Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 1883-1887
Received: 05-01-2018
Accepted: 06-02-2018

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Standardization of biofortification for enhance seed yield and its quality parameters in chickpea (*Cicer arietinum* L.)

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Abstract
The objective of the study was to standardize the biofertilizer doses wiith the selection of Rhizobium strain for exploitation of its natural symbiosis with chickpea for effective nodulation, maximum grain yield in chickpea under the agro-climatic conditions. The 27 treatments of bio-fertilizers and seed priming for chickpea variety (Pant G-186) were evaluated following 12 quantitative characters *viz,* Days to 50% flowering, Days to maturity, plant height on 30 and 60 days, number of branches on 30 and 60 days number of pods per plant, number of seeds per pod, biological yield per plant harvest index (%), seed yield (kg/ha), 100 seed weight (g). The treatment P_2 T_{12} (*Rhizobium* 12.5 g) was found best in, all the treatments. Maximum number of pods per plant (75.38) and seed yield (Kg/ha) (2170.08) was recorded in Inoculation with Biofertilizer (*Rhizobium*).

Keywords: chickpea, bio-fertilizers, priming

Introduction
Pulses are the cheapest and most widely consumed source of protein in countries like India, having predominantly vegetarian population. On an average pulse contain around 20-25% protein, which is 2.5 to 3.0 times higher than that of cereals and are correctly called as "poor man's meat". Besides protein, pulses are also rich source of calories, vitamins and minerals essential for human nutrition. Among the various pulses grown in our country, chickpea (*Cicer arietinum* L.) is the most important pulse crop in India with an average yield of 2500-3000 Kg/ha. This crop is mentioned in Sanskrit which indicates that it is cultivated in India since a longer period than in any other country in the world. Gram is an important *Rabi* season self pollinated legume crop having extensive geographical distribution. Chickpea is known by different names in various countries such as Gram, Channa, Bengal gram *etc*. Chickpea (*Cicer arietinum* L.) crop is self-pollinated and diploid (2n=2x=16) species. It is belongs to genus *Cicer*, tribe Cicereae, family *Fabaceae*, and subfamily *Papilionaceae.* It originated in South-Eastern Turkey. The *Cicer* is of Latin origin, derived from the Greek word 'kikus' meaning force or strength. Similarly bio-fertilizers such as *Rhizobium* and Phosphorous Solubilizing Bacteria (PSB) also have beneficial influence on plant growth, seed yield and quality as they fix large quantity of biological nitrogen. The application of micronutrient and bio-fertilizers through seed treatment not only economies the cost of nutrients but also are readily available to the young seedlings for their vigorous growth and this initial early benefit would help to obtain higher seed yield and quality. However, studies on influence of seed treatments with micronutrients and bio-fertilizers on plant growth, seed yield and quality in chickpea (Ravindra *et al*., 2007) [10].

Materials and Methods
The field experiments under present investigation were conducted during *Rabi* 2014-15 and 2015-16 at Student Instructional Farm and lab experiments were carried out in Seed Testing Laboratory of Seed Technology Section, N. D. University of Agriculture and Technology, Kumarganj, Faizabad (U. P.). Geographically, Narendra Nagar situated between 26.47^0 N latitude, 82.12^0 longitude and at an altitude of 113 meters above the mean sea level. The climate of district Faizabad is semi-arid with hot summer and cold winter. Nearly 80 per cent of total rain fall is received during the monsoon. The treatment details are presented in Table 1. Plant to plant distance and row to row distance was kept 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 plant height (cm), number of branches per plant,

50% flowering, 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) and seed yield (q/ha).

Table 1: Treatments used in this study.

Treatment No.	Description
P_1	Hydro priming with distilled water 13 hrs
P_2	Hydro priming with distilled water 16 hrs
P_3	Hydro priming with distilled water 18 hrs
T_1	*Trichoderma* 5 gm
T_2	*Trichoderma* 7.5 gm
T_3	*Trichoderma* 10 gm
T_4	PSB 7.5 gm
T_5	PSB10 gm
T_6	PSB 12.5 gm
T_7	*Rhizobium* 7.5 gm
T_8	*Rhizobium*10 gm
T_9	*Rhizobium*12.5 gm

Results and Discussion

Mean performance

The data presented in table 2, show mean performance of 27 treatments for 12 characters. The grand mean and range for all the traits are also depicted in table 2.

Days to 50% flowering

Perusal of data given in Table 1 clearly indicates that different bio-fertilizers treatments have their pronounced impact on flowering time of chickpea. Maximum flowering period of 102.22 days during 2014-15 and 103.11 days during 2015-16 was noted with treatment T_6 (PSB 12.5g) and T_3 (*Trichoderma* 10g) respectively. Treatment T_6 attended more period than rest treatments during first year while during second year T_3 being on par with T_5 (PSB 10g) (99.1) achieved more time to flowering that of rest treatments.

Minimum flowering period of 95.56 days was noted with T_8 (*Rhizobium* 10g) which was significantly followed by T_7 (*Rhizobium* 7.5g) (96.89),T_9 (*Rhizobium* 12.5g) (96.44), T_1 (*Trichoderma* 5g) (97.67) during 2014-15 During 2015-16 minimum flowering period 96.78 days was noted with T_1 (*Trichoderma* 5 gm) which was significantly followed by, T_2 (*Trichoderma* 7.5 gm) (97.27), T_4 (PSB 7.5 gm) (99.89) T_5 (PSB10 gm) (99.11).

Days to maturity

Maximum maturity period of 152.1 days during 2014-15 and 149.22 days during 2015-16 were noted with treatment T_6.(PSB 12.5). Treatment T_6, attended more period during first year while during second year, being on par with T_2 (*Trichoderma* 7.5g) achieved more time for maturity than rest of the treatments.

Minimum maturity period of 144.4 days was noted with T_5 (PSB 10g) which was significantly followed by T_4 (PSB 7.5g) 145.78 days, T_7 (*Rhizobium* 7.5 gm) 145.89 days and T_8 144.89 days during 2014-15. While, during 2015-16 minimum maturity period of 143.22 days was noted with T_9 (*Rhizobium* 12.5 g) followed by T_3 (*Trichoderma* 10 g) 146.11days, T_4 (PSB 7.5g) 145.78 days, T_5 (PSB10g) and T_8 (*Rhizobium* 10g) both 144.44 days during 2015-16.

Plant Height (cm) at 30 DAS

Maximum plant height on (30 days) 10.34 cm during 2014-15 and 11.91 cm during 2015-16 was noted with treatment T_9 (*Rhizobium*12.5g) and T_7 (*Rhizobium* 7.5g) respectively. Treatment T_9 attended significantly maximum plant height than rest of the treatments during first year while, during second year T_7 being significantly superior than that of T_1 (*Trichoderma* 5g) 7.32 cm, T_2 (*Trichoderma* 7.5g) 9.01 cm,T_3 (*Trichoderma* 10g) 10.00 cm, T_4 (PSB 7.5g) 9.09 cm, T_6 (PSB 12.5g) 9.40 cm and T_8 (*Rhizobium*10g) 9.66 cm.

Minimum plant height 7.98 cm during 2014-15 and 7.32 cm during 2015-16 was noted with treatment T_1 (*Trichoderma* 5g).

Plant Height (cm) at 60 DAS

Maximum plant height on (60 days) 19.62 cm and 20.09 cm were recorded with treatment T_9 (*Rhizobium* 12.5g) in both years during 2014-15 and 2015-16 respectively. Treatment T_9 attended significantly maximum plant height than treatment T_1 (*Trichoderma* 5g) 17.24, T_3 (*Trichoderma* 10g) 16.37, T_4 (PSB 7.5g) 16.67 and T_5 (PSB10g) 17.62 during first year while, during second year T_9 was found significantly superior over all treatment.

Minimum plant height 16.37 cm was recorded with treatment T_3 (*Trichoderma* 10 g) during 2014-15. Whereas, 16.10 cm during 2015-16 with treatment T_4 (PSB 7.5g).

Number of branches per plant at 30 DAS

Maximum number of branches per plant was noted 6.56 on 30 days during 2014-15 and 6.38 during 2015-16 with treatment T_9 (*Rhizobium* 12.5 gm). Treatment T_9 attended significantly maximum branches per plant than rest of the treatments during first year while during second year T_9 being significantly superior than T_1 (*Trichoderma* 5g) 5.36, T_2 (*Trichoderma*7.5g) 4.93, T_3 (*Trichoderma*10g) 4.87, T_4 (PSB 7.5g) 4.98, T_6 (PSB12.5g) 4.71, T_7 (*Rhizobium* 7.5g) 5.67 and T_8 (*Rhizobium*10g) 5.51.

Minimum branches per plant 4.84 was noted with treatment T_2 (*Trichoderma* 7.5g) during 2014-15. Whereas, during 2015-16, 4.71 with treatment T_6 (PSB 12.5g).

Number of branches per plant at 60 DAS

Maximum number of branches per plant was noted 10.89 during 2014-15 and 12.68 during 2015-16 with treatment T_8 (*Rhizobium* 10 g) and T_9 (*Rhizobium* 12.5g) respectively. Treatment T_8 significantly superior than treatment T_1 (*Trichoderma* 5g) 8.38, T_2 (*Trichoderma*7.5 g) 8.57, T_3 (*Trichoderma* 10 g) 9.00, T_4 (PSB 7.5 g) 8.90, T_6 (PSB10g) 9.44 and T_7 (*Rhizobium* 7.5g) 9.29 during first year while during second year T_9 being significantly superior than rest of the treatments.

Minimum branch per plant 8.38 was noted with treatment T_1 (*Trichoderma*5g) during 2014-15 and 8.8 with treatment T_3 (*Trichoderma* 10 g) during 2015-16. 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 findings in chickpea (Jain *et al.*, 1999) [7].

Number of pods per plant

Maximum number of pods per plant 79.59 and 75.38 was noted with treatment T_9 (*Rhizobium* 12.5 gm) in both year respectively. Treatment T_9 significantly superior than rest of treatments during first year, while during second years T_9 being significantly superior than treatment T_1 (*Trichoderma* 5g) 64.02, T_2 (*Trichoderma* 7.5g) 67.11, T_3 (*Trichoderma* 10g) 67.13, T_4 (PSB 7.5g) 67.98,. T_5 (PSB10g) 71.18, T_6 (PSB 12.5 g) 64.87 and T_7 (*Rhizobium* 7.5 g) 63.73. Minimum number of pods per plant 63.73 was noted with treatment T_7 (*Rhizobium* 7.5g) during 2014-15 and 56.31 with treatment T_2

(*Trichoderma* 7.5g) during 2015-16. The effects of organic and biologic fertilizers on soybean growth and quality of seed, Mekki and Amel (2005) [9] showed that the number of pods per plant was increased by applying biofertilizer.

Number of seeds per pod

Maximum recorded number of seeds per pod were 1.58 during 2014-15 and 1.49 during 2015-16 with treatment T_2 (*Trichoderma* 7.5g), T_9 (*Rhizobium* 12.5g), T_4 (PSB 7.5 g), and T_9 (*Rhizobium* 12.5g) in both years respectively. Treatment T_2 and T_9 significantly superior than treatment T_1 (*Trichoderma* 5g) 1.40, T_6 (PSB 12.5 g) 1.44, and T_7 (*Rhizobium* 7.5g) 1.42 during first year while during second year T_4 (PSB 7.5g) 1.49 and T_9 (*Rhizobium*12.5g) 1.49 being significantly superior than treatment T_1 (*Trichoderma* 5g) 1.33, T_2 (*Trichoderma* 7.5g) 1.31, T_3 (*Trichoderma* 10 g) 1.27, T_7 (*Rhizobium* 7.5 g) 1.33 and T_8 (*Rhizobium*10 g) 1.27.

Minimum number of seeds per pod 1.40 was noted with treatment T_1 (*Trichoderma* 5g) during 2014-15 and 1.27 during 2015-16 with treatment T_3 (*Trichoderma* 10g) and T_8 (*Rhizobium*10 g). These results are in confirmation with that of Karadavut and Ozdemir (2001) [8] and Fatima et *al*., 2008 [6] who reported that inoculation significantly increased grain yield (20% higher than control).

Biological yield per plant (g)

Maximum biological yield per plant 60.11g during 2014-15 and 58.74g during 2015-16 was noted with treatment T_9 (*Rhizobium* 12.5g) in both years respectively. Treatment T_9 significantly superior than rest of treatments during first year, while during second year T_9 being significantly superior than treatment T_1 (*Trichoderma* 5g) 48.53g, T_2,(*Trichoderma* 7.5 g) 49.82g, T_3 (*Trichoderma* 10g) 50.42g, T_5 (PSB10g) 48.03g, T_6 (PSB 12.5g) 52.20g and T_7 (*Rhizobium* 7.5g) 53.42g.

Minimum biological yield per plant 46.82g was recorded with treatment T_8 (*Rhizobium*10g) during 2014-15 and 48.03g during 2015-16 with treatment T_5 (PSB10g).

Harvest index

Maximum harvest index 43.24% during 2014-15 and 38.89% during 2015-16 was noted separately with treatment T_8 (*Rhizobium*10 g) and T_9 (*Rhizobium* 12.5 gm). Treatment T_8 significantly superior than treatment T_1 (*Trichoderma* 5 g) 34.12%, T_2 (*Trichoderma* 7.5 g) 34.28%, T_3 (*Trichoderma* 10 g) 30.07%, T4 (PSB 7.5g) 33.96%, T_5 (PSB10 g) 36.15% and T_6 (PSB 12.5 gm) 30.20% during first year while during second year T_9 being significantly superior than treatment T_1 (*Trichoderma* 5 g) 28.86%, T_2 (*Trichoderma* 7.5 gm) 30.15%, T_3 (*Trichoderma* 10g) 33.31%, T_6 (PSB 12.5 g) 31.15% and T_8 (*Rhizobium*10 g) 32.75%.

Minimum harvest index 30.07% was noted with treatment T_3 (*Trichoderma* 10 gm) during 2014-15. On the other hand during 2015-16 minimum harvest index 28.86% was registered with treatment T_1 (*Trichoderma* 5 gm).

100-Seed weight (g)

Maximum 100-seed weight 19.66g during 2014-15 and 20.78g during 2015-16 were noted with treatment T_7 (*Rhizobium* 7.5 gm) and, T_6, (PSB 12.5 g) respectively. Treatment T_7 significantly superior than treatment T_1 (*Trichoderma* 5 gm) 18.46 and T_9 (*Rhizobium* 12.5 gm) 19.77 during first year and whereas during second year treatment T_6 significantly superior than treatment T_1 (*Trichoderma* 5g) 19.25.

Minimum 100-seed weight 18.46 g was noted with T_1 which was at par with T_7 during 2014-15. During 2015-16 minimum 100-seed weight 18.59 g was noted with T_8 (*Rhizobium*10 gm) which was at par with T_9 (*Rhizobium*10 gm). 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) [11]. 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) [5].

Seed yield (Kg/ha)

Maximum Seed yield 2126.43 Kg/ha during previous year and 2083.17 Kg/ha last year was noted with treatment T_9 (*Rhizobium* 12.5 g), in both the years separately. Treatment T_9 was found significantly superior than treatments T_1 (*Trichoderma*5g) 1631.29 Kg/ha, T_2 (*Trichoderma* 7.5 g) 1604.67 Kg/ha, T_3 (*Trichoderma* 10g) 1783.50 Kg/ha, T_4 (PSB 7.5 g) 1867.90 Kg/ha, T_5 (PSB10 g) 1900.79 Kg/ha and T_6 (PSB 12.5 g) 1818.67 Kg/ha during previous year while during last year T_9 being significantly superior than the all the remaining. 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) [4] who recorded maximum yield in band placement. Seed inoculation also significantly affected the grain yield of chickpea.

Table 2: Effects of biofortification and hydropriming on twelve characters in chickpea

S.N.	Characters/ Treatments	Days to 50 (%) flowering								Days to maturity							
		Rabi 2014-15				*Rabi* 2015-16				*Rabi* 2014-15				*Rabi* 2015-16			
		HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP13 Hrs.	HP16 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean
T_1	*Trichoderma* 5g	94.00	102.33	96.67	97.67	92.67	101.33	96.33	96.78	150.33	148.00	147.33	148.56	150.00	145.67	147.00	147.56
T_2	*Trichoderma* 7.5g	91.00	105.67	97.00	97.89	94.00	98.13	99.67	97.27	151.67	149.67	145.33	148.89	150.67	149.33	142.00	147.33
T_3	*Trichoderma* 10g	95.67	97.00	94.33	95.67	106.33	99.00	104.00	103.11	146.33	147.33	144.67	146.11	144.33	147.67	143.67	145.22
T_4	PSB 7.5g	101.67	94.33	98.67	98.22	101.67	100.33	97.67	99.89	144.67	146.00	146.67	145.78	144.33	144.67	144.67	144.56
T_5	PSB 10g	97.67	97.33	102.00	99.00	102.00	96.33	99.00	99.11	145.00	143.67	144.67	144.44	144.67	144.67	146.00	145.11
T_6	PSB 12.5g	104.67	96.00	106.00	102.22	99.67	93.67	104.33	99.22	153.67	149.67	153.00	152.11	151.33	147.67	148.67	149.22
T_7	*Rhizobium* 7.5g	96.67	99.33	94.67	96.89	96.67	94.00	105.33	98.67	145.33	143.33	149.00	145.89	146.67	144.00	148.67	146.44
T_8	*Rhizobium* 10g	93.33	98.00	95.33	95.56	94.00	97.67	105.00	98.89	141.67	143.67	149.33	144.89	142.33	145.00	146.00	144.44
T_9	*Rhizobium* 12.5g	95.67	93.33	100.33	96.44	96.33	98.00	100.67	98.33	143.33	148.00	146.67	146.00	141.00	144.00	144.67	143.22
Grand Mean		96.70	98.15	98.33	97.73	98.15	97.61	101.33	99.03	146.89	146.59	147.41	146.96	146.15	145.85	145.70	145.90
SEM			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%	
Due to Treatment		0.972	2.759	3.677		1.397	3.964	5.284		0.548	1.554	2.072		0.721	2.046	2.727	
Due to Priming		0.561	1.593	2.123		0.807	2.288	3.050		0.316	0.897	1.196		0.416	1.181	1.574	
Due to Interaction PxT		1.684	4.778	4.778		2.420	6.865	9.151		0.949	2.692	3.588		1.249	3.543	4.723	

Continued----

S.N.	Characters/ Treatments	Plant height (cm) on 30 days								Plant height (cm) on 60 days							
		Rabi 2014-15				*Rabi* 2015-16				*Rabi* 2014-15				*Rabi* 2015-16			
		HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean
T_1	*Trichoderma* 5g	7.68	7.07	9.21	7.98	7.68	7.03	7.23	7.32	15.99	17.16	18.57	17.24	15.28	17.06	17.97	16.77
T_2	*Trichoderma* 7.5g	6.40	7.77	9.82	7.99	6.87	10.17	10.01	9.01	18.81	19.30	18.70	18.94	18.00	18.73	18.30	18.34
T_3	*Trichoderma* 10g	7.93	8.92	10.61	9.15	9.77	11.36	8.88	10.00	17.78	15.55	15.79	16.37	18.11	14.98	15.49	16.19
T_4	PSB 7.5g	7.21	10.00	8.67	8.62	8.12	9.91	9.23	9.09	17.69	16.03	16.30	16.67	16.87	15.40	16.03	16.10
T_5	PSB 10g	8.50	9.70	9.84	9.35	10.43	12.20	9.63	10.76	16.63	18.51	17.73	17.62	16.13	17.84	15.57	16.51
T_6	PSB 12.5g	9.49	8.78	8.80	9.02	9.39	9.80	9.00	9.40	20.42	17.80	16.24	18.15	19.90	17.07	17.64	18.20
T_7	*Rhizobium* 7.5g	7.57	10.88	10.58	9.68	11.97	11.29	12.46	11.91	18.41	18.99	17.20	18.20	17.83	16.95	17.50	17.43
T_8	*Rhizobium* 10g	8.03	13.14	7.17	9.45	7.97	13.49	7.53	9.66	16.74	19.90	18.67	18.44	15.52	20.67	16.90	17.70
T_9	*Rhizobium* 12.5g	9.02	15.17	6.83	10.34	9.25	15.02	8.17	10.81	17.10	23.29	18.47	19.62	16.77	24.45	19.04	20.09
Grand Mean		7.98	10.16	9.06	9.07	9.05	11.14	9.13	9.77	17.73	18.50	17.52	17.92	17.16	18.13	17.16	17.48
SEM			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%	
Due to Treatment		0.372	1.055	1.407		0.487	1.382	1.842		0.576	1.633	2.176		0.563	1.598	2.131	
Due to Priming		0.215	0.609	0.812		0.281	0.798	1.064		0.332	0.943	1.257		0.325	0.923	1.230	
Due to Interaction PxT		0.644	1.828	2.437		0.844	2.394	3.191		0.997	2.828	3.770		0.976	2.768	3.690	

Continued----

S.N.	Characters/ Treatments	Number of branches/plant on 30 days								Number of branches/plant on 60 days							
		Rabi 2014-15				*Rabi* 2015-16				*Rabi* 2014-15				*Rabi* 2015-16			
		HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP 13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean
T_1	*Trichoderma* 5g	4.87	5.77	4.53	5.06	4.87	6.80	4.40	5.36	8.47	8.60	8.07	8.38	8.60	10.27	8.67	9.18
T_2	*Trichoderma* 7.5g	4.60	5.67	4.27	4.84	4.13	5.53	5.13	4.93	8.07	9.60	8.93	8.87	9.27	8.63	9.70	9.20
T_3	*Trichoderma* 10g	5.27	4.60	5.00	4.96	3.53	6.80	4.27	4.87	7.93	7.87	11.20	9.00	8.00	7.87	10.80	8.89
T_4	PSB 7.5g	4.73	5.67	5.40	5.27	4.07	5.47	5.40	4.98	8.93	9.37	8.40	8.90	9.67	10.27	8.67	9.53
T_5	PSB 10g	4.77	6.00	6.13	5.63	5.17	7.07	6.13	6.12	10.20	11.47	9.53	10.40	8.80	11.93	8.20	9.64
T_6	PSB 12.5g	4.67	5.40	5.53	5.20	4.00	5.73	4.40	4.71	8.80	9.13	10.40	9.44	7.73	10.60	11.33	9.89
T_7	*Rhizobium* 7.5g	5.60	5.40	5.03	5.34	4.80	5.80	6.40	5.67	10.07	8.53	9.27	9.29	11.00	9.47	10.07	10.18
T_8	*Rhizobium* 10g	4.63	7.07	4.53	5.41	4.60	7.13	4.80	5.51	9.53	12.67	10.47	10.89	8.40	12.43	9.00	9.94
T_9	*Rhizobium* 12.5g	6.53	8.13	5.00	6.56	5.93	8.33	4.87	6.38	8.87	14.53	8.40	10.60	9.47	14.97	13.60	12.68
Grand Mean		5.07	5.97	5.05	5.36	4.57	6.52	5.09	5.39	8.99	10.20	9.41	9.53	8.99	10.71	10.00	9.90
SEM			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%	
Due to Treatment		0.264	0.748	0.997		0.223	0.634	0.845		0.395	1.121	1.495		0.434	1.231	1.640	
Due to Priming		0.152	0.432	0.576		0.129	0.366	0.488		0.228	0.647	0.863		0.250	0.710	0.947	
Due to Interaction PxT		0.457	1.295	1.727		0.387	1.097	1.463		0.685	1.942	2.589		0.751	2.131	2.841	

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S.N.	Characters/ Treatments	Number of pods/plant								Number of seeds/pod							
		Rabi 2014-15				*Rabi* 2015-16				*Rabi* 2014-15				*Rabi* 2015-16			
		HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean
T_1	*Trichoderma* 5g	58.73	73.07	60.27	64.02	66.67	77.53	50.40	64.87	1.53	1.33	1.33	1.40	1.40	1.40	1.20	1.33
T_2	*Trichoderma* 7.5g	59.73	69.93	71.67	67.11	47.80	64.00	57.13	56.31	1.60	1.73	1.40	1.58	1.00	1.40	1.53	1.31
T_3	*Trichoderma* 10g	64.07	77.93	59.40	67.13	73.97	70.73	62.53	69.08	1.40	1.60	1.40	1.47	1.40	1.40	1.00	1.27
T_4	PSB 7.5g	57.53	72.67	73.73	67.98	53.00	68.97	72.90	64.96	1.27	1.47	1.80	1.51	1.28	1.60	1.60	1.49
T_5	PSB 10g	71.53	75.67	66.33	71.18	58.30	74.57	69.37	67.41	1.40	1.60	1.47	1.49	1.60	1.60	1.20	1.47
T_6	PSB 12.5g	59.47	66.93	68.20	64.87	66.67	59.27	70.33	65.42	1.40	1.47	1.47	1.44	1.40	1.40	1.40	1.40
T_7	*Rhizobium* 7.5g	54.00	74.87	62.33	63.73	57.43	68.30	57.97	61.23	1.27	1.27	1.73	1.42	1.20	1.20	1.60	1.33
T_8	*Rhizobium* 10g	61.27	83.53	74.40	73.07	76.67	79.27	68.43	74.79	1.73	1.60	1.33	1.56	1.40	1.40	1.00	1.27
T_9	*Rhizobium* 12.5g	71.93	95.57	71.27	79.59	65.23	87.10	73.80	75.38	1.40	1.87	1.47	1.58	1.40	1.67	1.40	1.49
Grand Mean		62.03	76.69	67.51	68.74	62.86	72.19	64.76	66.60	1.44	1.55	1.49	1.49	1.34	1.45	1.33	1.37
SEM			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%	
Due to Treatment		1.535	4.355	5.805		2.770	7.859	10.476		0.047	0.134	0.179		0.052	0.147	0.195	
Due to Priming		0.886	2.514	3.352		1.599	4.538	6.049		0.027	0.077	0.103		0.030	0.085	0.113	
Due to Interaction PxT		2.659	2.659	10.055		4.798	13.613	18.146		0.082	0.232	0.309		0.089	0.054	0.338	

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S.N.	Characters/ Treatments	Biological yield (g)								Harvest index							
		Rabi 2014-15				*Rabi* 2015-16				*Rabi* 2014-15				*Rabi* 2015-16			
		HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean
T_1	*Trichoderma* 5g	48.67	58.60	50.33	52.53	46.57	53.50	45.53	48.53	31.52	39.65	31.19	34.12	31.19	30.08	25.30	28.86
T_2	*Trichoderma* 7.5g	52.53	56.53	51.44	53.50	45.60	50.90	52.97	49.82	38.39	38.37	26.07	34.28	30.49	27.39	32.59	30.15
T_3	*Trichoderma* 10g	56.40	53.44	46.93	52.26	47.93	51.57	51.77	50.42	27.66	30.77	31.77	30.07	34.70	30.99	34.24	33.31
T_4	PSB 7.5g	44.53	63.47	50.00	52.67	49.03	56.13	60.30	55.16	41.24	27.00	33.66	33.96	37.37	36.45	31.19	35.00
T_5	PSB 10g	44.63	59.87	52.10	52.20	47.00	49.37	47.73	48.03	30.65	35.85	41.94	36.15	42.71	33.06	30.14	35.30
T_6	PSB 12.5g	53.33	50.57	55.80	53.23	57.47	50.00	49.13	52.20	27.38	26.94	36.29	30.20	30.24	35.41	27.81	31.15
T_7	*Rhizobium* 7.5g	61.73	48.03	52.87	54.21	48.70	59.47	52.10	53.42	32.81	28.06	31.45	30.77	33.34	30.03	38.22	33.87
T_8	*Rhizobium* 10g	44.13	53.63	42.70	46.82	54.80	61.37	55.50	57.22	45.93	46.15	37.63	43.24	29.04	38.80	30.40	32.75
T_9	*Rhizobium* 12.5g	49.20	75.73	55.40	60.11	58.23	64.00	54.00	58.74	41.41	42.78	33.41	39.20	33.56	44.56	38.56	38.89

Grand Mean	50.57	57.76	50.84	53.06	50.59	55.14	52.11	52.62	35.22	35.06	33.71	34.66	33.63	34.08	32.05	33.25
SEM		CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%	
Due to Treatment	1.743	4.944	6.590		1.762	4.997	6.662		1.461	4.145	5.526		1.921	5.450	7.265	
Due to Priming	1.006	2.854	3.805		1.017	2.885	3.846		0.844	2.393	3.190		1.109	3.147	4.195	
Due to Interaction PxT	3.018	8.563	11.414		3.051	8.656	11.538		2.531	7.180	9.571		3.328	9.440	12.584	

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S.N.	Characters/ Treatments	100-seed weight (g)								Seed yield (Kg/ha)							
		Rabi 2014-15				*Rabi* 2015-16				*Rabi* 2014-15				*Rabi* 2015-16			
		HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean	HP13 Hrs.	HP16 Hrs.	HP18 Hrs.	Mean
T_1	*Trichoderma* 5g	17.88	18.91	18.60	18.46	17.80	20.90	19.05	19.25	1741.27	1607.53	1545.07	1631.29	1772.00	1450.63	1455.03	1559.22
T_2	*Trichoderma* 7.5g	21.10	18.75	18.53	19.46	20.60	18.93	18.61	19.38	1544.63	1549.03	1720.33	1604.67	1581.53	1860.83	1746.90	1729.76
T_3	*Trichoderma* 10g	18.47	20.49	19.02	19.32	18.23	18.37	20.70	19.10	1747.67	1845.90	1756.93	1783.50	1825.10	2005.50	1596.67	1809.09
T_4	PSB 7.5g	21.10	18.91	18.81	19.61	21.03	20.90	19.10	20.34	1682.07	1779.23	2142.40	1867.90	1433.50	1740.73	1627.00	1600.41
T_5	PSB 10g	17.30	19.93	20.40	19.21	20.90	19.17	21.20	20.42	1834.97	2138.57	1728.83	1900.79	1625.97	2165.47	1761.73	1851.06
T_6	PSB 12.5g	19.16	19.89	19.37	19.48	20.73	20.07	21.53	20.78	1655.10	1987.47	1813.43	1818.67	2149.83	1692.70	1651.33	1831.29
T_7	*Rhizobium* 7.5g	21.50	17.73	19.75	19.66	19.50	20.10	20.90	20.17	2137.23	2017.27	2355.73	2170.08	1474.77	1757.37	1849.07	1693.73
T_8	*Rhizobium* 10g	19.52	20.28	17.89	19.23	19.70	19.20	16.88	18.59	2453.03	2284.63	1650.37	2129.34	1610.67	2247.07	1463.70	1773.81
T_9	*Rhizobium* 12.5g	16.93	20.10	17.50	18.18	20.20	20.47	19.00	19.89	1752.87	2579.97	2046.47	2126.43	1755.77	2477.03	2016.70	2083.17
Grand Mean		19.22	19.45	18.87	19.18	19.86	19.79	19.66	19.77	1838.76	1976.62	1862.17	1892.52	1692.13	1933.04	1685.35	1770.17
SEM			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%			CD 5%	CD 1%	
Due to Treatment		0.360	1.020	1.360		0.439	1.245	1.659		50.371	142.897	190.482		41.339	117.274	156.326	
Due to Priming		0.208	0.589	0.785		0.253	0.719	0.958		29.081	82.502	109.975		23.867	67.708	90.255	
Due to Interaction PxT		0.623	1.767	2.355		0.760	2.156	2.873		87.244	247.505	329.924		71.600	203.124	270.765	

Conclusion

From the present study it was concluded that nodulation and seed yield of chickpea can be improved by inoculation with *Rhizobium* (12.5g) which could be economically feasible to increase chickpea production.

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