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# Influence of Seed Priming on Seed Yield Attributes in Quality Protein Maize (QPM) and its Parental Lines (*Zea mays* L.)

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## ABSTRACT

The present study was conducted to assess the effect of seed priming with different bacterial suspensions *viz*. *Azospirillum*, Phosphorus solubilizing bacteria and Potassium solubilizing bacteria on performance of seed yield attributes such as plant height, days to 50% silking and tasseling, days to maturity, no. of cobs /plant, cob length, no. of kernels/cob, shelling percentage, kernel yield/plot, test weight and harvest index. The seeds of quality protein maize, HQPM-5 and its parental lines, HKI-163 and HKI-161 were subjected to different bio-priming treatments and the results revealed that HQPM-5 seeds bioprimed with combination of *Azospirillum* @ 20 % + Phosphorous solubilizing bacteria @ 20 % + Potassium solubilizing bacteria @ 20 % at 12h recorded higher performance than other priming treatments.

**Keywords:** *Bacterial suspensions, Kernel yield, Quality Protein Maize (QPM) and Seed priming*

The third-most significant cereal crop in world agriculture is maize (*Zea mays* L.). Its highest yield potential and widest adaptability have earned it the title of "Queen of Cereals." The Poaceae family of grass includes maize. As a $C_4$ plant, maize has a larger capacity for carbohydrate synthesis. It is predominantly a cross-pollinated species with chromosome number of 2n=2×=20, a feature that has contributed to its morphological variability. Maize ranks as the third most important crop in India among cereals. India ranks fourth in area and seventh in production, representing around 4% of the world maize area and 2% of the total production (http://www.fao.org).

Quality Protein Maize (QPM) grain contains nearly twice as much lysine and tryptophan amino acids that are essential for humans and other monogastric animals but are limiting amino acids in grains. QPM, which is not genetically engineered, is a byproduct of conventional plant breeding and an illustration of biofortification. The goal of QPM breeding is to produce high-quality protein maize, high-yield, taking into account the significance of the energy crisis, the need for more food and feed, and other crucial agronomical attributes (Micic-Ignjatovic *et al*., 2008).

Hydrating and drying seeds is a physiological approach known as priming and it helps to improve germination, seedling development and yield under both normal and stressful conditions. Seeds are hydro primed or soaked in water and then dried again to their initial moisture content, before being sown (Lutts et al., 2016). By applying bacteria prior to seeding, an efficient inoculation method called "bio-priming" raises the possibility that bacteria will colonise the rhizosphere and establish a bond with the plant.

In addition to the soil, air, and water, it is hoped that using biofertilizers instead of chemicals will improve health of soil and intern human. They are not only very nutrient-dense but also provide the soil with advantageous bacteria. Inoculating maize with Azospirillum improved nutrient uptake, plant development and yield (Dobbelaere *et al*., 2001). In order to increase plant growth, nutrition, root growth, competitiveness and reactions to external stress factors, biofertilization with phosphorous and potassium-solubilizing bacteria and potassium-solubilizing bacteria is a sustainable approach (Meena *et al*., 2015, Raghvendra *et al.,* 2016, Kumar *et al.,* 2016).

## MATERIALAND METHODS

A field experiment on enhancement of seed yield attributes through hydropriming and biopriming in hybrid maize HQPM-5 and its parental lines i.e., HKI-163 and HKI-161 was conducted at the Regional Agricultural Research Station, Nandyal, Andhra Pradesh during *Rabi* 2022-23. A preliminary experiment was carried out to standardize the optimum concentration of liquid biofertilizers and the duration of priming. The best concentration and duration of seed priming of each of the liquid biofertilizers identified in the preliminary experiment were used in the subsequent experiments. The details of priming agents, their concentrations and duration of priming are given in Table1. The field trial was conducted following Factorial Randomized Block Design (FRBD) with nine treatments and three replications. The seeds of maize hybrid HQPM-5, were subjected to hydropriming and biopriming treatments using different biofertilizers either individually or in combination for 12 h and shade dried to 12% moisture content. Unprimed seed along with the primed seed were evaluated for the seed quality attributes. Five competitive plants per genotype were selected randomly for recording observations on different characters viz., plant height (cm), number of cobs per plant, cob length, number of kernels per cob, while observations on days to 50% tasseling and silking, days to maturity, stover yield (kg/ha) and kernel yield per plot (kg/ha) were recorded on plot basis. For 100-kernel weight, a sample of 100 kernels were counted randomly from the threshed seed and the weight was recorded in grams. For shelling percentage, the grains were shelled from five randomly selected cobs at harvest for every plot by following formula kernel weight/cob weight*100. Harvest index was calculated by using the formula given by Donald and Hamblin (1976). Statistical analysis was performed on mean of five plants. The analysis of variance (ANOVA) method was used, as described by Panse and Sukhatme, 1985.

## RESULTS AND DISCUSSION

Analysis of variance of data revealed highly significant differences among genotypes and treatments for plant height, days to 50 per cent tasselling, days to 50 per cent silking, days to maturity, number of cobs/plant, shelling (%), kernel yield (kg/ha), test weight (g) and harvest index. Cob length was significant whereas number of kernels per cob was found non-significant among the treatments and both were highly influenced by genotypes. The interaction effects between genotypes and treatments were found non-significant for most of the parameters except highly significant for days to 50 per cent silking and found significant in days to 50 per cent tasselling. The highest (221.24 cm) and lowest (153.18 cm) plant height was recorded after seed priming with of $T_9$ in HQPM-5 and $T_1$ in HKI-163 respectively with overall mean plant height of 190.70 cm. The results are in accordance with Mutetwa *et al.* (2019) where bio priming of maize seeds with *Trichoderma* and *Bacillus* had a significant influence on plant height which significantly increased the N and P uptake by the maize as a result of incorporating the bio fertilizers. The highest (1.40) number of cobs/plant was recorded after seed priming with $T_9$ in HQPM-5 while HKI-161 recorded no significant treatment effect, HKI-163 showed no significant effect by $T_2$ and with $T_3$ compared with $T_1$ and HQPM-5 showed no significant effect by $T_2$ compared with the $T_1$. Nawaz *et al.* (2020) reported that seed biopriming considerably ameliorated the drought induced deterioration in agronomic characters such as cobs per plant, as well as physiological parameters of maize plants.

Seed priming caused a significant reduction in the mean duration of 50 per cent tasseling and silking. The mean days to 50 per cent tasselling was recorded lowest (60) with $T_9$ and the highest (66) in $T_1$. Similarly, mean days of 50 per cent silking was the lowest (62) with $T_9$ and recorded highest in (68) in $T_1$. The results are in confirmation with Madhukeswara and Ashok (2017) where a reduction in days to 50 per cent tasseling and silking in maize hybrid after seed treatment was observed with *pseudomonas* @ 20 per cent as well as *Azospirillum* @ 20 per cent. The days to maturity was recorded lowest (92) in $T_9$ and recorded highest in (113) in $T_1$. The overall mean days to maturity was recorded as 105 days. Similar results were obtained by Harris *et al*. (1999) in which seed priming resulted in quicker growth and development with earlier flowering followed by maturity and increased yields in maize. Cob length was recorded highest (18.26 cm) and lowest (14.06 cm) with $T_9$ in HQPM-5 and $T_1$ in HKI-161 respectively with overall mean of 16.34 cm. Obid *et al.* (2016) reported that application of liquid biofertilizers significantly increased the cob length in maize. The highest (431.74) number of kernels/cob was recorded after seed priming with $T_9$ in HQPM-5 and the lowest (356.72) with $T_1$ in HKI-161 with overall mean number of kernels/cob of 384.54. The results are in accordance with Yazdani *et al*. (2009) by use of phosphorous solubilizing microorganisms and PGPR in addition to conventional fertilizer applications (NPK) could improve row number, grain number per row and ultimately increased grain yield in maize.

The cob weight was recorded highest (202.53g) in HQPM-5 with $T_9$ and recorded lowest (126.12g) in HKI-161 in $T_1$ with overall mean of 153.96 g. The results are in confirmation with Yazdani *et al*. (2009) that by using phosphorous solubilizing microorganisms and PGPR in addition to conventional fertilizer applications (NPK) improved ear weight resulting in increased grain yield. The kernel weight was highest (168.42 g) in HQPM-5 with treatment combination of $T_9$ and recorded lowest in (73.726 g) in HKI-161 in $T_1$ with overall mean of 107.99 g. The highest (83.16 %) and lowest (58.09 %) shelling percent was recorded after seed priming with $T_9$ in HQPM-5 and $T_1$ in HKI-161 respectively with overall mean shelling percent of 70.14. The results are in confirmation with Ragab and Ibrahim (2009) where 120 kg N/fed plus [bio fertilizer notroben] resulted in a significant effect on shelling percentage in maize [single cross 10]. The kernel yield/plot was highest (2.57 kg) in HQPM-5 with $T_9$ and lowest in (1.11 kg) in HKI-161 in $T_1$ with overall mean of 1.65 kg. The kernel yield was highest (7125.97 kg $ha^{-1}$) in HQPM-5 with $T_9$ and recorded lowest in (3088.72 kg $ha^{-1}$) in HKI-161 in $T_1$ with overall mean of 4581.43 kg $ha^{-1}$. The results are in accordance with Sahar *et al*. (2012) that using bio-fertilizers like *Azospirillum* and *Azotobacter* as a source of natural growth regulators led to increased yield in corn as one of the ways of reducing chemical fertilization rate and cost with increased growth benefits.

The highest (34.55 g) and lowest (26.44 g) test weight was recorded after seed priming with a combination of $T_9$ in HQPM-5 and $T_1$ in HKI-161 respectively with overall mean test weight of 30.01 g. Meysam Beigzade *et al*. (2013) reported that in their study on seed inoculation with *Azospirillum* + *Pseudomonas* bacteria increased thousand seed weight compared to control in *Zea mays*. The stover yield was highest (7500.87kg $ha^{-1}$) in HQPM-5 with $T_9$ and recorded lowest in (5384.47 kg $ha^{-1}$) in HKI-161 in $T_1$ with overall mean of 6278.37 kg $ha^{-1}$. The highest (48.71) and lowest (36.45) harvest index was recorded after seed priming with a combination of $T_9$ in HQPM-5 and $T_1$ in HKI-161 respectively with overall mean harvest index of 42.18. The findings are in accordance with Ragab and Ibrahim (2009) that 120 kg N/fed plus [bio fertilizer notroben] resulted in a significant effect on straw yield /fed in ton and seed index in maize.

## CONCLUSION

In conclusion, the seed biopriming treatments combination of *Azospirillum* + Phosphorous solubilizing bacteria + Potassium solubilizing bacteria each at @ 20 % and at duration of 12 h soaking was found to be more effective than other priming treatments. HQPM-5 maize hybrid responded better

**Table 1. Details of seed priming treatments under study**

| Treatment No. | Treatment |
|---|---|
| $T_1$ | Untreated Seed (control) |
| $T_2$ | Hydro-priming |
| $T_3$ | *Azospirillum* @ 20 % |
| $T_4$ | Phosphorous solubilizing bacteria @ 20 % |
| $T_5$ | Potassium solubilizing bacteria @ 20 % |
| $T_6$ | *Azospirillum* @ 20 % + Phosphorous solubilizing bacteria @ 20 % |
| $T_7$ | *Azospirillum* @ 20 % + Potassium solubilizing bacteria @ 20 % |
| $T_8$ | Phosphorous solubilizing bacteria @ 20 % + Potassium solubilizing bacteria @ 20 % |
| $T_9$ | *Azospirillum* @ 20 % + Phosphorous solubilizing bacteria @ 20 % + Potassium solubilizing bacteria @ 20 % |

to the priming treatments than its parental lines i.e., HKI-161 and HKI-163.

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**Table 2: Influence of seed hydro-priming and bio-priming on yield attributing traits of Quality Protein Maize (QPM)**

| Treatments | Plant height (cm) | | | | No. of cobs/plant | | | | Days to 50% tasseling | | | | Days to 50% silking | | | | Days to maturity | | | | Cob length | | | | No. of kernels/cob | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean |
| | 153.2 | 189.2 | 192 | **178.1** | 1 | 1 | 1 | **1** | 69 | 71 | 58 | **66** | 71 | 73 | 60 | **68** | 112 | 113 | 102 | **109** | 15.36 | 14.06 | 16.12 | **15.18** | 361.8 | 356.7 | 423.3 | **380.6** |
| $T_2$ | 154.1 | 194 | 196 | **181.4** | 1 | 1 | 1 | **1** | 68 | 70 | 57 | **65** | 70 | 71 | 60 | **67** | 109 | 113 | 102 | **108** | 15.91 | 14.64 | 16.74 | **15.76** | 364 | 357.1 | 424.2 | **381.8** |
| $T_3$ | 158.5 | 201.5 | 204.1 | **188** | 1 | 1 | 1.07 | **1.02** | 68 | 68 | 56 | **64** | 69 | 70 | 59 | **66** | 108 | 111 | 99 | **106** | 16.21 | 15.23 | 17.03 | **16.16** | 365.9 | 358.1 | 425.4 | **383.1** |
| $T_4$ | 157.4 | 203.1 | 205.7 | **188.8** | 1.2 | 1 | 1.07 | **1.09** | 66 | 67 | 56 | **63** | 67 | 70 | 58 | **65** | 107 | 112 | 99 | **106** | 16.42 | 15.02 | 17.09 | **16.18** | 364.5 | 359.4 | 426.2 | **383.4** |
| $T_5$ | 161.4 | 204.3 | 208 | **191.2** | 1.2 | 1 | 1.13 | **1.11** | 64 | 65 | 54 | **61** | 68 | 70 | 57 | **65** | 108 | 110 | 97 | **105** | 16.35 | 15.42 | 17.28 | **16.35** | 368.4 | 358.2 | 427.3 | **384.6** |
| $T_6$ | 167.6 | 206.4 | 210.6 | **194.9** | 1.13 | 1 | 1.2 | **1.11** | 65 | 67 | 54 | **62** | 68 | 69 | 58 | **65** | 107 | 109 | 99 | **105** | 16.76 | 15.56 | 17.56 | **16.63** | 369.5 | 361.3 | 427.9 | **386.3** |
| $T_7$ | 165.5 | 207.8 | 216.1 | **196.5** | 1.2 | 1 | 1.2 | **1.13** | 66 | 67 | 56 | **63** | 69 | 70 | 59 | **66** | 105 | 110 | 97 | **104** | 16.78 | 15.67 | 17.47 | **16.64** | 367.5 | 362.1 | 428.6 | **386.1** |
| $T_8$ | 166.2 | 208.1 | 218.8 | **197.7** | 1.13 | 1 | 1.33 | **1.16** | 66 | 67 | 53 | **62** | 67 | 72 | 56 | **65** | 102 | 111 | 96 | **103** | 16.98 | 16.01 | 17.68 | **16.89** | 369.6 | 361 | 429.2 | **386.6** |
| $T_9$ | 168.1 | 209.8 | 221.2 | **199.7** | 1.33 | 1 | 1.4 | **1.24** | 63 | 65 | 52 | **60** | 64 | 67 | 55 | **62** | 99 | 109 | 92 | **100** | 17.43 | 16.23 | 18.26 | **17.31** | 370.1 | 363.7 | 431.7 | **388.5** |
| **Mean** | **161.3** | **202.7** | **208.1** | **190.7** | **1.14** | **1** | **1.16** | **1.1** | **66** | **67** | **55** | **63** | **68** | **70** | **58** | **65** | **106** | **110** | **98** | **105** | **16.47** | **15.32** | **17.25** | **16.34** | **366.8** | **359.8** | **427.1** | **384.5** |
| | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | |
| **S Em±** | 2.479 | 4.294 | 7.437 | | 0.027 | 0.047 | 0.081 | | 0.326 | 0.564 | 0.977 | | 0.324 | 0.561 | 0.972 | | 0.542 | 0.939 | 1.627 | | 0.223 | 0.387 | 0.67 | | 4.523 | 7.834 | 13.569 | |
| **CD (5%)** | 7.048 | 12.21 | NS | | 0.077 | 0.133 | NS | | 0.927 | 1.606 | 2.781 | | 0.922 | 1.597 | 2.767 | | 1.543 | 2.673 | NS | | 0.635 | 1.1 | NS | | 12.87 | NS | NS | |
| **CV (%)** | 6.85 | | | | 12.75 | | | | 2.7 | | | | 2.58 | | | | 2.68 | | | | 7.1 | | | | 6.11 | | | |

| Treatments | Cob weight (g) | | | | Kernel weight (g) | | | | Shelling percentage % | | | | Kernel yield (kg/ha) | | | | Test weight (g) | | | | Stover yield (kg ha$^{-1}$) | | | | Harvest Index (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean | HKI-163 | HKI-161 | HQPM-5 | Mean |
| | 138.1 | 126.1 | 178.2 | **147.5** | 87.19 | 73.26 | 123.5 | **95.32** | 63.15 | 58.09 | 69.33 | **64.64** | 3303 | 3089 | 5150 | 3847 | 26.89 | 26.44 | 28.61 | 27.31 | 5730 | 5384 | 7079 | **6064** | 36.56 | 36.45 | 42.11 | **38.81** |
| $T_2$ | 138.5 | 127.2 | 182 | **149.2** | 88.95 | 79.43 | 134.2 | **100.9** | 64.24 | 62.43 | 73.74 | **67.58** | 3483 | 3270 | 5359 | 4038 | 27.53 | 27.13 | 29.07 | 27.91 | 5846 | 5415 | 7253 | **6171** | 37.33 | 37.65 | 42.49 | **39.54** |
| $T_3$ | 139.3 | 128.5 | 189.7 | **152.5** | 89.62 | 82.14 | 142 | **104.6** | 64.35 | 63.91 | 74.85 | **68.58** | 3765 | 3434 | 5519 | 4240 | 28.97 | 28.47 | 30.19 | 29.21 | 5836 | 5582 | 7436 | **6285** | 39.21 | 38.08 | 42.6 | **40.28** |
| $T_4$ | 141.8 | 129.6 | 191.2 | **154.2** | 93.55 | 83.42 | 149 | **108.6** | 65.98 | 64.35 | 77.89 | **70.44** | 3878 | 3593 | 4905 | 4125 | 29.36 | 29.12 | 30.43 | 29.64 | 5848 | 5552 | 7529 | **6310** | 39.87 | 39.28 | 40.16 | **40.23** |
| $T_5$ | 140.6 | 128.5 | 185.7 | **151.6** | 94.91 | 83.63 | 141.3 | **106.6** | 67.52 | 65.11 | 76.06 | **70.32** | 3916 | 3840 | 5991 | 4582 | 29.86 | 29.54 | 30.81 | 30.07 | 5920 | 5694 | 7368 | **6327** | 39.8 | 40.27 | 44.84 | **42** |
| $T_6$ | 142.8 | 130.2 | 194 | **155.7** | 95.63 | 84.07 | 147.3 | **109** | 66.98 | 64.55 | 75.91 | **70.01** | 4509 | 3885 | 6127 | 4840 | 30.11 | 30.08 | 31.23 | 30.47 | 5865 | 5552 | 7338 | **6252** | 43.46 | 41.17 | 45.5 | **43.63** |
| $T_7$ | 141.3 | 131.3 | 196 | **156.2** | 96.35 | 86.81 | 154 | **112.4** | 68.21 | 66.14 | 78.53 | **71.94** | 4408 | 3985 | 6206 | 4866 | 30.56 | 30.34 | 32.84 | 31.25 | 5920 | 5627 | 7323 | **6290** | 42.68 | 41.45 | 45.87 | **43.61** |
| $T_8$ | 143.3 | 132.9 | 197 | **157.7** | 99.91 | 87.22 | 157 | **114.7** | 69.74 | 65.63 | 79.67 | **72.72** | 4649 | 4167 | 6542 | 5119 | 31.11 | 30.76 | 33.75 | 31.87 | 5929 | 5673 | 7373 | **6325** | 43.95 | 42.34 | 47.01 | **44.73** |
| $T_9$ | 147.5 | 133 | 202.5 | **161** | 105.6 | 89.37 | 168.4 | **121.1** | 71.56 | 67.18 | 83.16 | **75.21** | 5030 | 4569 | 7126 | 5575 | 31.48 | 31.04 | 34.55 | 32.36 | 6237 | 5705 | 7501 | **6481** | 44.64 | 44.47 | 48.71 | **46.24** |
| **Mean** | **141.4** | **129.7** | **190.7** | **154** | **94.57** | **83.21** | **146.3** | **108** | **66.86** | **64.15** | **76.7** | **70.14** | 4105 | 3759 | 5881 | 4581 | 29.54 | 29.21 | 31.28 | 30.01 | **5903** | **5576** | **7356** | **6278** | **41.01** | **40.26** | **44.42** | **42.18** |
| | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | | **G** | **T** | **G×T** | |
| **S Em±** | 0.686 | 1.187 | 2.057 | | 0.624 | 1.081 | 1.873 | | 0.373 | 0.646 | 1.118 | | 47.53 | 82.32 | 142.586 | | 0.57 | 0.987 | 1.709 | | 24.17 | 41.86 | 72.496 | | 0.173 | 0.3 | 0.52 | |
| **CD (5%)** | 1.951 | 3.379 | 5.835 | | 1.777 | 3.077 | 5.33 | | 1.061 | 1.837 | NS | | 135.3 | 234.3 | NS | | 1.621 | 2.808 | NS | | 68.77 | 119.1 | NS | | 0.493 | 0.854 | NS | |
| **CV (%)** | 7.93 | | | | 9.27 | | | | 9.51 | | | | 5.35 | | | | 9.3 | | | | 5.21 | | | | 6.67 | | | |

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