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Influence of different pre sowing seed invigoration techniques on early growth of different maize hybrids

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Abstract

Several seed conditioning approaches utilizing maize hybrids of priming precursors may develop crop establishment, performance and quality of corn. Seed priming treatments are used to minimize emergence time, enhanced germination rate and crop establishment in field crops like maize under adverse environment. A laboratory experiments were conducted to investigate the effect of pre-sowing technique on early growth of different maize hybrids. The trail was carried out at Agronomy research laboratory, The University of Agriculture Peshawar during 2017. The experiment was laid out in complete randomized design (CRD) with three replications. The experiment was consists of two factors i.e., priming sources (Control, hydro, solid matrix priming, osmo-priming with PEG-6000) and maize hybrids (Gorilla, Pioneer 3025, CS-220). Priming was done for 24 hours in all priming techniques. Results of the lab experiment revealed that osmo-priming (PEG-6000) gave maximum germination (95.2 %), seedling fresh weight (30.8 mg), seedling dry weight (20.8 mg), germination energy (83 %), shoot length (13.3 cm) and root length (10 cm). Among hybrids CS-220 produced maximum germination (93.9%), seedling fresh weight (26.8 mg), seedling dry weight (16.9 mg), germination energy (82.9 %), shoot length (12.9 cm) and root length (9.7 cm). It is concluded from the experimental results that CS-220 with osmo-priming (PEG-6000) is recommended for cultivation under the agro-ecological conditions of Peshawar.

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Introduction

Maize (*Zea mays* L.) belongs to grass family and it is cultivated in many countries of the world. Maize is used for multiple purposes as it is used for human food, animal and poultry feed as well as in industrial products (Bibi *et al.*, 2010).It was grown on area of about 1142.5 thousand ha. The total production was 4936.8 thousand tons having average yield of 4321 kg ha^{-1}.Whereas in Khyber Pakhtunkhwa it was grown on area of 463 thousand ha and its production was 909.7 thousand tons with the average yield of 1965 kg ha^{-1} (MNFSR, 2016).Crops often fail to establish quickly and uniformly due to high temperature (Wahid *et al.*, 2007). Seed priming treatments are used to minimize emergence time, enhanced germination rate and crop establishment in field crops like wheat, rice and maize under adverse environment (Rehman *et al.*, 2011).

Several techniques have the potential to hasten the crop emergence and stand in the field. Priming is a well-known technique that improves germination, emergence and production of the crop (Harris *et al.*, 2007). Seed priming includes hydro-priming, halo-priming, osmo-priming, osmo-conditioning, osmo-hardening, harmo-priming, hardening, matrix-priming and others. Since primed seeds are usually loss their storage life thus they should be sown immediately after priming (Basra *et al.*, 2003). Seeds priming have improve germination particularly under adverse conditions. Seed priming is low cost and low risk intervention used to overcome poor stand establishment. Seed priming is comprised of soaking of seed in water and drying back to the storage moisture content until use. The soaking induced a range of biochemical changes in the seed that required the starting the germination process, some of these processes that precede germination is triggered by priming persist following the desiccation of seed (Asgedom and Becker, 2001). Seeds rapidly imbibe and revive metabolismupon priming that resulting in a higher germination rate and reduction in the inherent physiologyand heterogeneity in germination (Rowse, 1995). Higher yield is associated with early seedling growth (Harris *et al.*, 2001). The health of seed can be improved by techniques generally known as seed priming which speed up germination and uniformity of germination. (Basra *et al.,* 1989) found that priming of corn seeds with polyethylene glycol (PEG) or potassium salts (K_2HPO_4 or KNO_3) resulting in enhancing germination. Seed priming in rapeseed improved germination percentage and increased seedling growth and establishment (Basra *et al.,* 2003).

Keeping in view the significance of priming techniques for improving the performance of crop, the present study was designed to study the effects of priming techniques on growth and yield of maize hybrid under the agro-ecological conditions of Peshawar.

Materials and methods

The experiment was carried out at Agronomy research laboratory of the University of Agriculture, Peshawar during summer 2017.The experiment was done in complete randomized design (CRD) for lab observations. The experiment was consisted of two factors i.e. priming sources (Control, hydro priming, solid matrix priming and osmo priming with PEG-6000) and maize hybrids (Gorilla, Pioneer 3025 and CS-220). Priming was done for lab as well as for field observations. Priming sources were, Control (Dry seed), H_2O (Distill water) (Hydro priming), Halo priming (NaCl), Solid matrix priming (Press mud), Osmo priming with PEG-6000 were used respectively. For Seed Treatments, inHydro-priming525 g seed were soaked in 1 L distilled water at room temperature for hydro-priming. Halo priming, 525 g seed was soaked in 50 g L^{-1} NaCl at room temperature for halo priming. Solid matrix priming, Solid matrix priming was done with solid matrix carrier “press mud” that is cheaper to commercial product. Press mud is a byproduct of sugar cane produced by sugar industry of Pakistan in large amount and is rich in organic matter. Press mud was taken from Mardan sugar mill**.** First of all 525 g of seed was mixed with 1 kg press mud separately and 1 L of distilled water in a close container and was kept at room temperature. The seeds were then sieved

from press. Osmo priming, Forosmo priming with PEG-6000 525 g seeds were soaked in 100 g L^{-1} solution at room temperature. Data observation was taken on Standard germination test, Seedling fresh weight (mg), Seedling dry weight (mg), Germination energy, Shoot length (cm) and Root length (cm).

Procedure for data observation

Standard germination test

A sample of 50 seeds was collected from each treatment, which was replicated three times. These tests were placed in germination trays between 2 sheets of standard germination paper. The trays were kept in germinator at 25 ˚C for 7 days. The germination trays were examined on daily basis. Percentage (%) of seedling germination was recorded from the mean number of seedling.

$$\text{Germination (\%)} = \frac{\text{Numberof seeds germinated}}{\text{Total number of seeds}} x100$$

Seedling fresh weight: Seedlings fresh weight was done of the seedlings obtained after standard germination test. With the help of electronic balance seedling weight was taken in mg.

Seedling dry weight: The seedling obtained after standard germination test, were utilized for seedling dry weight test.

Germination energy: On the very fourth day of the performed experiment, germination energy (%) was noted. It was the percentage of seeds germination on the fourth day, after the commencement of the experiment in relation to the mean number of seeds tested.

Shoot and root length (cm): After the germination process shoot and root length were measured with the help of measuring scale and were expressed in centimeters.

Statistical analyses

Data will be analysed statistically using analysis of variance techniques appropriate for randomized complete block design. Means will be compared using LSD test at 0.05 level of probability, when the F-values are significant (Steel and Torrie, 1984)."

Results

Standard germination test (%)

Priming techniques and maize hybrids significantly affected standard germination test while P × H interaction was found non-significant. Mean values of the data revealed that highest germination % (93.9) was recorded from CS-220 while lowest germination % (90.4) were recorded for Gorilla hybrid which was statistically similar to (91.5) for Pioneer-3025 (Table 1).

While (Table 2) shows that among different priming treatments, higher germination % (95.2) was observed for solid matrix priming withpress mud which was statically similar to osmo priming with PEG-6000 (95.1) while lower germination % (83.1) was recorded in control.

Table 1. Germination (%), germination energy (%),shoot and root length, seedling fresh and dry weight of different maize hybrids as influenced by different priming techniques.

	Hybrid varieties			
	Gorilla	3025	CS-220	LSD
Germination (%)	94.4 b	91.5 b	93.9 a	1.13
Germination energy (%)	78.1 b	79.3 b	82.9 a	2.99
Mean germination time	3.0 a	2.7 a	2.1 a	0.45
Shoot length (cm)	12.1 ab	11.8 b	12.9 a	0.77
Root length (cm)	9.1 ab	8.8 b	9.7 a	0.69
Seedling fresh weight (mg)	24.5 b	25.7 ab	26.8 a	1.69
Seedling dry weight (mg)	14.4 b	15.7 ab	16.9 a	1.46

Germination Energy (%)

Priming techniques and maize hybrids significantly affected germination energy (%). While P × H interaction was found non-significant. (Table 2) shows that maximum germination energy (83%) was recorded for osmo priming which was statistically similar to hydro priming (81.4%) and solid matrix priming (81.3%) and halo priming (79.3%) while minimum germination energy (75.4%) was recorded for control. In folder of maize hybrids maximum germination energy (82.9%) was recorded for CS-220 while minimum germination energy (79.3%) was recorded for Pioneer-3025 which was statistically similar to (78.1%) for Gorilla mentioned in (Table 1).

Table 2. Germination (%), germination energy (%), shoot and root length, seedling fresh and dry weight of maize as affected by different priming techniques.

	Priming Techniques					
	Control	Hydro-Priming	Halo-Priming	Solid matrix-priming	Osmo-Priming	LSD
Germination (%)	83.1c	93.4b	92.8b	95.2a	95.1a	1.46
Germination energy (%)	75.4 b	81.4 a	79.3 ab	81.3 a	83.0 a	3.87
Mean germination time	4.1 a	3.5 b	2.5 c	1.5 d	1.5 d	0.58
Shoot length (cm)	11.2 c	12.9 ab	12.1 bc	11.7 c	13.3 a	0.99
Root length (cm)	8.2 c	9.9 a	9.3 ab	8.7 bc	10.0 a	0.89
Seedling fresh weight (mg)	23.0 c	25.0 bc	23.2 c	26.4 b	30.8 a	2.19
Seedling dry weight (mg)	13.2 c	15.0 bc	13.2 c	16.4 b	20.8 a	1.89

Shoot Length (cm)

Statistical analysis showed that shoot length had significantly affected by priming techniques and maize hybrids. While interaction of P × H was found non-significant. Mean values of the data in (Table 1) revealed that lengthy shoot (12.9 cm) were produced by CS-220 which was statistically similar to Gorilla (12.1 cm) while shorter shoot lengths (11.8 cm) were obtained from Pioneer-3025. In (Table 2) For priming treatments, maximum shoots length (13.3 cm) were obtained when seed received PEG-6000 (osmo priming) which was statistically similar to hydro priming (12.9 cm) while minimum shoot lengths (11.2cm) were recorded in control.

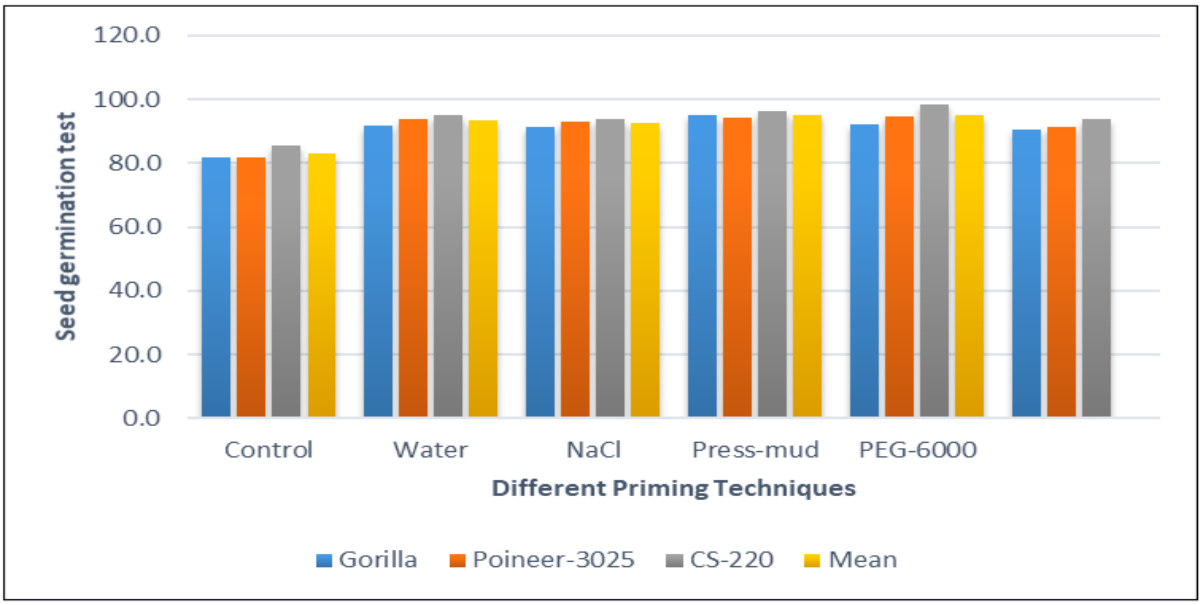

Fig. 1. Standard germination Test (%) as affected by application different priming techniques and maize hybrid varieties.

Root Length (cm)

The impact of seed priming and different hybrids on root length is shown in table. All the factors and the interactive response had significantly affected root length. Data shows in (Table 1) the greatest root length (9.7 cm) was observed for CS-220 hybrid and lowest root length (8.8 cm) was recorded for pioneer-3025. While (Table 2) shows mean comparison of the data for priming treatments revealed that lengthy roots (10 cm) were observed for seeds treated with PEG-6000 while shorter root length (8.2 cm) were recorded in control.

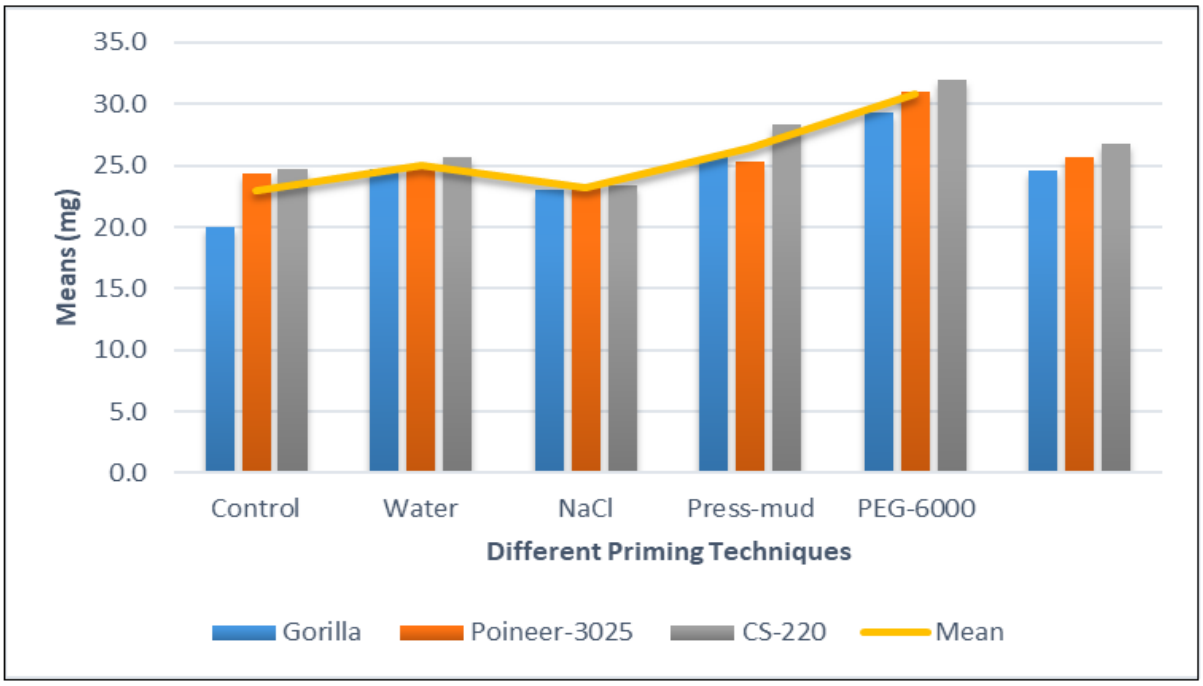

Fig. 2. Seedling Fresh Weight (mg) as affected by application different priming techniques and maize hybrid varieties.

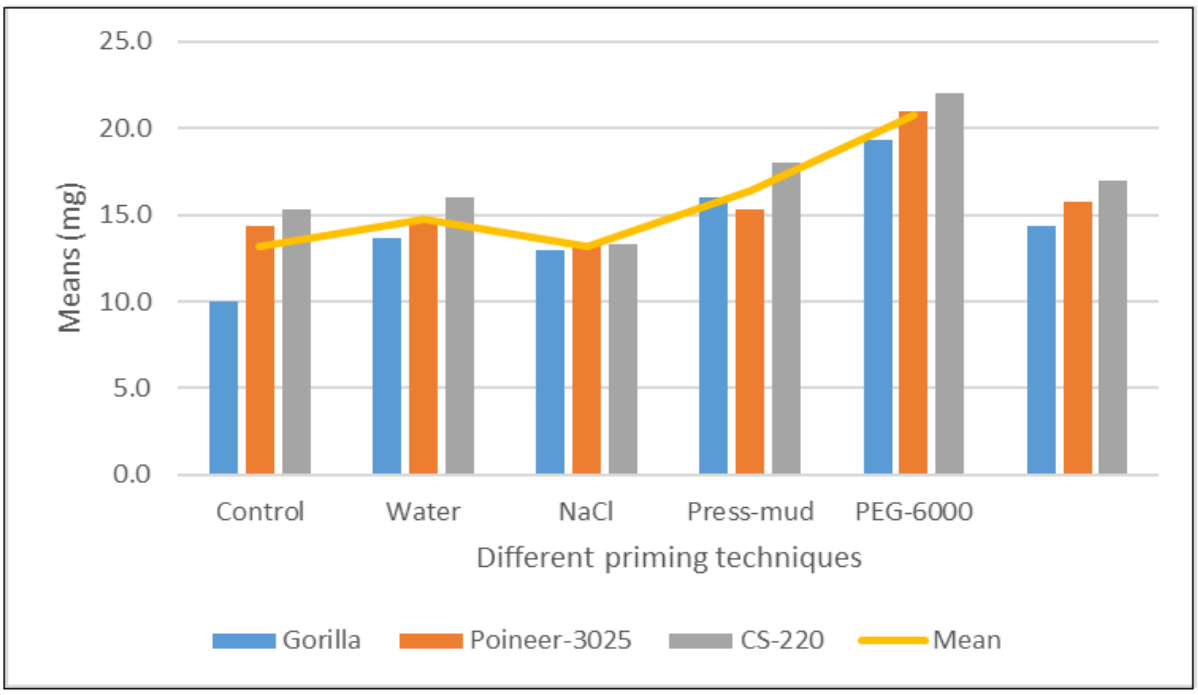

Fig. 3. Seedling dry weight (mg) as affected by application different priming techniques and maize hybrid varieties.

Seedling fresh weight (mg)

Statistical analysis of the data showed significant effect of priming techniques and maize hybrids on seedling fresh weight and interaction had no significant effect. Mean comparison of the data in (Table 1) for hybrids showed that heavier fresh weight (26.8 mg) were produced by CS-220 hybrid which is statistically similar to fresh weight (25.7 mg) of pioneer-3025 while lighter fresh (24.5 mg) weight was produced by Gorilla hybrid. In case of different priming sources, (Table 2) shows maximum fresh weight (30.8 mg) was produced when seeds primed with PEG-6000, followed by press mud primed seeds (26.4 mg) while minimum fresh weight (23 mg) was recorded in control.

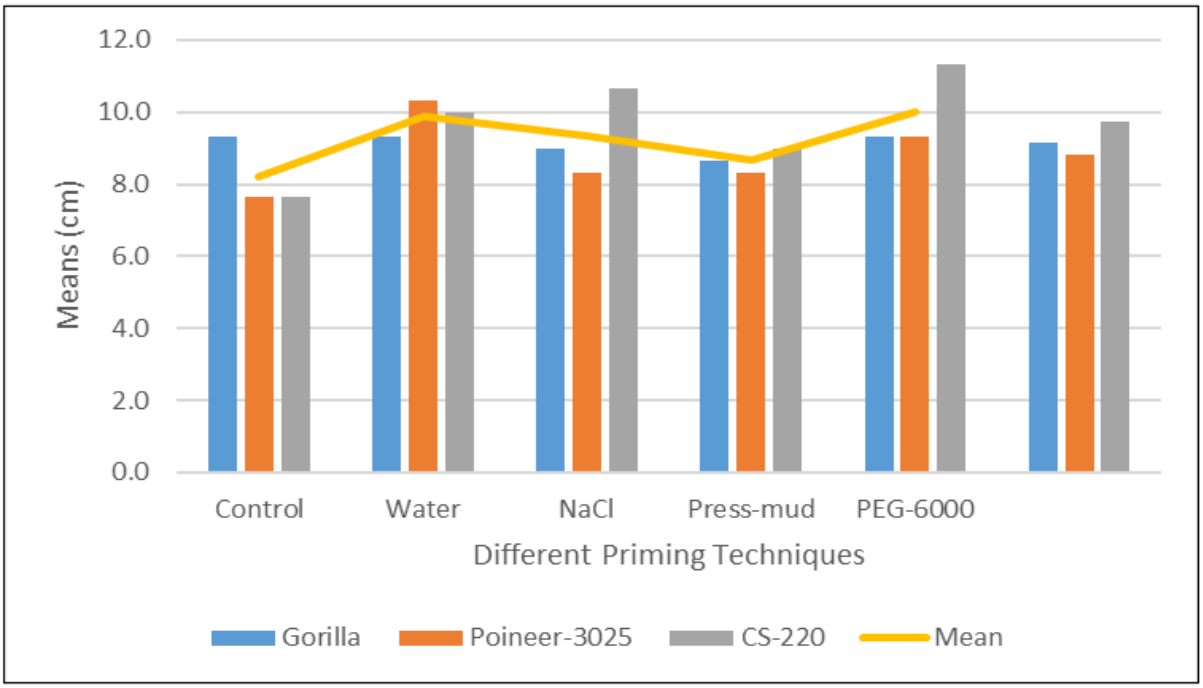

Fig. 4. Root length (cm)as affected by application different priming techniques and maize hybrid varieties.

Seedling dry weight (mg)

Analysis of the data revealed that seedling dry weight was significantly affected by various priming techniques and maize hybrids while interaction of priming sources and hybrids was found non-significant. Among hybrids in (Table 1), maximum seedling dry weight (16.9 mg) was produced by CS-220 while minimum seedling dry weight (14.4 mg) was observed in Gorilla hybrid. While (Table 2) shows that in case of priming techniques heavy roots (20.8 mg) was recorded when seeds were primed with PEG-6000, followed by press mud treated plots (16.4 mg) while low root weight (13.2) were obtained from control.

Discussion

Priming techniques (P) and maize hybrids (H) significantly affected standard germination test. Mean values of the data revealed that highest germination) was recorded from CS-220 while lowest germination was recorded for Gorilla hybrid.

This results are in line with Kurdikeri *et al.*, (1995) they reported differences for germination and germination time due to genetic variability of hybrids. Among different priming treatments, higher germination was observed when seeds received press mud which was statically as per with PEG-6000 primed seeds while lower germination is recorded in control plots. Our result is in line with Guan (2009) they reported maximum emergence in osmoprimed treated plots as compared to control, this enhancement in rate of germination is due to physiological and biological changes takes place which begins germination sequence before sowing.

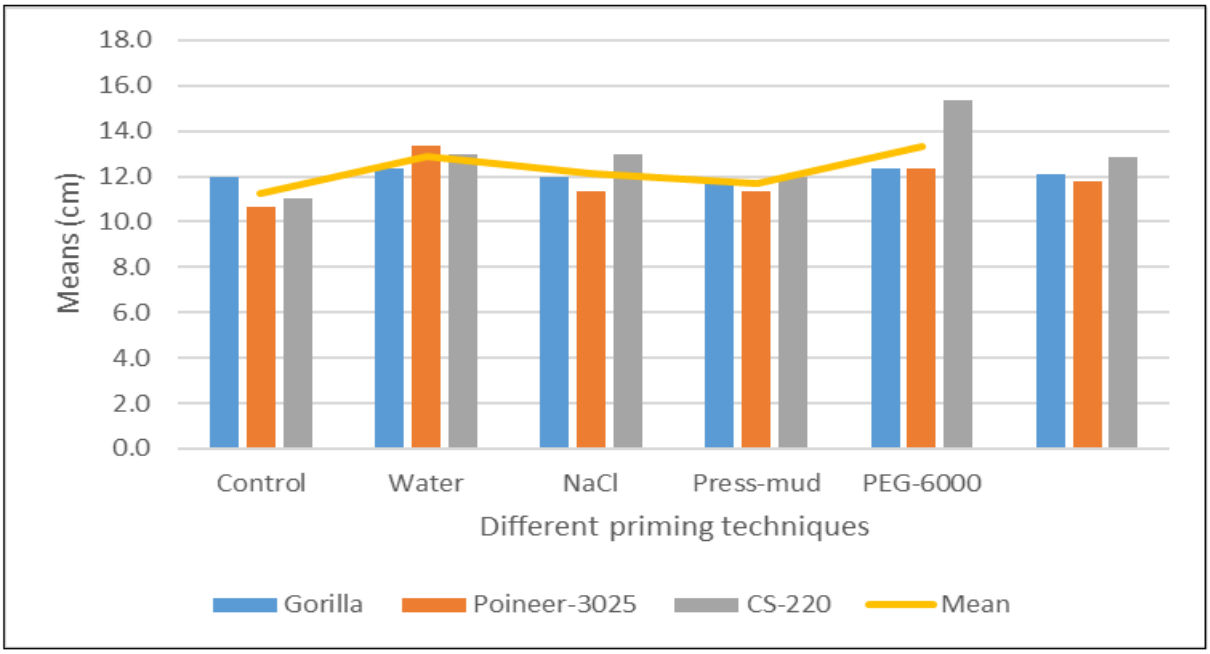

Fig. 5. Shoot Length (cm) as affected by application different priming techniques and maize hybrid varieties.

Maximum germination energy was recorded for osmo priming which was statistically similar to hydro priming and solid matrix priming and halo priming while minimum germination energy was recorded for control. Our result is in agreement with (Basra *et al.*, 2005) who reported that this improved germination energy in osmo primed seeds is due to efficient mobilization and utilization of seed reserves. In case of maize hybrids, maximum germination energy was recorded for CS-220 while minimum germination energy was recorded for Pioneer-3025 which was statistically similar to Gorilla. Similar results was reported by Khan *et al.* (2007) who reported that variation among cultivars with respect to germination energy and its related attributes may be due to genetic potentiality of these newly released maize.

Statistical analysis showed that shoot length had significantly affected by priming sources, hybrids and interaction of P × H. Mean values of the data revealed that lengthy shoot were produced by CS-220 while shorter shoot lengths were obtained from Gorilla. Our findings are in conformity with (Khan, 2007) who reported that variation among cultivars with respect to germination and its related attributes may be due to genetic potentiality of these newly released maize cultivars and their positive response to different priming technique. For priming treatments, maximum shoots lengths were obtained when seed received PEG-6000 followed by Press mud treatments while minimum shoot lengths were recorded in control plots. Similar findings were reported by (Kaya *et al.*, 2006) for primed seeds in comparison to unprimed seeds.

Priming techniques and maize hybrids had significantly affected root length while the interactive response was non-significant. The greatest shoot length) was observed for CS-220 hybrid and lowest root length was recorded for pioneer-3025. Our findings are in conformity with (Kilic *et al,* 2013) who noted significant variations for shoot and root length of wheat genotypes. Mean comparison of the data for priming treatments revealed that lengthy roots were observed for seeds treated with PEG-6000 while shorter root length were obtained in control plots. Our findings are supported by Khatami *et al.* (2015) who observed longer seedlings in prime's seeds as compared to untreated seeds.

Statistical analysis of the data showed significant effect of priming sources and different hybrids on seedling fresh weight and interaction had no significant effect. Mean comparison of the data for

hybrids showed that heavier fresh weight were produced by CS-220 hybrid which is statistically similar to fresh weight of pioneer-3025 while lighter fresh weight was produced by Gorilla hybrid.

In case of different priming sources, maximum fresh weight was produced when seeds primed with PEG-6000, followed by press mud primed seeds while minimum fresh weight was recorded in control plots. This increase in seedling fresh weight in osmo primed treated plots is due to osmotic adjustment which enhanced water absorption and turgor pressure and ultimately seedling fresh weight (Yohannes and Abraha, 2013).

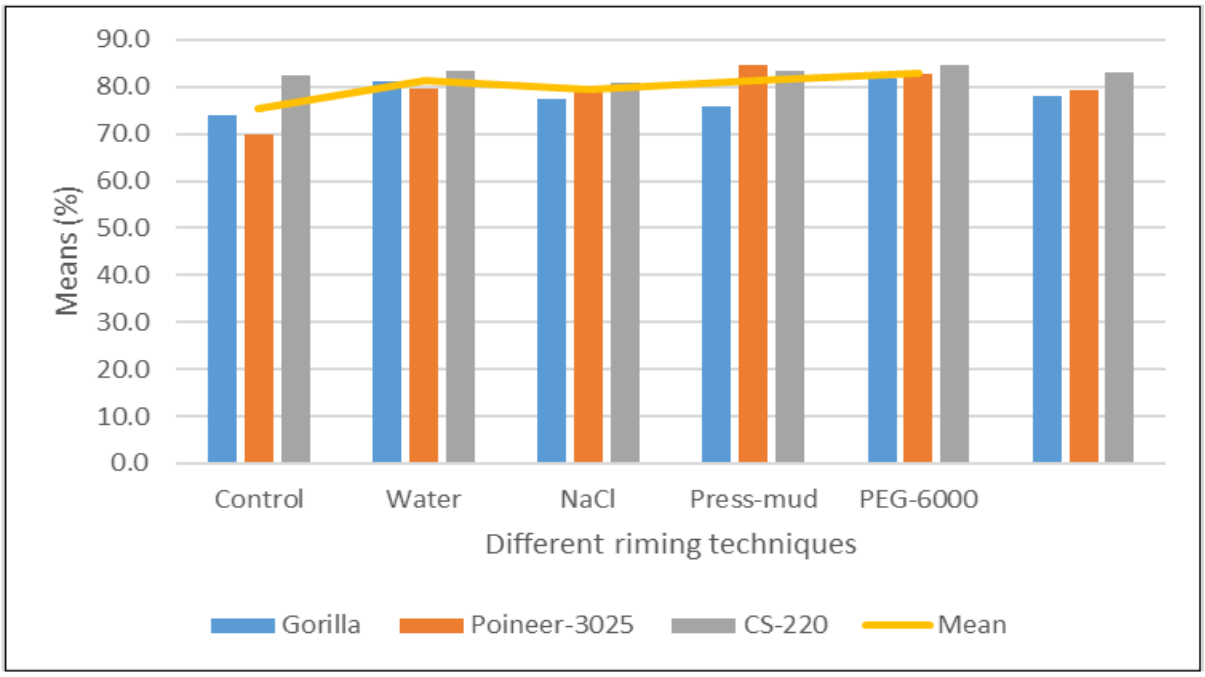

Fig. 6. Germination energy (%) as affected by application different priming techniques and maize hybrid varieties.

Statistical analysis of the data showed significant effect of priming sources and different hybrids on seedling dry weight and interaction had no significant effect. Mean comparison of the data for hybrids showed that heavier fresh weight were produced by CS-220 hybrid which is statistically similar to dry weight of pioneer-3025 while lighter dry weight was produced by Gorilla hybrid. Similar results were founded by (Rauf *et al.*, 2007) that different maize hybrids exhibited differently in response to seedling fresh and dry weight due to genetic differences.

In case of different priming sources, maximum fresh weight was produced when seeds primed with PEG-6000, followed by press mud primed seeds while minimum dry weight was recorded in control plots. Similar findings were reported by (Chiu *et al.*, 2002) they concluded that osmo priming improved germination, reduced lipid pre oxidation, enhanced anti oxidative activity and hence increased seedling growth.

Conclusion

From the current experimental observations it was concluded that Osmo priming with PEG-6000 resulted in highest germination (%), germination energy, maximum shoot and root length (cm), seedling fresh and dry weight (mg) as compared to other priming techniques. Among maize hybrids CS-220 improved crop productivity.

On the basis of above conclusion it is further recommended that osmo priming with PEG-6000 and maize hybrid CS-220 is recommended for early growth and development of maize.

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