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STANDARDIZATION OF BIOFORTIFICATION AND HYDROPRIMING FOR ENHANCE SEED YIELD AND ITS QUALITY PARAMETERS IN CHICKPEA (*Cicer arietinum* L.)

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Abstract
The present study were carried out in the Department of Genetics and Plant Breeding, Faculty of Agriculture, NDUAT, Faizabad during *rabi* season 2014-15 entitled "standardization of biofortification and hydropriming for enhance seed yield and its quality parameters in chickpea (*Cicer arietinum* L.)" The objective of the study was assessing the comparative performance of yield and quality. The 8 treatments of bio-fertilizers and seed priming for chickpea variety (Pusa-362) were evaluated following 13 quantitative characters *viz*., Field emergence (%), Days to 50% flowering, plant height, number of branch/plant, number of pods per plant, number of seeds per pod, days to maturity, harvest index (%), test weight (g), grain yield (kg/ha), biological yield, seed yield per plant (g) and qualitative character viz., protein content. The treatment T5 (HP+PSB+*Rhizobium*) was found best in plant height, number of branch, days to 50% flowering, number of pods plant^{-1} , number of seeds pod^{-1}, biological yield, harvest index, seed yield plant^{-1}, seed yield kg ha^{-1}, test weight and % protein content. While, T7 (PSB+*Rhizobium*) was found in maximum Field emergence and days to maturity. The T5 (HP+PSB+ *Rhizobium*) is the best treatment for chickpea variety on the basis of seed yield and seed quality. These finding are based on six months experiment, further experiments are to substantiate for this results.
Keywords: Chickpea, Bio-fertilizers, Priming, Protein.

I. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the most important pulse crop in India with an average yield of 1500-2000 kg/ha. Chickpea is a diploid species with a chromosome number 2n = 16. It belongs to subfamily Papilionaceae of the family Leguminaceae. It's seeds contain 16.4-31.2% protein, 3.0% fibre, 38.1-73.3% carbohydrates, 1.6-9.0% cellulose, 0.2% Ca, 0.3% P, 3.0% ash, vitamins (C and B) and minerals (Mg, Zn, K, Fe) (Huda et al., 2003 and Ozer et al., 2010). Osmopriming is a commonly used method for priming the seeds. Chickpea play important role to improve soil fertility by fixing up atmospheric nitrogen with help of root nodules (Singh et al., 2008).

A healthy crop of chickpea can fix up to 141 kg nitrogen per hectare (Rupela, 1987). The role of symbiotic nitrogen fixing bacteria, plant growth promoting rhizobacteria (PGPR) and phosphate solubilizing microorganisms in crop productivity is well documented (Kennedy et al., 2004). Combined inoculation of *Rhizobium* with *Pseudomonas striata* or *Bacillus polymyxa* and with *Bacillus megaterium* have shown increased dry matter, grain yield and phosphorus uptake significantly over the uninoculated control in legumes (Elkoca et al., 2008). Phosphate solubilising bacteria (PSB) plays an important role in making phosphorus available to crop plants.

The present experiment entitled Standardization of biofortification and hydropriming for enhance seed yield and its quality parameters in Chickpea (*Cicer arietinum* L.) was undertaken with the following objectives.

1. To standardize the hydropriming duration,
2. to standardize the biofortification doses, and

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2. MATERIALS AND METHODS

The present study was conducted in the Department of Genetics and Plant Breeding, Faculty of Agriculture, NDUAT, Faizabad during rabi season 2014-15. The chickpea crop was sown in the field in November 2014 using randomized complete block design with eight treatments and three replications. The treatment details are presented in Table 1.

Treatment No.	Description
T_0	Control
T_1	Hydro priming (HP)with distilled water
T_2	Phosphate solubilizing bacterium (*Bacillus megaterium*)
T_3	*Rhizobium*
T_4	Hydro priming + Phosphate solubilizing bacterium (*Bacillus megaterium*)
T_5	Hydro priming + Phosphate solubilizing bacterium (*Bacillus megaterium*) + *Rhizobium*
T_6	Hydro priming + *Rhizobium*
T_7	Phosphate solubilizing bacterium (*Bacillus megaterium*) + *Rhizobium*

The inoculums of *Rhizobium* and phosphate solubilizing bacterium were obtained from the Biotechnology Park Lucknow. Chickpea (Pant G-186) seeds inoculated by soaking in liquid culture for one hour and then were sown immediately.

For hydro-priming priming treatments seeds of chickpea were washed with water, dipped in 0.1 % mercuric chloride for 5 min and then washed thoroughly with sterilized water. The seeds were soaked in aerated solutions (Kaur et al., 2005). The seeds were then put in the refrigerator at a temperature of 5°C until it was later used.

Plant to plant distance and row to row distance was 10 and 30 cm, respectively. Fertilizer was applied @ 20:40:40 (kg ha -1) N:P:K at the time of sowing. The chickpea crop was cultivated using

standard agronomic practices. The observations were recorded at days to 50% flowering, plant height (cm), days to maturity, number of branches per plant, number of pods per plant, number of seeds per pod, biological yield per plant (g), seed index (g), harvest index (%),seed yield per plant (g), seed yield (q/ha), and protein content (%).

3. RESULT & DISCUSSION

Table: 2. Mean performance of 8 treatments in chickpea for 13characters.

S.N.	Characters / Treatments	Field emergence %	Plant height (cm)			No. of branches per plant		Days to 50% flowering	No. of pods/ plant	No. of seeds per pod
			30 DAS	60 DAS	At maturity time	30 DAS	60 DAS			
1	T_0	84.33	8.73	15.33	54.67	5.27	6.87	82.00	49.13	1.07
2	T_1	89.00	11.17	18.93	57.93	4.87	6.07	85.67	56.20	1.47
3	T_2	85.33	10.60	17.60	57.93	5.53	7.47	88.00	57.00	1.33
4	T_3	88.00	9.63	18.27	60.67	5.40	8.47	86.33	54.77	1.33
5	T_4	89.33	9.73	16.20	60.80	6.47	9.80	87.00	55.50	1.40
6	T_5	91.33	11.53	21.07	66.40	7.33	9.53	89.66	63.07	1.80
7	T_6	90.67	10.99	19.33	64.13	6.20	8.87	85.33	61.73	1.60
8	T_7	93.33	9.78	16.47	62.47	5.93	8.13	87.33	57.20	1.53
Mean		**88.92**	**10.27**	**17.90**	**60.63**	**5.88**	**8.15**	**86.00**	**56.83**	**1.44**
Ran	Maximum	93.33	11.53	21.07	66.40	7.33	9.80	88.0	63.07	1.80
	Minimum	84.33	8.73	15.33	54.67	4.87	6.07	82.00	49.13	1.07
S. Ed. (±)		1.765	0.465	0.577	1.573	0.282	0.481	1.246	2.051	0.072
CD at 5%		3.742	0.987	1.223	3.334	0.598	1.021	2.641	4.347	0.153

Mean performance

S.No.	Characters / Treatments	Days to maturity	Harvest index	Biological yield per plant (g)	Seed yield per plant (g)	Seed yield (kg/ha)	Test weight (g)	Protein content (%)
1	T_0	118.00	40.48	21.00	5.91	1598.90	237.17	16.76
2	T_1	120.00	51.52	22.00	10.34	1807.99	250.00	17.73
3	T_2	120.67	55.62	21.20	9.95	1893.93	251.90	18.36
4	T_3	121.00	53.88	23.00	10.59	1957.73	257.93	19.20
5	T_4	124.33	45.93	24.40	10.71	2134.25	254.63	21.23
6	T_5	129.67	65.82	26.40	12.59	2407.83	287.17	25.70
7	T_6	132.00	59.68	25.07	11.88	2319.53	267.67	24.40
8	T_7	135.00	56.51	24.13	10.83	2264.32	262.45	23.03
Mean		**125.08**	**53.68**	**53.68**	**10.35**	**2048.06**	**2048.06**	**20.80**
Range	Maximum	135.00	65.82	26.40	12.59	2407.83	287.17	25.70
	Minimum	118.00	40.48	21.00	5.91	1598.90	237.17	16.76
S. Ed. (±)		1.613	4.500	1.607	0.351	160.358	7.193	0.57
CD at 5%		3.420	9.539	3.408	0.745	339.958	15.250	1.61

The data presented in table 2, show mean performance of 8 treatments for 13 characters. The grand mean and range for all the traits are also depicted in table 2.

3.1 Pre harvest observations

3.1.1 Field emergence (%)

The result showed that the maximum field emergence (%) was recorded in T7-PSB+*Rhizobium* (93.33). However T5- HP+PSB+ *Rhizobium* (91.33) and T6 – HP+ *Rhizobium* (90.67) were statistically at par with treatment T7 (93.33). Whereas T0- Control (84.33) estimated minimum field emergence (%).

3.1.2 Plant Height (cm) at 30 DAS

The results showed that the maximum plant height (cm) was recorded in T5- HP+PSB+*Rhizobium* +(11.53). However T1-HP (11.17), T6 - HP+ *Rhizobium* (10.99) and T2- PSB (10.60) were statistically at par with treatment T5 (11.53). Whereas T0- Control (8.73) estimated minimum plant height (cm).

3.1.3 Plant Height (cm) at 60 DAS

The presented results revealed that the maximum plant height (cm) was recorded in T5- HP+PSB+*Rhizobium* (21.07). Whereas T0- Control (15.33) estimated minimum plant height (cm).

3.1.3 Plant Height (cm) at maturity

The result showed that the maximum plant height (cm) was recorded in T5- HP+PSB+*Rhizobium* (66.40). However T6 - HP+ *Rhizobium* (64.13) were statistically at par with treatment T5 (66.40). Whereas T0-Control (54.67) estimated minimum plant height (cm).

It has been reported that inoculation chickpea of with both *Pseudomonas fluorescence* and *Rhizobium* enhances stem height, root length and dry weight (Dilip kumar et al., 2001). Mekki and Amel (2005) also claimed that application of biofertilizer increase plant height and dry weight of soybean.

3.1.4 Number of branches per plant at 30 DAS

The result showed that the maximum branches per plant were recorded in T5- HP+PSB+*Rhizobium* (7.33).Whereas T1-HP (4.87) estimated minimum branches per plant.

3.1.5 Number of branches per plant at 60 DAS

The result showed that the maximum branches per plant was recorded in T4- HP+PSB (9.80).Whereas T0-Control (6.07) estimated minimum branches per plant.

The increase in number of branches per plant could be due to atmospheric N fixed by *Rhizobium* and growth promoting substances produced by P-solubilizers. These results are in collaboration with the earlier finding in chickpea (Jain et al., 1999).

3.1.6 Days to 50% flowering

The result revealed that the maximum flowering was recorded in T5- HP+PSB+*Rhizobium* (89.66). However, T2-PSB (88.00) and T7- PSB+*Rhizobium* (88.00) were statistically at par with treatment T5 (87.33).Whereas, T0-Control (82.00) estimated minimum flowering.

3.1.7 Number of pods per plant

The maximum number of pods per plant was recorded in T5- HP+PSB+*Rhizobium* (63.07). However, T6- HP+*Rhizobium* (61.00) were statistically at par with treatment T5 (63.07). Whereas, T0-Control (49.13) estimated minimum number of pods per plant.The effects of organic and biologic fertilizers on soybean growth and quality of seed, Mekki and Amel (2005) showed that the number of pods per plant was increased by applying biofertilizer.

3.1.8 Number of seeds per pod

Result showed that the maximum number of seeds per pod was recorded in T5- HP+PSB+*Rhizobium* (1.80).Whereas T0-Control (1.07) estimated minimum number of seeds per pod.These results are in confirmation with that of Karadavut and Ozdemir (2001) and Fatima et al., 2008 who reported that inoculation significantly increased grain yield (20% higher than control).

3.1.9 Days to maturity

The results showed that the maximum days to maturity were recorded in T7-PSB+*Rhizobium* (135.0). However, T6-HP+*Rhizobium* (132) were statistically at par with treatment T7 (135.0).Whereas T0-Control (118) estimated minimum days to maturity.

3.2 Post harvest observations

3.2.1 Harvest index

The results revealed that the maximum harvest index was recorded in T5- HP+PSB+*Rhizobium* (65.82). However T6- HP+*Rhizobium* (59.68), and T7 –PSB+*Rhizobium* (56.51) were statistically at par with treatment T5 (65.82). Whereas T0-Control (40.48) estimated minimum harvest index.

3.2.2 Biological yield per plant (g)

After being dry, the harvested seed crop in the field the weight of dry seed including the respective dry plant was taken for biological yield. The results revealed that the maximum biological yield was recorded in T5- HP+PSB+*Rhizobium* (26.40). However T6-HP+*Rhizobium* (25.07), T7 –PSB+*Rhizobium* (24.13), T4-HP+PSB (24.40) and T3-*Rhizobium* (23.0) were statistically at par with treatment T5 (65.82). Whereas T0-Control (21.0) estimated minimum biological yield.

3.2.3 Seed yield per plant (gm)

Results revealed that the maximum seed yield was recorded in T5- HP+PSB+*Rhizobium* (12.59). However T6- HP+*Rhizobium* (11.88) was statistically at par with treatment T5 (12.59). Whereas T0-Control (5.91) estimated minimum seed yield. Bacteria had beneficial effect on plant growth and seed yield, because they fix atmospheric nitrogen and release auxins to the root zone to enhance growth (Rees et al., 2009). Addition of biofertilizer promotes bacterial response to nitrogen fixation and soil fertility. Higher rates of atmospheric nitrogen fixation promote growth and yield (El-Desuki et al., 2010).

3.2.4 Seed yield kg per hectare

The results revealed that the maximum seed yield (kg/ha) was recorded in T5- HP+PSB+*Rhizobium* (2407.83). However T6-HP+*Rhizobium* (2319.53), T7- PSB+*Rhizobium* (2264.37) and T4 – HP+PSB (2134.25) were statistically at par with treatment T5 (2407.83).Whereas T0- control (1598.90) estimated minimum yield. It might be due to the availability of plant nutrients in the vicinity of rhizosphere and less losses of nutrient due to fertilizer banding. These results are in conformity with those of Din et al. (1999) who recorded maximum yield in band placement. Seed inoculation also significantly affected the grain yield of chickpea.

3.2.5 Test weight (g)

The results revealed that the maximum test weight (g) was recorded in T5- HP+PSB+*Rhizobium* (287.17). Whereas, T0- control (237.17) estimated minimum test weight (g). This increase in 1000 grains weight may be due to the more availability of nutrients like nitrogen and phosphorus in the rhizosphere and less losses as compared to the broadcast method. These findings are in agreement with those of Timmons et al. (1973) who reported less losses of fertilizer in band placement. Similar results were reported by Alam et al. (1999), El-Hadi and Sheikh (1999), Meena et al. (2001) who stated that *Rhizobium* inoculation significantly increased 100 seed weight and yield.

3.2.6 Protein content (%)

The results showed that the maximum protein content (%) was recorded in T5- HP+PSB+*Rhizobium* (25.70).However T6-HP+*Rhizobium* (24.40) were statistically at par with treatment T5 (25.70). Whereas, T0- control (16.76) estimated minimum protein content (%).

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