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Growth and yield traits of maize hybrid genotypes as influenced by different priming techniques

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Abstract

A field study was conducted at university of agriculture Peshawar-Pakistan with the purpose of to investigate the influence on different seed priming techniques on different maize hybrid genotypes. The experiment was carried out in randomized complete block design (RCBD) replicated four times. Two factors experiment was performed i.e. sources of priming (Control, hydro, solid matrix priming, osmo-priming with PEG-6000) and maize hybrids (Gorilla, Pioneer 3025, CS-220). All priming techniques was done for 24 hours. Results of the experiment shows taller plants (227 cm), leaf area plant^{-1} (3179 cm^{-2}), maximum ear length (19.2 cm), grains ear^{-1} (556.2 grains), thousand grain weight (331 g), biological yield (150778 kg ha^{-1}), grain yield (5098 kg ha^{-1}) and harvest index (33.9%) was recorded with osmo-priming (PEG-6000). In folder of maize hybrids more leaf area plant^{-1} (3131 cm^{-2}) maximum ear length (19 cm), grains ear^{-1} (532.2 grains), thousand grain weight (327.8 g), biological yield (15065 kg ha^{-1}) and grain yield (4564 kg ha^{-1}) was recorded with CS-220. From the experimental results, it is concluded that CS-220 with osmo-priming (PEG-6000) is recommended for cultivation under the agro-ecological conditions of Peshawar Pakistan.

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Introduction

In Pakistan maize was grown about on area of 1140.5 thousands hectare with average yield production of about 4322 kg ha^{-1}. While in Khyber Pakhtunkhwa province it was grown on area of about 465 thousands hectare with average yield production of about 910 thousand tons (MNFSR, 2015). It contributes 6.4% of the total grain production in Pakistan and plays very important role in national economy of our country. Moreover, maize is also used for preparation of starch, corn soup, dextrose, corn syrup and corn flakes industries as raw materials (Khaliq *et al.*, 2004).

Different techniques were used to hasten the maize crop stand and to increase the average production with proper use of several mechanisms. Different seed priming techniques were also used to improve the ability of maize crop (Harris *et al.*, 2007). Priming techniques including halo-priming, hydro-priming, osmo-conditioning, osmo-priming, osmo-hardening, hardening, matrix-priming, harmo-priming and others (Basra *et al.*, 2003).

Seed priming has positive effects on germination characteristics of other crops such as corn (Murungu *et al.*, 2003). Seed priming can lead to bitter establishment in tropical crops such as maize, rice, sorghum, wheat and chickpea (Harris, 1996). Seed priming have been employed for developed resistance against several biotic stresses in wide range of field crops. Priming of seeds with zincsulphate ($ZnSO_4$) increased significantly grain yield in maize up to 26%. Seed priming in response to enzymatic activities and low temperature tolerance in different plants like maize seed priming reduces the optimum and high temperature limits for germination. Priming of maize seeds with sodium chloride (NaCl) could be important for improving vegetative growth and yield in areas that are potentially susceptible to salinity problems and totally unproductive salt affected wastelands (Guan *et al.*, 2009).

The present study was planned to view in light of the significance of seed priming for improvement of better yield and crop stand and to study the influence of different seeds priming techniques on performance of different maize genotypes under the agro-climatic condition of Peshawar-Pakistan.

Materials and methods

The experiment entitled “Response of different maize hybrid genotypes to several priming techniques” was carried out at Agronomy Research Farm and Agronomy research laboratory of the University of Agriculture, Peshawar. The experiment was carried out randomized complete block design (RCBD) for field observations. Four replications were used in the experiment. Factorial experiment was carried out 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). A plot size was 3.5 m × 4.5 m. Row to row distances for maize crop was 75 cm. Each plot had six rows. Recommended dose of phosphorus (90 kg ha^{-1}) was applied at the time of seed bed preparation and 150 kg of nitrogen was applied at a split doses (half at sowing and half at knee stage). All other agronomic practices were carried out uniformly for all the experimental units throughout the growing season. Data was observed on different yield traits of maize i.e., plant height (cm), leaf area plant^{-1}, ear length (cm), grains ear^{-1}, thousands seed weight (g), biological yield (kg ha^{-1}), grain yield (kg ha^{-1}) and harvest index (%).

Procedure for data observations

Plant height (cm); Data on plant height (cm) at physiological maturity was recorded with the help of meter rod by choosing five plants randomly from each plot and then average was taken.

Leaf area plant^{-1}(cm^2): Leaf area was calculated by measuring the length and width of all leaves of five randomly selected plants from each plot and then average was worked out to calculate leaf area plant^{-1} by using the formula:

$$\text{Leaf area plant}^{-1} = \text{Leaf length} \times \text{leaf width} \times 0.75$$

Ear length (cm): For recording data on ear length five ears were selected randomly from each plot and measured its length with the help of meter rod and then average was worked out.

Number of grains ear^{-1}: Data regarding number of grains ear^{-1} was measured by taking 5 randomly selected cobs from each plot and number of grain were counted from each cob and the average was worked out.

1000 seeds weight (g): To determine seed weight a sample of 1000-seed weight was obtained randomly from the seed lot of each plot. These samples were weighted with the help of electronic balance.

Biological yield (kg ha^{-1}): Three rows were harvested at their maturity from each plot, tied into bundles separately. The bundles were sun dried and weighed by spring balance for calculating biological yield and the data was then converted to kg ha^{-1}.

$$\text{Biological yield kg ha}^{-1} = \frac{\text{Yield from harvested area} \times 10000}{\text{area harvested}}$$

Grain yield (kg ha^{-1}): Data regarding grain yield, three central rows were harvested in each plot with the help of a sickle. Ears were removed from the harvested plants, dried, threshed and weight was done by the help of an electronic balance and the data was then converted into kg ha^{-1}.

$$\text{Grain yield} = \frac{\text{Yield from harvested area} \times 10000}{\text{area harvested}}$$

Harvest index (%): Harvest index was determined according to the formula:

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Statistical analysis

The data recorded was analyzed statistically using analysis of variance techniques appropriate for randomized complete block design using with split plot arrangement with analysis software statistix 8.1. Means was compared using LSD test at 0.05 level of probability, when the F-value is significant (Steel and Torrie 1996).

Results and discussion

Plant height (cm)

Data about plant height is presented in Fig. 1. Statistical analysis of the data indicated that plant height and priming techniques significantly affected plant height, P × H interaction was also found significant. Maximum plan height (227.7 cm) was recorded for osmo-priming which was statistically similar to solid matrix-priming (226.3 cm).

Minimum plant height (209.7 cm) was recorded for control treatment. For maize hybrids maximum plant height (225.5 cm) was recorded for Gorilla, while minimum plant height (217.4 cm) was recorded for Pioneer-3025 which is statistically similar to CS-220 (219.5 cm). Data showed that plant height was significantly affected by priming techniques and maize hybrids. While P × H interaction was found non-significant. Osmopriming resulted in maximum plant height as compared with halo-priming and hydro-priming. Earlier, Kilicet *al.* 2010 also documented higher plants for osmo-priming. Maximum plant height were recorded for Gorilla as compared with Pioneer-3025 and Cs-220. These results are in conformation with Basra *et al.*, 2002 and Subedi *et al.*, 2005, who reported that Gorilla resulted in more plant height.

Leaf area plant^{-1}

Data regarding leaf area plant^{-1} as affected by maize hybrids and priming techniques is presented in Fig. 2. Analysis of variance showed that leaf area plant^{-1} is significantly affected by maize hybrids and priming techniques, while interaction was found non-significant. Maximum leaf area plant^{-1} (3179.1 cm) was recorded for osmo-priming which is statistically similar to hydro-priming (3059.7 cm) and solid matrix-priming (3045.8 cm). While minimum leaf area plant^{-1} (2939.1 cm) was recorded for control followed by halo-priming (2982.6 cm).In folder of maize hybrids maximum leaf area plant^{-1} (3131.2 cm) was recorded for CS-220 while minimum leaf area plant^{-1} (2977.2 cm) was recorded for Pioneer-3025 which was statistically similar to (3015.4 cm) for Gorilla. Statistical analysis of the data revealed that that leaf area plant^{-1} was significantly affected by maize hybrids and priming techniques, while priming and hybrid genotypes interaction was found non-significant. Maximum leaf area plant^{-1}was recorded for osmo-priming which is statistically similar to hydro-priming while minimum leaf area plant^{-1} was recorded for control. Leaf area is one the most important plant part that produce photosynthetic product. Our results are in line with those of Akhter *et al.* 2009 who recorded more leaf area for osmo-priming. Hybrid CS-220 resulted in maximum leaf area as compared with Pioneer-3025. The same result were found by Jamal *et al.*, 2011.

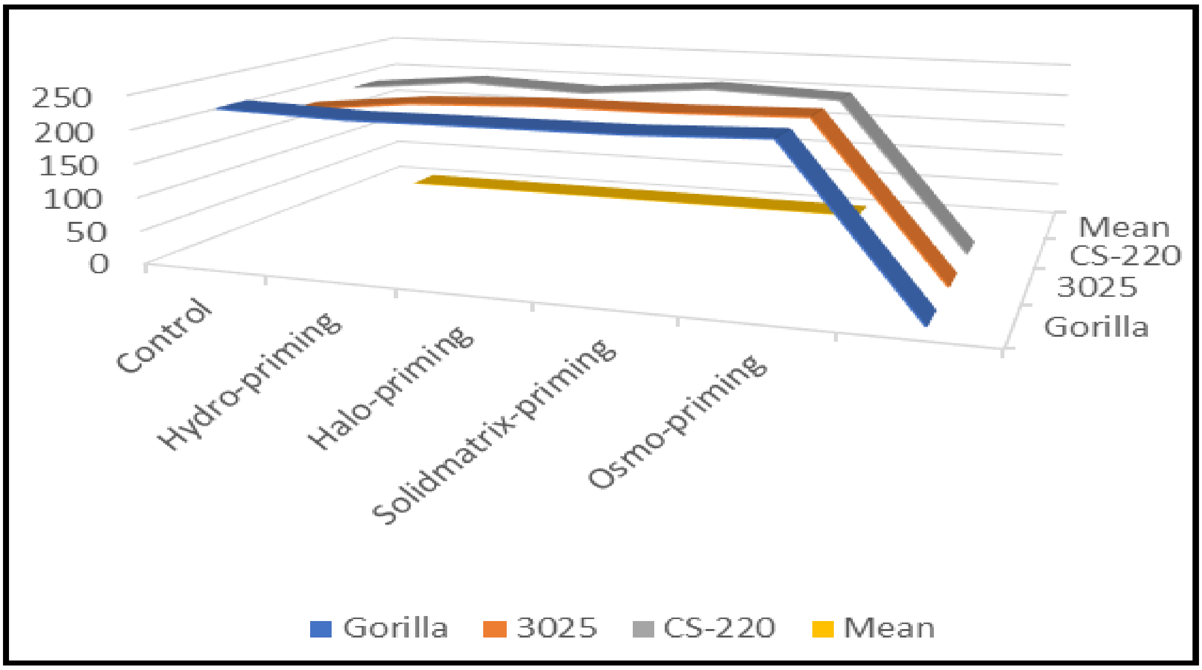

Fig. 1. Plant height (cm) of different maize genotypes as influenced by different seed priming techniques.

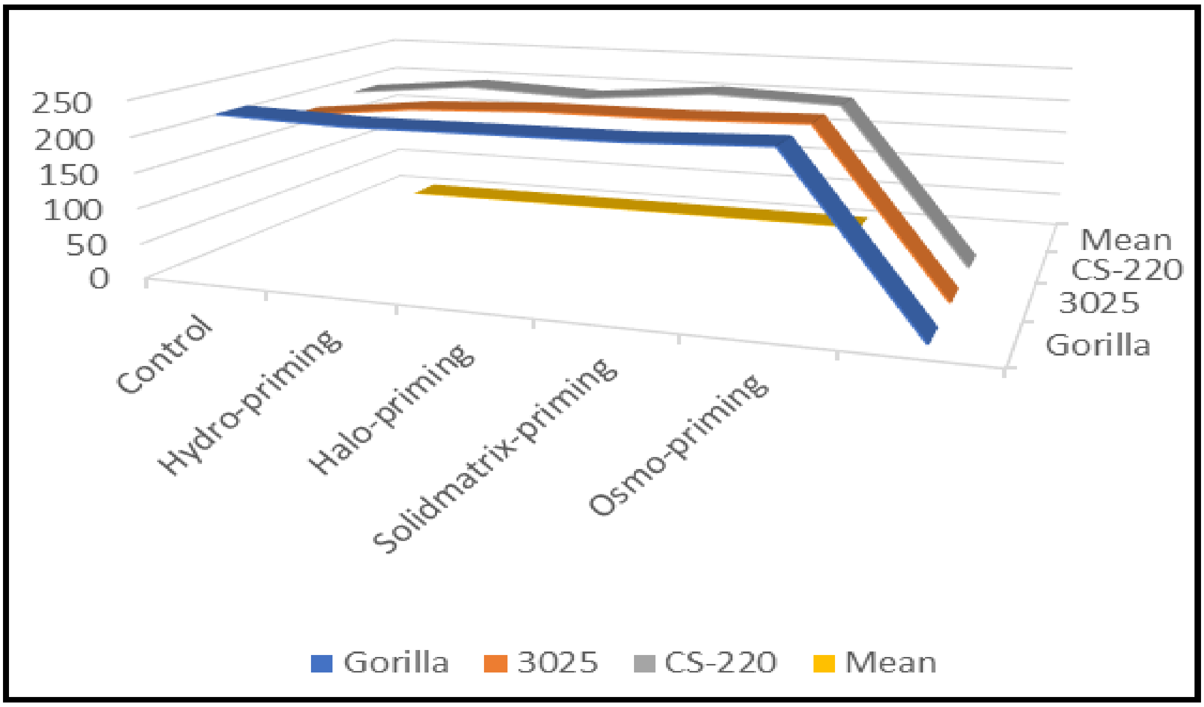

Fig. 2. Leaf area plant^{-1} of different maize genotypes as influenced by different seed priming techniques.

Ear length (cm)

Data about ear length is presented in (Fig. 3). Analysis of data showed that ear length was significantly affected by priming and maize hybrids, whereas, priming and hybrid genotypes interaction was also found significant. Maximum ear length (19.2 cm) was measured for osmo-priming which was statistically similar with halo-priming (18.7 cm) and solid matrix-priming (18.5 cm) while minimum ear length (17.9 cm) were recorded for control plots which was statistically similar with hydro-priming.

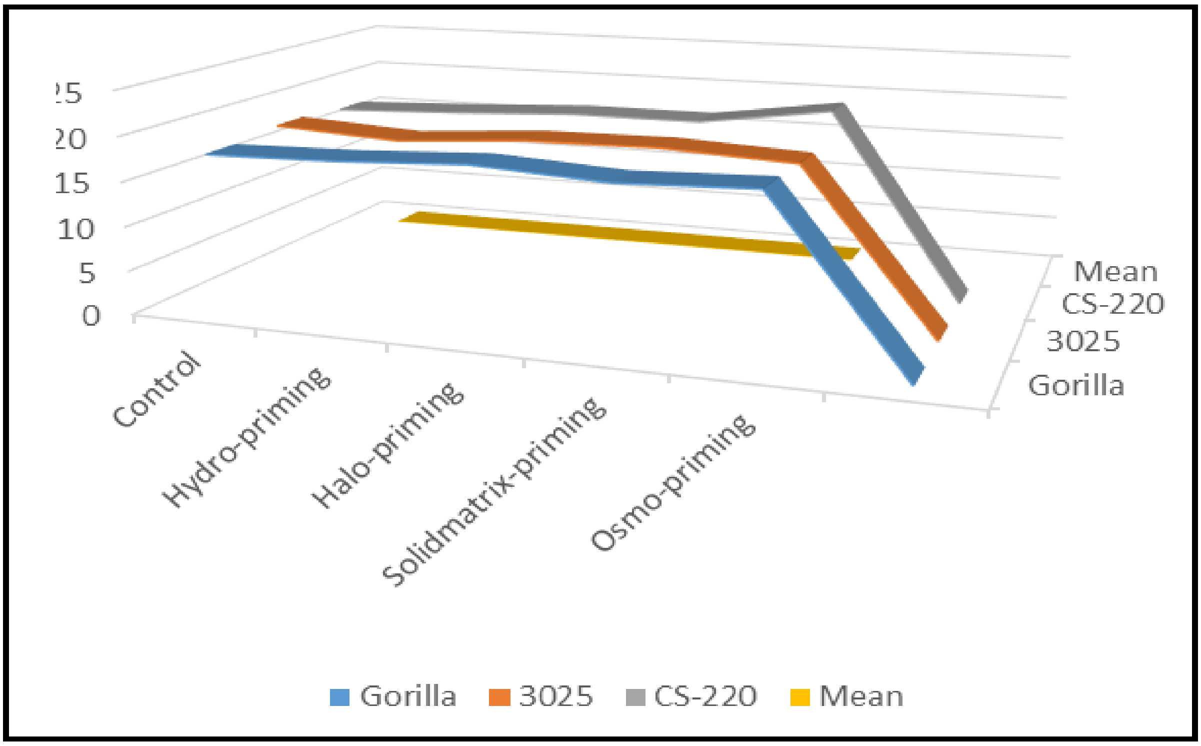

Fig. 3. Ear length (cm) of different maize genotypes as influenced by different seed priming techniques.

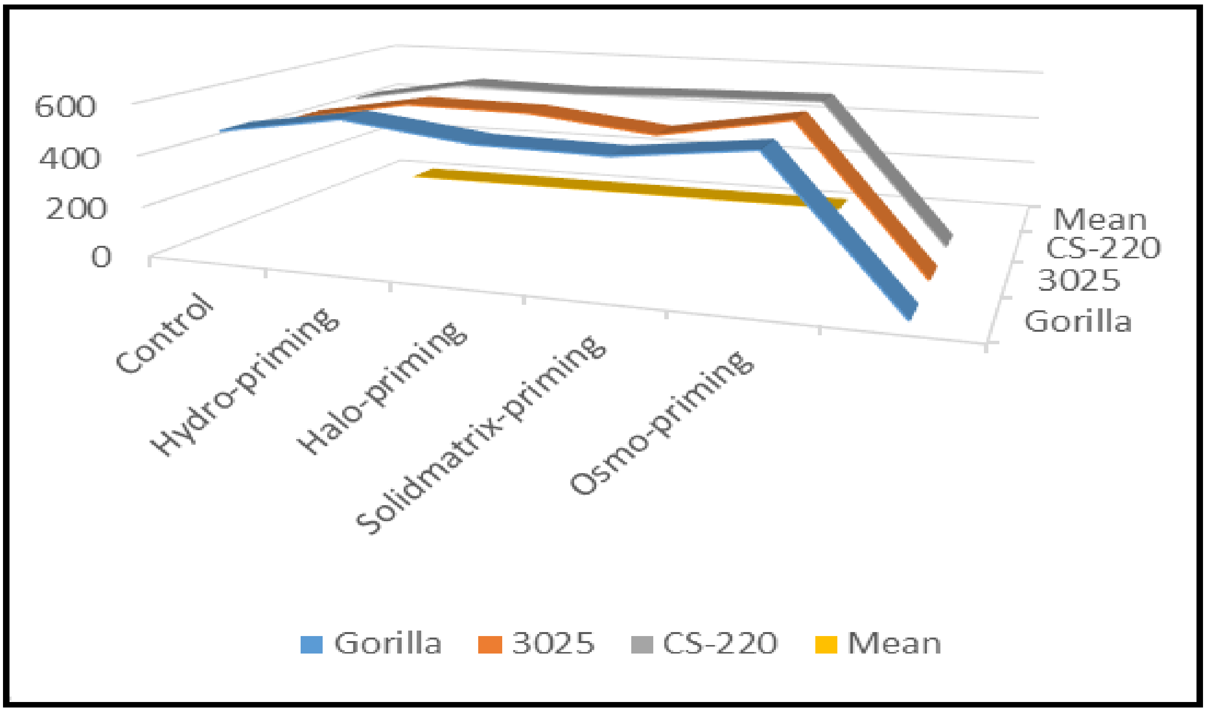

Fig. 4. Grains ear-1 of different maize genotypes as influenced by different seed priming techniques.

In case of maize hybrids maximum ear length (19 cm) was recorded for CS-220 while minimum ear length (18.1 cm) was recorded for Gorilla which was statistically similar to Pioneer-3025 (18.2 cm).Analysis of data showed that ear length was significantly affected by priming and maize hybrids, whereas, priming and hybrid genotypes interaction was also found significant (Fig.3). Maximum ear length was measured for osmo-priming which was statistically similar with halo-priming while minimum ear length were recorded for control plots.

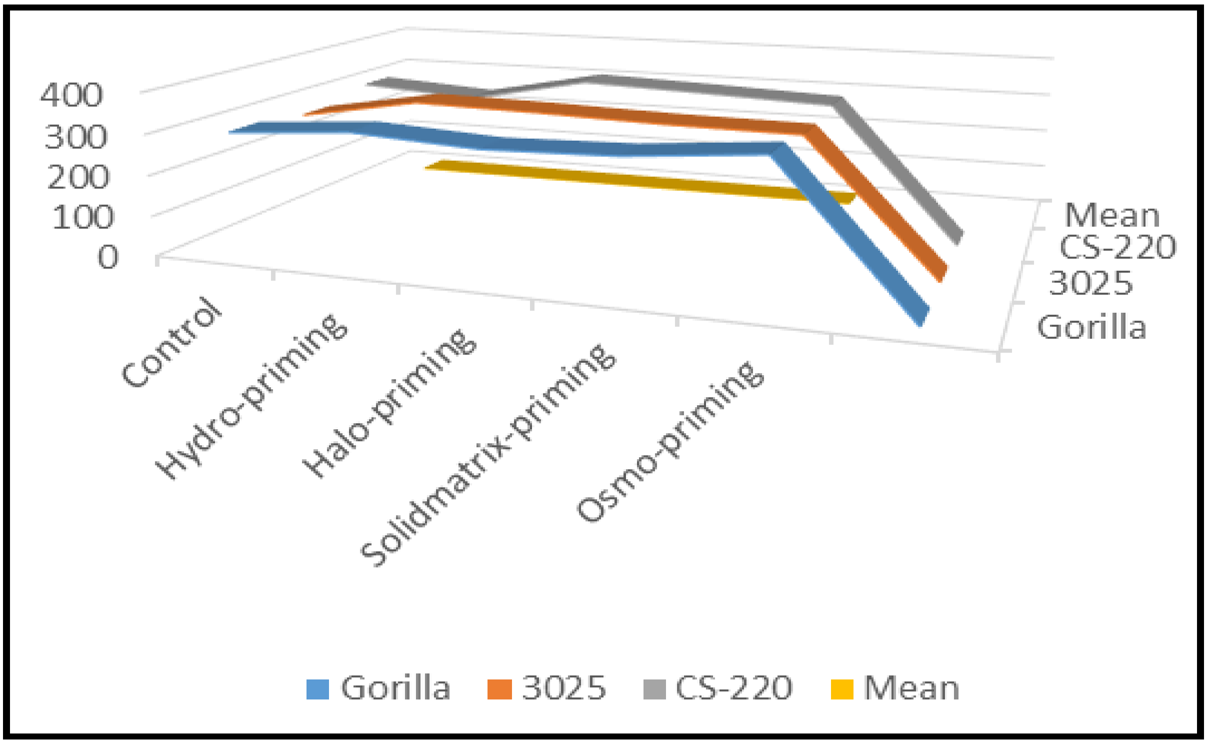

Fig. 5. Thousands grains weight of different maize genotypes as influenced by different seed priming techniques.

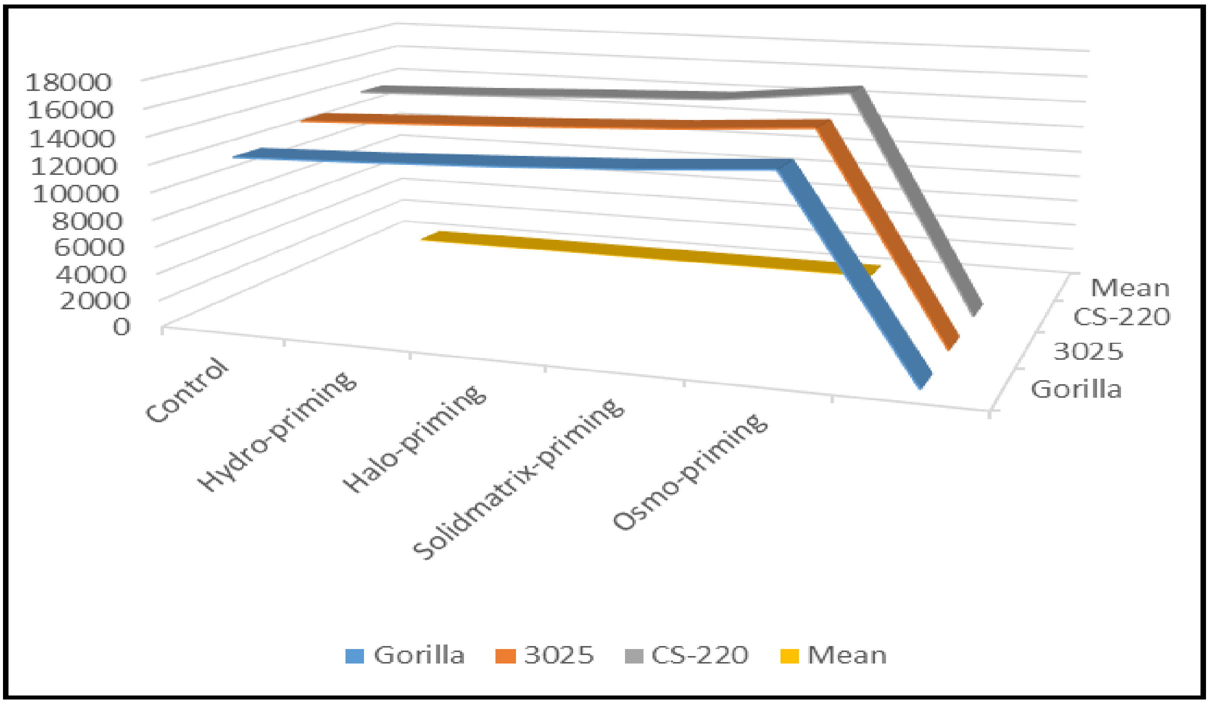

Fig. 6. Biological yield (kg ha^{-1}) of different maize genotypes as influenced by different seed priming techniques.

These results are in accordance with the findings of Andoh *et al.*, 2002 who reported more ear length for the osmo-priming. In case of maize hybrids maximum ear length was recorded for CS-220 while minimum ear length was recorded for Gorilla.

Grains ear⁻¹

Data about grains ear^{-1} is computed in (Fig 4). Statistical analysis of data showed that grains ear^{-1} was significantly affected by priming techniques and maize hybrids, similarly priming and hybrid genotypes interaction was also found significant. Maximum grains ear^{-1} (556.2 grains) were recorded for osmo-priming which was statistically similar with hydro-priming (549.1 grains) followed by halo-priming (523.6 grains) and solid matrix-priming (506.2 grains). While minimum grains ear^{-1}(468 grains) were recorded for control plots.

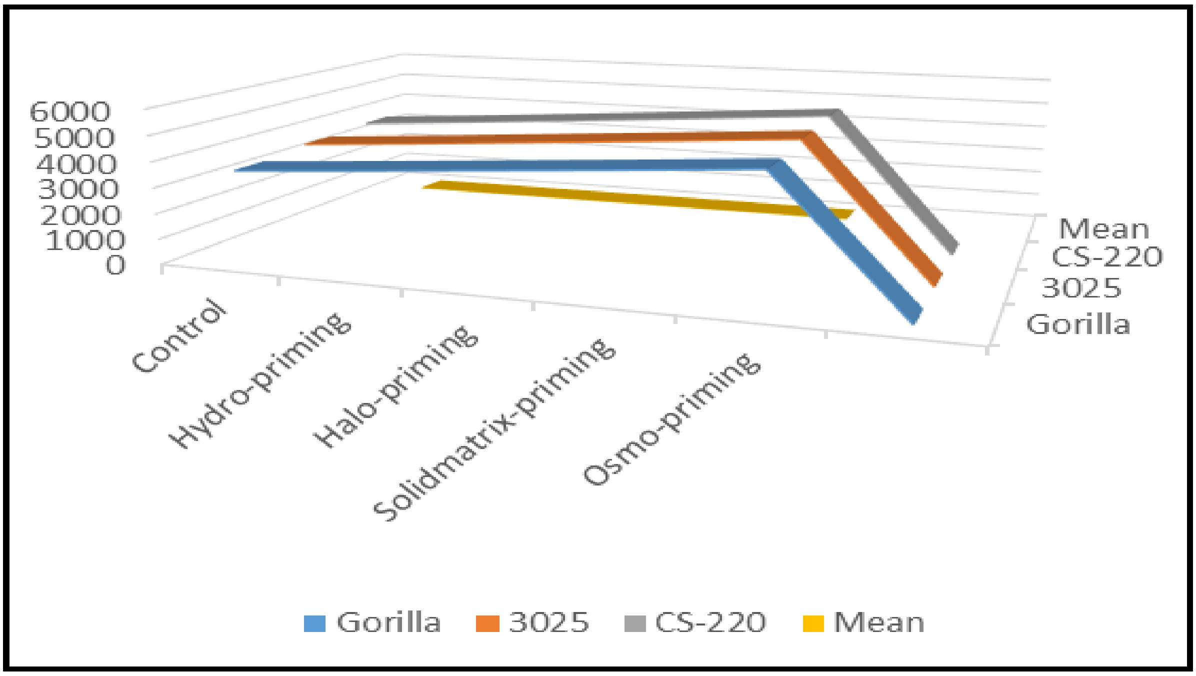

Fig. 7. Grain yield (kg ha^{-1}) of different maize genotypes as influenced by different seed priming techniques.

In case of maize hybrids maximum grains ear^{-1}(532.2 grains) were recorded for CS-220 which was statistically similar to Gorilla (515.8 grains), while minimum grains ear^{-1}(513.8 grains) were recorded for Pioneer-3025.Statistical analysis of data showed that grains ear^{-1} was significantly affected by priming techniques and maize hybrids, similarly priming and hybrid genotypes interaction was also found significant. Maximum grains ear^{-1} were recorded for osmo-priming while minimum grains ear^{-1} were recorded for control plots (Fig.4). These results are also matching with Khush *et al.*, 2008 who reported that priming had significant effect on number of grains ear^{-1}. In case of maize hybrids maximum grains ear^{-1}were recorded for CS-220 which was statistically similar to Gorilla while minimum grains ear^{-1} were recorded for Pioneer-3025. Kouio *et al.*, 2007 concluded that hybrids had significant effect on the number of grains ear.

Thousands grain weight (g)

Data about thousand grains weight is presented in (Fig. 5). Statistical analysis of data showed that priming techniques and maize hybrids significantly affected thousand grain weight. While priming and hybrid genotypes interaction was also found significant. Maximum thousand grain weight (331 g g) was recorded for osmo-priming which was statistically similar to halo priming (329.6 g) and solid matrix-priming (326.6 g). Minimum thousand grain weight (297.5 g) was recorded for control. For maize hybrids maximum grain weight (327.8 g) was recorded for CS-220 while minimum thousand grain weight (314.8 g) was recorded for Gorilla which was statistically similar to (318.0 g) for Pioneer-3025.Analysis of data showed that priming techniques and maize hybrids significantly affected thousand grain weight, priming and hybrid genotypes interaction was also found significant (Fig 5). Maximum thousand grain weight was recorded for osmo-priming while minimum thousand grain weight was recorded for control plots. Similar results were presented by Rouhi 2011, who reported that osmo-priming resulted in heavier grains.

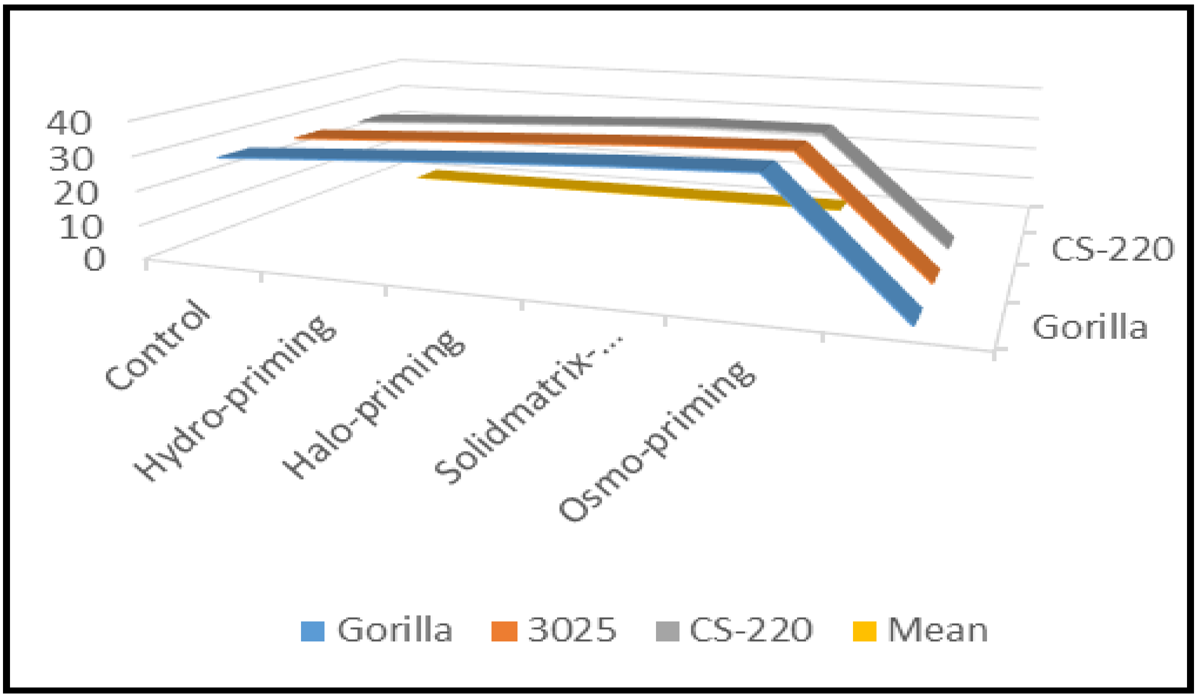

Fig. 8. Harvest index (%) of different maize genotypes as influenced by different seed priming techniques.

Biological yield, grain yield (kg ha⁻¹) and harvest index

Data regarding biological yield (kg ha^{-1}) is presented in Fig 6. Analysis of variance showed that biological yield was significantly affected by priming techniques and maize hybrids, whereas priming and hybrid genotypes interaction was found non-significant. Maximum biological yield (15078 kg ha^{-1}) was recorded for osmo-priming followed by (14361 kg ha^{-1}) solid matrix-priming. While minimum biological yield (13383 kg ha^{-1}) was recorded for control plots. In case of maize hybrids maximum grain yield (15065 kg ha^{-1}) was recorded for CS-220 followed by Pioneer-3025 (14199 kg ha^{-1}). While minimum biological yield (13019 kg ha^{-1}) was recorded for Gorilla. Data about grain yield (kg ha^{-1}) is computed in (Fig 6). Statistical analysis of data showed that grain yield ha^{-1} was significantly affected by priming techniques and maize hybrids, whereas priming and hybrid genotypes interaction was found non-significant. Maximum grain yield (5098 kg ha^{-1}) was recorded for osmo-priming followed by solid matrix-priming (4743 kg ha^{-1}). While minimum grains yield (3733 kg ha^{-1}) was recorded for control plots. For maize hybrids maximum grain yield (4564 kg ha^{-1}) was recorded for CS-220 while minimum grain yield (4224 kg ha^{-1}) was recorded for Gorilla. Data regarding harvest index is presented in (Fig 8).

Analysis of variance showed that harvest index was significantly affected by priming techniques and maize hybrids, while priming and hybrid genotypes interaction was found non-significant. Maximum harvest index (33.9 %) was recorded for osmo-priming followed by solid matrix-priming (33.1 %), while minimum harvest index (27.9 %) was recorded for control plots. For maize hybrids maximum harvest index (32.4 %) was recorded for Gorilla while minimum harvest index (30.2%) was recorded for CS-220.

Osmo priming technique improved the grain yield, biological yield and harvesting index over control under both factors (4, 5, 6). However, maximum biological yield was recorded from osmo-priming followed by solid matrix priming. Similarly osmo-priming were the best to improve grain yield. Likewise, highest harvest index was noted for osmo-priming while minimum harvesting index was observed in control plots. Rehman *et al.*, 2014 stated that priming improving seed vigor corn. Rehman *et al.,* 2011 reported that priming increased yield of maize. Kurdikeri *et al.*, 1995 supported that biological yield, grain yield and harvest index was recorded higher for osmo priming while lower for control plots. These results are also in line with Sallam, 1999 and Rehman *et al.*, 2011. Improved yield performance by seed osmo-priming had been reported in maize crop under field conditions (Liu *et al.*, 2002).

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