming with $CaCl_2$ and KNO_3 could improve some parameters of sorghum emergence and seedling growth.

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