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Efficacy of seed priming techniques on performance of maize hybrids in Multan

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Abstract

The present study was conducted to evaluate the efficacy of seed priming technologies on the performance of hybrid maize cultivated under different sowing times at University College of Agriculture, Bahauddin Zakariya University, Multan during 2011. The crop was cultivated on 1st March resulted maximum cob length, number of grains per cob, 1000-grain weight while differing maize hybrids showed non-significant effect on number of rows per cob. However maize hybrid i.e. Syngenta-NK-8441 enhanced entire yield components compared to Pioneer-32B33.Different yield components were non-significantly affected by different seed enhancement techniques except grain yield which was higher in control seeds compared with hydro and osmo-priming. 1st March sown crop enjoyed the favorable environmental conditions and resulted longer primary root along with higher number of lateral roots and root growth rate. Maize hybrid Pioneer-32B33 results in well developed root system due to its genetic makeup. The effect of seed priming techniques was non-significant on root system.

Keywords: *Zea mays* L. ; Hybrid; Varieties; Priming; Techniques, Punjab, Pakistan

Introduction

Maize (*Zea mays* L.) an important cereal crop, cultivated throughout the world, is of significant importance for countries like Iran, where rapid increase in population have already out stripped the available food supplies (Golbashy *et al*., 2010). In Pakistan corn is grown on an area of 0.93 million hectares with a total annual production of 3.3 million tones and shows an average seed yield of 3.61 tha^{-1} (Anonymous, 2010). Approximately 83% of the total area under maize is cultivated by the use of hybrid seeds however average yield of maize in the country is below to potential yield. Genetic development in traits shows economic significance along with maintaining adequate amount of variability is always the objective in maize breeding programs (Hallauer *et al*., 1973). Grzesiak (2001) observed significant genotypic inconsistency among various maize genotypes for diverse characters. Ihsan *et al*. (2005) reported momentous genetic variability for morphological parameter for maize genotypes. This changeability is a key to crop improvement (Welsh, 1981). Distinctive responses to priming are faster to emergence over all seedbed environments, leading to improved crop stands, and therefore improved yield and product quality (Halmer, 2004). The primed seeds germinate quickly and come out more speedily than non-primed seeds, particularly under low temperatures (Bodsworth & Bewley, 1981; Murray, 1990; Zheng *et al*., 1994). Although appropriate exogenous application of plant hormones along with nutrients, antioxidants, organic and inorganic chemicals promotes plant growth, however, this technique is not cost effective and out of the reach of farmers. So efforts should be made to explore the cheaper and best alternatives of expensive priming agents. Environmental changes associated with different sowing dates (sunshine, temperature) have a modifying effect on the growth and development of maize plants. Each hybrid has an optimum sowing date, and the greater the deviation from this optimum (early or late sowing), the greater the yield loss (Sárvári and Futó, 2000; Berzsenyi and Lap, 2001). Planting date was reported to affect the growth and yield of maize significantly. To date, the challenge for maize growers is finding the narrow window between planting too early and planting too late (Nielson *et al*., 2002). Good quality seeds imply vigour, uniformity and structural soundness besides its genetic and physical purity. Seed priming, identified as an effective seed invigoration method has become a common seed treatment to increase the rate and uniformity of emergence and crop establishments. Several literatures exposed that seed priming could advance germination, perk up the preliminary quality characters, advance field emergence, superior establishment and crop stand and thus augment yields in many diverse environments. Amarjit *et al*., (1988) found that priming maize seed with 2.5% K_2HPO_4 and 2.5% K_2HPO_4+KNO_3 accelerated germination even at a chilling temperature and the effect of priming was largely retained after seeds had been dried back. Harris *et al*., (1999) soaked the maize seeds for 8 hrs in distilled water and in 200ppm of NaCl, KCl, and $CaCl_2$ to alleviate the adverse effects of salt stress on maize at germination stage and found that $CaCl_2$ proved to be more effective, showing higher germination per cent, rate of germination and fresh and dry weights of plumules and radicles than those primed with other salts and distilled water. Seed priming with salicylic acid increased germination under low temperature condition (Sedghi *et al*., 2010) and improved chilling tolerance faster, synchronous emergence of maize by activation of antioxidants, maintenance of tissue water contents and reduced membrane permeability (Farooq *et al*., 2008). Seed priming with ascorbic acid (Athar *et al*., 2008), H_2O_2 (Wahid *et al*., 2007) and salicylic acid induced salinity tolerance (Gautam and Singh, 2009). Thus, it seems that ascorbic acid, salicylic acid and hydrogen peroxide are promising materials for seed treatments. In the present study, the effects of seed priming with different concentration of ascorbic acid, salicylic acid and hydrogen peroxide were investigated. For better understanding the results, hybrid-maize was used to determine germination and seedling growth in relation to physiological changes under low temperature stress after the seed priming.

Materials and Methods

The present study was conducted to evaluate the efficacy of different seed priming techniques on the performance of maize hybrids planted under different planting dates at Agronomic Research Area, Bahauddin Zakariya University, Multan during 2011. Pre-soaking irrigation of 10 cm was applied in the field. The seedbed was prepared 2-3 times with tractor-mounted cultivator followed by planking at required moisture level. The experiment was laid out in randomized complete block design (RCBD) with split-split plot arrangements having net plot size of 4 m x 3 m and replicated four times. The Maize Hybrid (H_1= Pioneer-32B33 and H_2= Syngenta-NK-8441) were sown on 29th Jan, 14th Feb and 1st March 2011. Seed priming techniques were used as Hydro priming with distilled water (P_2) and Osmo priming with $CaCl_2$ (P_3) compared to Control (P_1). Maize crop was cultivated by hand dibbling on ridges however row to row distance was kept (75 cm) and plant to plant (20 cm). Nitrogenous fertilizer was applied @ 200 kgha^{-1} in the form of urea and 150 kgha^{-1} phosphorus in the form of DAP. Full dose of phosphorus and one third dose of nitrogen was broadcasted in sowing. 2nd one third dose of nitrogen was applied at the time knee height stage and remaining nitrogen was `applied at tasseling. After first irrigation, hoeing was done to keep crop free from weeds and earthing up was applied. Carbofuran 5% Granules applied @ 25 kgha^{-1} for controlling shoot fly however three grains of insecticide per head was applied on the top portion of the plant. Crop was harvested on different dates when reached to harvest maturity.

Total number of rows per cob, number of rows of 10 randomly selected cobs from each plot were counted and then take its average. For calculation of grains per cob 10 randomly selected cobs from each plot were threshed manually. Their total grains were counted and then taken its average to get number of grains per cob. 1000-grain weight (g) was calculated by taking five samples, each of 1000-grains were randomly taken from the seed lot of each plot, weighed and then taken its average to calculate 1000-grain weight**.** Length of primary root (cm) and lateral roots were determined at fortnight intervals by selecting five plants randomly from each subplot. The sampling was started 30 days after sowing (DAS). Plants were uprooted with extensive care to avoid roots damage, washed with water and air dried. Length of primary root was calculated by measuring tape and then taken its average. Data regarding all the parameters were collected using standard procedures and were analyzed by using Fisher's analysis of variance technique and LSD test at 5% probability will be used to compare the differences among treatments' means (Steel *et al*., 1997). All other agronomic and plant protection measures were kept constant to avoid any biasness.

Results and Discussion

Number of rows per cob

From table-I that individual and interactive effects of all the factors included in the study except planting dates, maize hybrids and seed priming techniques showed non significant effects while interactions among planting dates, maize hybrids and seed priming protocols had significant effects on number of rows per cob. The interactions among sowing dates, varying maize hybrids and seed priming techniques interactions maximum number of rows per cob was produced in hydro primed seeds of NK-8441 in 1st Feb sowing against the minimum in both the hybrids in all seed priming techniques along with control in 14th Feb and 1st March sown crop. These results are in line with Mujtaba, 2001.

Table.I. Effect of different seed enhancement techniques on rows per cob of varying maize hybrids grown under different sowing dates

Sowing Dates	D_1		D_2		D_3		Means
Hybrids	H_1	H_2	H_1	H_2	H_1	H_2	**Priming**
P_1	12.70 b	12.93 b	13.97 ab	14.10 ab	12.69 b	12.12 b	13.08
P_2	12.77 b	17.77 a	14.37 ab	14.17 ab	13.09 ab	12.19 b	14.05
P_3	13.07 ab	12.77 b	14.00 ab	13.90 ab	12.72 b	11.92 b	13.06
Means Sowing Dates	13.66		14.08		12.45		
Means Hybrids	13.26			13.54			

D×H	12.84	14.49	14.11	14.06	12.83	12.08			
H×P	13.12	13.41	13.26	13.05	14.71	12.86			
D×P	12.82	15.27	12.92	14.03	14.27	13.95	12.40	12.64	12.32

Means not sharing the same letters within a column or a row differ significantly from each other at 5% level of probability

LSD at 5% D = NS; H = NS; P = NS; D×H = NS;H×P = NS; D×P = NS; D×H×P = 4.78

Number of grains per cob

From table-II the statistical analysis revealed that different planting dates showed significant effect while maize hybrids and different seed priming techniques showed non-significant effects on number of grains per cob. Regarding different interactions among the factors included in the study, maize hybrids and planting dates interactions does not produced significant differences with respect to each other while, all other interactions were statistically different. Maximum grains per cob were produced in 14th Feb and 1st March sown crop against the minimum in 1st Feb sown crop. Maize hybrids and different seed enhancement techniques do not differed significantly. Regarding interactions among maize hybrids and different sowing dates maximum number of grains per cob was resulted in maize hybrid P-32B33 in 14th Feb sowing while minimum was the outcome in both the hybrids in 1st Feb sowing. Likely in case of interactions among different planting dates and seed priming techniques maximum and minimum number of grains per cob was the result in all the seed enhancement techniques along with control treatment in 14th Feb and 1st March and 1st Feb sown crop. Conversing about the interactions among all the three factors studied maximum and minimum number of grains per cob were produced in hydro and osmo-primed seeds of both the maize hybrids along with control in 14th Feb and 1st March and 1st Feb sowing. These results are in line with Mujtaba, 2001.

Table.II Effect of different seed enhancement techniques on grains per cob of varying maize hybrids grown under different sowing dates

<table>
<tr><th>Sowing Dates</th><th colspan="6">D1</th><th colspan="6">D2</th><th colspan="6">D3</th><th colspan="3" rowspan="2">Means Priming</th></tr>
<tr><th>Hybrids</th><th colspan="3">H1</th><th colspan="3">H2</th><th colspan="3">H1</th><th colspan="3">H2</th><th colspan="3">H1</th><th colspan="3">H2</th></tr>
<tr><td>P1</td><td colspan="3">298.2 b</td><td colspan="3">306.2 b</td><td colspan="3">459.0 a</td><td colspan="3">439.8 a</td><td colspan="3">449.5 a</td><td colspan="3">433.8 a</td><td colspan="3">397.77</td></tr>
<tr><td>P2</td><td colspan="3">301.6 b</td><td colspan="3">300.8 b</td><td colspan="3">455.9 a</td><td colspan="3">441.9 a</td><td colspan="3">423.5 a</td><td colspan="3">428.3 a</td><td colspan="3">391.99</td></tr>
<tr><td>P3</td><td colspan="3">313.0 b</td><td colspan="3">288.9 b</td><td colspan="3">420.8 a</td><td colspan="3">439.3 a</td><td colspan="3">427.8 a</td><td colspan="3">435.9 a</td><td colspan="3">387.61</td></tr>
<tr><td>Means Sowing Dates</td><td colspan="7">301.46 B</td><td colspan="7">442.78 A</td><td colspan="7">433.14 A</td></tr>
<tr><td>Means Hybrids</td><td colspan="10">394.37</td><td colspan="11">390.54</td></tr>
<tr><td>D×H</td><td colspan="3">304.3 C</td><td colspan="3">298.6 C</td><td colspan="3">445.2 A</td><td colspan="3">440.3 AB</td><td colspan="3">433.6 B</td><td colspan="6">432.7 B</td></tr>
<tr><td>H×P</td><td colspan="3">402.2</td><td colspan="3">393.7</td><td colspan="3">387.2</td><td colspan="3">393.3</td><td colspan="3">390.3</td><td colspan="6">388.0</td></tr>
<tr><td>D×P</td><td colspan="2">302.2 B</td><td colspan="2">301.2 B</td><td colspan="2">301.0 B</td><td colspan="2">449.4 A</td><td colspan="2">448.9 A</td><td colspan="2">430.0 A</td><td colspan="2">441.7 A</td><td colspan="2">425.9 A</td><td colspan="5">431.8 A</td></tr>
</table>

Means not sharing the same letters within a column or a row differ significantly from each other at 5% level of probability

LSD at 5% D = 28.51; H = NS; P = NS; D×H = 10.88; H×P = NS; D×P = 30.98; D×H×P = 43.82

1000-grain weight

From table-III indicated that different planting dates had significant while varying maize hybrids and different seed priming techniques had non-significant effects on 1000-grain weight. Regarding different interactions among the factors studied, maize hybrids and planting dates interactions does not produced significant differences with respect to each other while, all other interactions were statistically different. Heavier grains were produced in 14th Feb sowing where maximum 1000-grain weight was recorded while minimum 1000-grain weight was the outcome in crop sown on 1st Feb.

Table.III. Effect of different seed enhancement techniques on 1000-grain weight of varying maize hybrids grown under different sowing dates

<table>
<tr><th>Sowing Dates</th><th colspan="6">D1</th><th colspan="6">D2</th><th colspan="6">D3</th><th colspan="3" rowspan="2">Means Priming</th></tr>
<tr><th>Hybrids</th><th colspan="3">H1</th><th colspan="3">H2</th><th colspan="3">H1</th><th colspan="3">H2</th><th colspan="3">H1</th><th colspan="3">H2</th></tr>
<tr><td>P1</td><td colspan="3">243.9 cde</td><td colspan="3">235.6 e</td><td colspan="3">286.5 abc</td><td colspan="3">270.1 bcde</td><td colspan="3">310.4 ab</td><td colspan="3">319.3 a</td><td colspan="3">277.62</td></tr>
<tr><td>P2</td><td colspan="3">240.0 de</td><td colspan="3">247.9 cde</td><td colspan="3">273.4 bcde</td><td colspan="3">280.7 abcd</td><td colspan="3">311.0 ab</td><td colspan="3">297.2 ab</td><td colspan="3">275.05</td></tr>
<tr><td>P3</td><td colspan="3">242.3 cde</td><td colspan="3">251.9 cde</td><td colspan="3">282.6 abcd</td><td colspan="3">304.7 ab</td><td colspan="3">321.8 a</td><td colspan="3">313.6 ab</td><td colspan="3">286.16</td></tr>
<tr><td>Means Sowing Dates</td><td colspan="7">243.60 C</td><td colspan="7">283.01 A</td><td colspan="7">263.60 B</td></tr>
<tr><td>Means Hybrids</td><td colspan="10">279.10</td><td colspan="11">280.12</td></tr>
<tr><td>D×H</td><td colspan="3">242.1 C</td><td colspan="3">245.1 C</td><td colspan="3">280.8 B</td><td colspan="3">285.2 B</td><td colspan="3">314.4 A</td><td colspan="6">310.0 A</td></tr>
<tr><td>H×P</td><td colspan="3">280.3</td><td colspan="3">274.8</td><td colspan="3">282.2</td><td colspan="3">275.0</td><td colspan="3">275.3</td><td colspan="6">290.1</td></tr>
<tr><td>D×P</td><td colspan="2">239.7 D</td><td colspan="2">244.0 D</td><td colspan="2">247.1 CD</td><td colspan="2">278.3 BC</td><td colspan="2">277.1 BC</td><td colspan="2">293.7 AB</td><td colspan="2">314.9 A</td><td colspan="2">304.1 AB</td><td colspan="5">317.7 A</td></tr>
</table>

Means not sharing the same letters within a column or a row differ significantly from each other at 5% level of probability

LSD at 5% D = 14.83; H = NS; P = NS; D×H = 20.20; H×P = NS; D×P = 31.81; D×H×P = 44.99

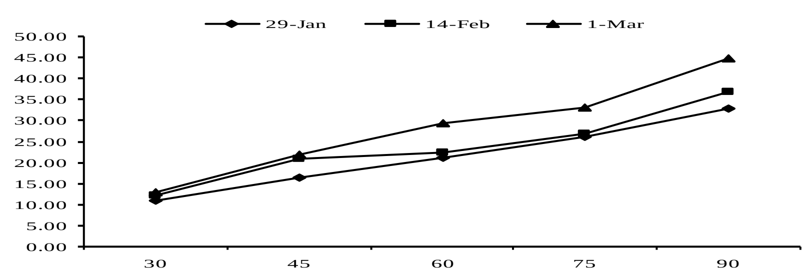
Maximum and minimum 1000-grain weight in maize hybrids and sowing dates interactions was produced in both the hybrids in 1st March and 1st Feb sown crop respectively. Similarly in case on interactions among seed priming techniques and different sowing dates heavier and lighter 1000-grains were produced in hydro and osmo-primed seeds as well as in control sown seeds in 1st March and 1st Feb sowing correspondingly. Likely conferring about interactions among the all three factors tested, osmo-primed seeds of P-32B33 and control seeds of NK-8441 resulted in higher 1000-grain weight in crop sown on 1st March while control seeds of NK-8441 sown on 1st Feb resulted in minimum 1000-grain weight.

Primary root length (cm)

From figure-1(a); (b); (c) showed that primary root length is a crucial consideration in the plant nutrition and water uptake. More the length of primary root better is the uptake and utilization of available resources. The data showed that primary root length progressively increased up till 90 days after sowing (DAS). Maximum root length was recorded in crop sown on 1st March at all intervals of primary root length measurement (i.e., 30, 45, 60, 75 and 90 DAS) while the minimum root length was recorded in 29th Jan sown crop at intervals (Fig-1a). Similarly among different maize hybrids tested maximum and minimum length of primary root was resulted in P-32B33 and NK-8441 (Fig-1b). Likely in case of different seed priming techniques, the difference in length of primary root was obvious at initial days of measurement (30 DAS) and maximum length of primary root was observed in osmo-priming against the minimum in hydro-priming and control sown seeds. In later growth stage the differences among the root length were not so obvious up till 75 DAS. However at 90 DAS maximum length of primary root was again recorded in osmo-priming against the minimum in control and hydro-primed seeds (Fig-1c).

Number of lateral roots

The data Figure-2(a); (b); (c) indicated that number of lateral roots increased progressively up till 90 DAS. The differences in the number of lateral roots were quite marked among various planting dates. The crop sown on 1st March outperformed for number of lateral roots and fabricated maximum number of lateral roots at each count while the performance of crop sown on 29th Jan was poor and resulted in minimum number of lateral roots at all intervals of lateral roots counting (Fig-2a). The differences among different maize hybrids were not obvious up to 75 DAS and both the hybrids behaved similarly for number of lateral root. However, at 90 DAS both the hybrids behaved differently and maximum number of lateral roots was observed in hybrid P-32B33 against the minimum in NK-8441 (Fig-2b). Different seed priming protocols also behaved similar to each other along with control up to 75 DAS. Afterwards the behavior towards number of lateral roots was different and maximum lateral roots were observed in osmo-priming against the minimum in control treatment at 90 DAS (Fig-2c).



Primary root length (cm)

Fig.1a Effect of different sowing dates of maize hybrids

Days after sowing

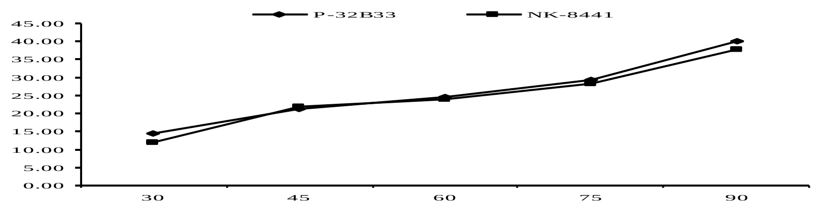


Fig.1b Effect of different sowing dates on different priming techniques

Days after sowing

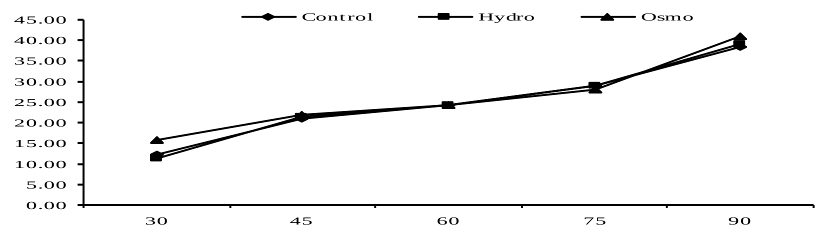


Fig.1c Effect of different sowing dates on primary root length of maize

Days after sowing

Number of lateral roots

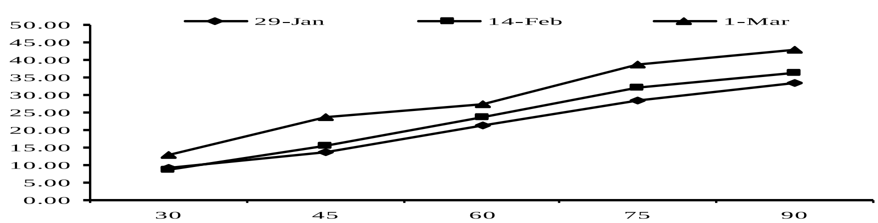


Fig-2a Effect of different sowing dates on maize hybrids

Days after sowing

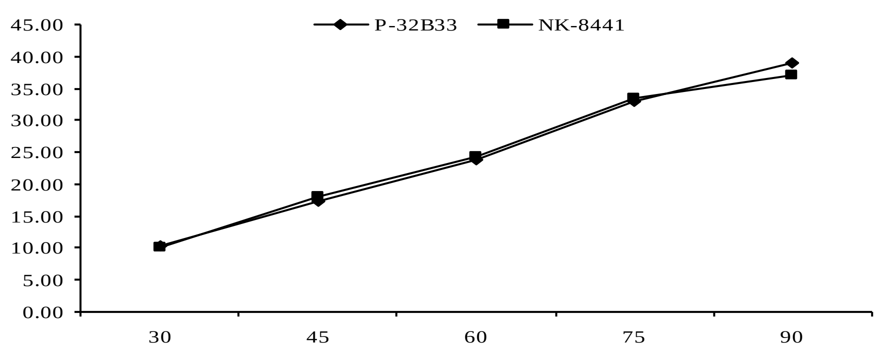


Fig-2b Effect of different sowing dates on different priming techniques of lateral root of maize

Days after sowing

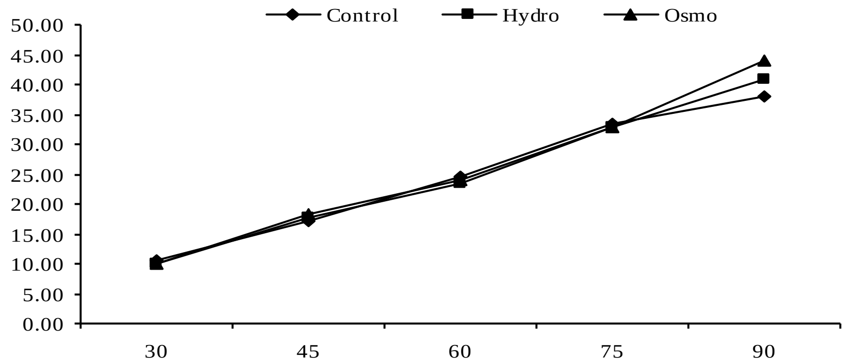


Fig-2c Effect of different sowing dates on number of lateral roots of maize
Days after sowing

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