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Impact of different priming methods on the performance of Maize (*Zea mays* L.)

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Abstract
For better cereal production, good stand establishment and seedling emergence are necessary parameters. Seed priming is a very best option to improve stand establishment which ultimately improve the crop yield. The main objective of this experiment was to evaluate efficiency of various seed priming techniques on growth and yield of maize. The treatments of the experiment were Control, hydro-priming, urea priming, zinc priming and moringa leaf extract (MLE) priming on two maize hybrids i.e. Pioneer 30T60 and Rustam12. The experiment was conducted under field conditions in Multan, Punjab, Pakistan during winter, 2016-17. The trial was laid out in randomized complete block design (RCBD) with factorial arrangement having three replications. Priming methods and maize cultivars significantly affected all yield related parameters. Pioneer 30T60 gave maximum values for all yield related parameters. The maximum values for all parameters like plant height, average cob length, number of cobs per plant, number of grains per cob, chlorophyll contents, 1000-grains weight, biological yield and grain yield were recorded where maize seeds were primed with urea solution.

Keywords: seed priming, hydro-priming, urea priming, zinc priming, MLE priming, RCBD

Introduction

Maize is an important cereal crop after wheat and rice in all over the world (Farina and Shafie, 2015) [10] including Pakistan (GOP, 2017) [18]. It is mostly utilized as food and feed for humans and livestock around the globe respectively (Hossain and Shahjahan, 2007) [20]. Grains of maize are generally used by humans directly or after processing and maize stalks can be consumed as forage, feed and making silage after fermentation (GOP, 2017) [18].

Poor stand establishment is the major constraints for lower maize yield. Better yield as a result of improved stand establishment have been observed in many crops due to different seed priming techniques (Farooq *et al.*, 2008) [15]. Seed priming played an important role in improving the seed performance under field and controlled conditions (Amin *et al*., 2016) [3]. Several vegetables, cereals as well as ornamental crops have been primed effectively for better seed quality and durability. Fast and homogenous crop emergence are two main essentials which plays their role in improving crop productivity. Final yield and quality of direct seeded crops are mainly affected by homogeny and percentage of seedling emergence (Khan *et al.*, 2016) [3]. Mostly, seed priming reduced the emergence time and emergence percentage of sweet corn seedlings (Chiu & Sung, 2002) [7]. It showed positive response in improving stand establishment under semi-arid (Clark *et al.*, 2001) [8] and drought conditions (Kaur *et al.*, 2002) [22], getting better the seed with low vigor (Bittencourt *et al.*, 2005) [6], breaking down the seed dormancy (Farooq *et al.*, 2005) [5] or improving yield of the crop (Hussein *et al.*, 2007) [21].

Different seed priming techniques have been developed which include hydro-priming, halo-priming, osmo-priming and hormonal priming. In hydro-priming, crops seeds are imbibed in water for whole night, drying under shade and sowing is done at same day. Osmo-priming is done in osmotic solution followed by drying previous to sowing (Ashraf and Foolad, 2005) [4]. Halo-priming refers to soaking of seeds in solution of inorganic salts i.e NaCl, KNO3, CaCl2 and CaSO4 etc. and Hormonal priming is the pre - seed treatment with different hormones like GA3, kinetin, ascorbate etc. (Singh *et al*., 2015) [24]

Basra *et al*. (2005) [5] showed that seed soaking technique can improve germination and crop establishment. Seed priming with zinc solution significantly improved the grain yield of wheat (16%) and maize (26%) (Haris *et al*., 2007). The seedlings and stand establishment of rice significantly affected by the priming with $CaCl_2$ (Farooq *et al*., 2006c) [16]. Farroq *et al*. (2008a) [15] reported the improved low temperature tolerance in late sown wheat by $CaCl_2$ priming.

Priming with CaCl2 is considered as the most effective technique in order to improve the growth of rice nursery seedling (Farooq *et al*., 2007b) [13] and stand establishment in coarse and fine rice (Farooq *et al*., 2006c) [16]. In another study, Farooq *et al*. (2008a) [15] stated that improved low temperature tolerance in late sown wheat by seed priming with CaCl2. Biochemical and photosynthetic functions were increased due to priming with salicylic acid and increased the root and shoot growth of rice (Dashtmian *et al*., 2014) [9]. Ahmadvand *et al*. (2012) [2] concluded that priming with KNO3 in soybean got better the germination and seedling dry weight. Seed priming of maize with moringa leaf extract improved germination index by reducing mean germination time which at the end improved the seedling growth (Afzal *et al*., 2012) [1]. In another study, application of moringa extended the leaf area duration and biological yield of wheat (Yasmeen *et al*., 2012) [26]. For that reason, this study was accomplished to investigate the beneficial effects of different priming techniques on maize.

Materials and method

Seed material and experimental details

Seeds of maize hybrid cultivars i.e. Pioneer 30T60 and Rustam12 were taken from Monsanto private Ltd., Pakistan. The study was conducted at agronomic research area, Bahauddin Zakariya University, Multan during autumn 2017. Experiment was comprised of two maize hybrids (Pioneer 30T60 and Rustam12) and five priming methods (Control, Hydro-priming, Urea priming, Zinc priming and priming with Moringa leaf extract solution).

The experiment was carried out in Randomized Complete Block Design (RCBD) with factorial arrangement having three replications. The net plot dimension of each unit was 5.0 m × 3.0 m. The P-P (plant to plant) space was 20.0 cm whereas R-R (row to row) spacing was 75.0 cm. Recommended seed rate of 20 kg ha^{-1} was used for sowing and fertilizer N: P: K (200:150:100 kg/ha) was applied. All other agronomic and plant protection measures were uniform for all treatments. Data on plant height, average cob length, number of cobs per plant, number of grains per cob, chlorophyll contents, 1000-grains weight, biological yield and grain yield were recorded using standard procedure.

Seed priming protocol

Untreated seeds were taken as control treatment. For hydro-priming, seeds were soaked in distilled water for 12 hours. Seeds were osmoprimed in urea solution with -1.2MPa osmotic potential for 12 hours. For zinc priming, maize seeds of both cultivars were imbibed in zinc solution for 12 hours while for moringa leaf extract priming, seeds were soaked in 3% MLE solution. After soaking, seeds were desiccated to their original weight under shade.

Statistical analysis

Recorded data of all parameters were investigated by using Fisher's method of analysis of variance (ANOVA) to compare the variation in between the treatment means through least significance difference test at 5% probability level (Steel *et al.,* 1997) [25].

Results

Both maize cultivars differ significantly for plant height, average cob length, number of cobs per plant, number of grains per cob, chlorophyll contents, 1000-grains weight, biological yield and grain yield. Similarly, different priming methods on maize seeds positively affected the plant height, average cob length, number of cobs per plant, number of grains per cob, chlorophyll contents, 1000-grains weight, biological yield and grain yield. The interaction of maize cultivars and priming methods were also significant for plant height, average cob length, number of cobs per plant, number of grains per cob, chlorophyll contents, 1000-grains weight, biological yield and grain yield (Table 1).

The maximum plant height (197.10 cm), average cob length (18.18 cm), number of cobs per plant (1.72), number of grains per cob (388.13), chlorophyll contents (40.82), 1000-grains weight (278.67 g), biological yield (15.30 t ha^{-1}) and grain yield (6.65 t ha^{-1}).was observed in Pioneer 30T60. Whereas maximum plant height (209.68 cm), average cob length (20.40 cm), number of cobs per plant (2.23), number of grains per cob (429.00), chlorophyll contents (44.02), 1000-grains weight (303.00 g), biological yield (16.01 t ha^{-1}) and grain yield (7.04 t ha^{-1}).were recorded where priming of urea was done (Table 1).

Discussion

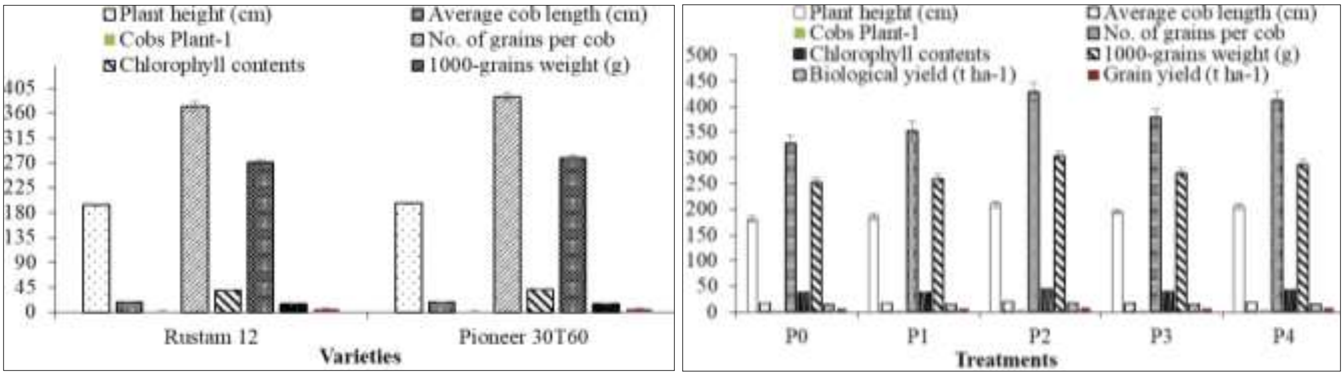
Use of different priming methods with both maize hybrids significantly affected yield related traits. Result shows that all studied parameters were affected by all priming methods as compared to control (Table 1). It is understood that primed seeds attain most excellent performance due to repair mechanisms, reformation of membrane and well-organized reserve system (Fialho *et al*., 2010) [17]. Seed priming plays a role in starting metabolic processes in the seeds. When seeds are desiccated to their original weight, these processes become inactive as a result of decline in starch metabolism (Farooq *et al*., 2010a) [27].

All the priming techniques especially urea priming significantly improve morphological and yield parameters due to better stand establishment of the crop (Table 1). When stand establishment of the crop is better, the plant growth is improved which have a propensity for longer roots that can enter into the soil and receive more water and nutrients as compared to non-primed seeds (Alam *et al*., 2013) [28]. As a result, higher grain yield was observed in primed seeds due to early stand establishment which probably played their role in enhancing crop growth and ultimately the yield parameters and grain yield (Table 1).

Table 1: Effect of different priming methods on growth and yield contributing parameters of maize

Treatments	Plant height (cm)	Average cob length (cm)	Cobs $Plant^{-1}$	No. of grains per cob	Chlorophyll contents	1000-grains weight (g)	Biological yield (t ha^{-1})	Grain yield (t ha^{-1})
Maize Cultivars (V)								
V_1	194.08 B	17.80 B	1.60 B	372.07 B	39.75 B	270.07 B	14.73 B	6.26 B
V_2	197.10 A	18.18 A	1.72 A	388.13 A	40.82 A	278.67 A	15.30 A	6.65 A
LSD	2.59	0.31	0.09	5.35	0.26	3.75	0.15	0.10
Priming methods (P)								
P_0	181.32 E	16.83 D	1.18 D	327.50 E	37.42 E	252.33 E	14.31 D	6.00 D
P_1	186.35 D	17.11 CD	1.35 C	353.17 D	37.95 D	259.00 D	14.77 C	6.30 C
P_2	209.68 A	20.40 A	2.23 A	429.00 A	44.02 A	303.00 A	16.01 A	7.04 A
P_3	195.23 C	17.36 C	1.46 C	378.50 C	39.06 C	270.83 C	14.80 C	6.37 BC
P_4	205.35 B	18.25 B	2.06 B	412.33 B	42.92 B	286.67 B	15.20 B	6.54 B
LSD	4.10	0.49	0.15	8.47	0.41	5.93	0.25	0.17

V_1= Rustam12; V_2 Pioneer 30T60; P_0= Control; P_1= Hydro-priming; P_2= Urea priming; P_3= Zinc priming; P_4= Moringa leaf extract (MLF)



V_1= Rustam12; V_2 Pioneer 30T60; P_0= Control; P_1= Hydro-priming; P_2= Urea priming; P_3= Zinc priming; P_4= Moringa leaf extract (MLF)

Fig 1

Conclusion

Urea primed seeds show highest result from all above findings we concluded that the priming techniques that were used in this experiment are efficient and helpful in plant morphological development and grain yields as compared to control.

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