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Effect of biofertilizers and phytohormone on growth and yield attributes of chickpea crop C*cicer arietinium)* (L.) Under irrigated conditions

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Abstract

The demonstration was conducted through Krishi Vigyan Kendra at adopted village (Bhikampura, Block Lahar, Distt- Bhind) during Rabi season of 2018-19 and 2019-20 were conducted on 06 ha of 12 innovative farmer's field to find out the response of biofertilizers and phytohormone on growth and yield of chickpea (Cicer arietinium L.). The experiment was laid out in factorial RBD with five levels of biofertilizers (No inoculation, Rhizobium, Phosphate solubilizing bacteria, Vesicular arbuscular mycorrhizae, Rhizobium+ Phosphate solubilizing bacteria + Vesicular arbuscular mycorrhizae) and three levels of homo brassinolide spraying (No spray, Pre-flowering and Pre-flowering + Pod development). Results revealed that inoculation of biofertilizers significantly improved growth parameters like plant height yield parameters like number of pods plant^{-1}, weight of pods plant^{-1}, number of gains plant^{-1}, test weight, grain yield, stalk yield and harvest index. Among the biofertilizers, combined inoculation of Rhizobium + PSB + VAM produced higher grain yield amounting 62.19, 37.37, 19.62 and 15.34 % in first year and 60.66, 37.46, 20.26 and 17.17 % in second year higher grain yield over no inoculation, rhizobium, phosphate solubilizing bacteria, vesicular arbuscular mycorrhizae respectively. With increase in levels of spraying of homo-brassinolide increased the growth and productivity of chickpea. Spraying of homo-brassinolide at preflowering + pod development stages increased higher grain yield by 32.52 and 14.73 % in first year and 31.61 and 14.23 % in second year in comparison with the higher grain yield than spraying of homo-brassinolide at no spray and pre-flowering stage.

Key words: Chickpea, rhizobium, PSB, VAM, homo-brassinolide, grain yield

Introduction

Pulses form an integral part of the vegetarian diet and the cheapest source of protein for the poor farmers of the Indian sub-continent. Every pulse plant named as an itself mini-fertilizers factory which enriches soil nitrogen It fixes atmospheric nitrogen in symbiotic association with Rhizobium bacteria. Pulse crops have deep penetrating root systems which enable them to utilize the limited available moisture more efficiently than many other crop including cereals. Pulses can minimize the magnitude of protein malnutrition and provide a superior quality of food and fodder and fed to the vast human and cattle population, respectively. Amelioration of phosphorus deficiency by application of costly phosphorus fertilizer is also not a viable option to many resource poor farmers (Rao et al., 1997). In modern days, intensive crop cultivation requires the use of higher quantity of chemical fertilizer which helps in increasing environment pollution. There is a need to develop a suitable agricultural system which requires lower fertilizer input with higher fertilizer use efficiency. Therefore, the current trend needs to explore the possibility of supplementing chemical fertilizers with organic ones, more particularly bio fertilizers of microbial origin. Research efforts are therefore, needed to develop low input technology for farmers. Several attempts were made to enable technology for substituting or supplementing costly phosphatic fertilizer using micro-organisms capable of solubilizing the native and applied phosphorus. The use of rhizobium, phosphate solubilizing bacteria (PSB) and vesicular arbuscular mycorrhizae (VAM) have opened new vistas of phosphorus nutrition. Brassinolide (BL), considered to be the most important homobrassinolide (HBR) playing a pivotal roles in the hormonal regulation of plant growth and development, so as to increase crop yield. Hence, an experiment was conducted to study the response of biofertilizers and phytohormone on growth and yield of chickpea (Cicer arietinium L.).

Materials and Methods

The demonstration was conducted through Krishi Vigyan Kendra at adopted village(Bhikampura, Block Lahar, Distt- Bhind) during Rabi season of 2018-19 and 2019-20 were conducted on 06 ha of 12 innovative farmer's. The soil was slightly acidic (PH - 5.7), low in available nitrogen (130 kg ha^{-1}), phosphorus (10.30 kg ha^{-1}) and medium in potassium (155.6 kg ha^{-1}).The experiment was laid out in factorial randomized block design with five levels of biofertilizers inoculation (no inoculation, Rhizobium, Phosphate solubilizing bacteria (PSB), Vesicular arbuscular mycorrhizae (VAM) and Rhizobium+ Phosphate solubilizing bacteria (PSB) + Vesicular arbuscular mycorrhizae (VAM)) and 3 sprayings of homo-brassinolide at No spraying, Preflowering stage and Pre-flowering + Pod development stage. The spraying of homo-brassinolide was 0.2 ppm (Double @0.5 ml $litre^{-1}$, Godrej Agrovet). In all fifteen treatments replicated thrice. The chickpea, 'Mahamaya-2 (B-115)' was sown on November 20 and November 15 during 20018-19 and 2019-20 respectively. The seed was inoculated with Rhizobium and PSB. The pure VAM culture was mixed thoroughly with slightly moisten soil and applied below the seed @ 2g/seed and then preinoculated seeds were sown according to the treatment. The yield parameters and yield were recorded at harvesting stage (115 days) of plant. The rainfall received during the cropping period 10.10 and 25.3mm in 2018-19 and 2019-20, respectively.

Results and Discussion

Plant height The plant height of chickpea was significantly influenced by biofertilizers in both the experimental years (Table 1). The tallest plant height (66.25 and 72.90 cm) was recorded with inoculation of Rhizobium+ PSB + VAM in in 2018-19 and 2019-20, respectively. The smallest plant height (49.82 and 55.20 cm) was obtained from no inoculation treatment in in 2018-19 and 2019-20, respectively. The increase in growth might be due to the enhanced photosynthetic efficiency of Rhizobium + PSB + VAM inoculated plant. This showed a strong synergistic effect between Rhizobium + PSB + VAM. Inoculations of PSB which are known to produce growth hormones (Sattar and Gaur, 1987) are likely to favour increased plant height. The results are conformity with those of Mukherjee and Rai (2000) and Jain et al. (1999). The plant height was influenced by spraying of homobrassinolide at pre-flowering and pod development stage in both years. The tallest plant height (56.17 and 61.94 cm) was obtained with twice spraying of homobrassinolide at pre-flowering + pod development stage in 2018-19 and 2019-20, respectively. The smallest plant height (51.17 and 57.90 cm) was obtained without spraying of homo-brassinolide in 2018-19 and 2019-20, respectively. Similar result was reported by Ramraj et al. (2017). Increased plant height might be due to positive effect of homo-brassinolide on meristamatic tissues of plant as well as in increasing number and size of cell

Table 1: Plant height, number of pods and grains plant-1 as influenced by treatments

Treatments	Plant height (cm) at harvest		No. of pods $plant^{-1}$			No. of grains $plant^{-1}$		
	2018-19	2019-20	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Bio-fertilizers								
No inoculation	49.82	55.20	24.22	26.77	25.50	28.66	32.88	30.77
Rhizobium	49.42	55.74	28.66	31.33	30.00	33.00	37.88	35.44
PSB	52.73	59.45	30.77	34.00	32.39	36.00	41.44	38.72
VAM	53.57	60.76	32.00	35.66	33.83	37.88	42.33	40.11
Rhizobium+PSB+VAM	66.25	72.90	38.91	42.02	40.49	45.91	50.13	49.02
SEm at (±)	0.37	0.40	0.31	0.36	0.23	0.30	0.31	0.21
CD at (0.05)	0.89	0.96	0.90	1.05	0.65	0.87	0.89	0.59
Homo-brassinolide								
No spray	51.17	57.90	29.28	32.35	30.82	35.02	39.42	37.23
Pre-flowering	53.31	60.18	30.80	33.80	32.32	36.26	40.93	38.60
Pre-flowering+pod development	56.17	61.94	35.48	38.55	37.02	40.42	45.28	42.84
SEm at (±)	0.29	0.31	0.24	0.28	0.18	0.23	0.24	0.16
CD at (0.05)	0.70	0.75	0.70	0.81	0.51	0.67	0.69	0.45

(Prakash et al., 2018).

Number of pods and grains plant-1 Number of pods plant-1 and number of grains plant-1 (Table 1) were significantly influenced by biofertilizers inoculation. Inoculation of Rhizobium + PSB + VAM, VAM, PSB and Rhizobium recorded significantly higher number of pods plant-1 and number of grains plant-1 than control plot (without inoculation). Analysis of table 1 reveals that combine inoculation of Rhizobium + PSB + VAM recorded significantly higher pods plant-1 of 38.91, 42.02 and 40.49 over the other biofertilizer treatments during 2018-19 and 2019-20 and pooled of two years respectively. Combine inoculation of Rhizobium + PSB + VAM proved to be better regarding grains plant-1 (45.91, 50.13and 49.02) during 2018-19 and 2019-20 and pooled of two years respectively. The percentage increase in number of grains plant-1 with Rhizobium + PSB + VAM, VAM, PSB and Rhizobium was 49.53%, 30.38%, 25.85% and 15.21% over no inoculation in respect of pooled of two years. This increase in yield parameters by Rhizobium + PSB + VAM inoculation might be due to more supply of nutrients particularly of phosphorus which helps in increase nodule number and root growth could be ascribed to a better translocation of photosynthate towards the number of pods and grains plant-1. Shinde (2008) and Yadav and Shrivastava (2017) were recorded similar findings. Number of pods plant-1 and number of grains plant-1 (Table 1) were significantly influenced by spraying of homo-brassinolide. The highest number of pods plant-1 (35.48, 38.55 and 37.02) and number of grains plant-1 (40.42, 45.28 and 42.84) was obtained with twice sprayings of homo- brassinolide at pre-flowering + pod development stages during 2018-19 and 2019-20 and pooled of two years respectively. The lowest number of pods plant-1 (29.28, 32.35 and 30.82) and number of grains plant-1 (35.02, 39.42 and 37.23) was obtained from control plot (without spraying of homo-brassinolide) during 2018-19 and 2019-20 and pooled of two years respectively. The increase in yield attributes might be due to application of homo-brassinolide which was in consonance with the findings of Mai et al. (1989).

Weight of pods and grains plant-1 and test weight

The biofertilizer exerted significant effect on weight of pods and grains plant-1 and test weight during both years and pooled of two years (Table 2). The highest pods weight of 12.66 g, 13.82g and 13.75 g was produced in crop receiving Rhizobium + PSB + VAM whereas the lowest pods weight of 10.45 g, 10.50g and 10.47 g was obtained from the crop with no inoculation of biofertilizers during 2018-19 and 2019-20 and pooled of two years respectively. Similarly, the highest grains weight plant-1 was produced in crop receiving Rhizobium + PSB + VAM whereas the lowest grains weight was obtained from the crop with no inoculation of biofertilizers during 2018-19 and 2019-20 and pooled of two years respectively. The percentage increase in grains weight plant-1 with Rhizobium + PSB + VAM, VAM, PSB and Rhizobium was 57.93%, 29.48%, 23.85% and 13.04 % over no inoculation in respect of pooled of two years. Test weight was also influenced by inoculation of biofertilizer (Table 2). Combine inoculation of Rhizobium + PSB + VAM showed to be better regarding test weight (224.3

Table 2: Pods weight plant-1, grains weight plant-1 and test weight as influenced by treatments

Treatments	Pods weight plant-1 (g)			Grains weight plant-1 (g)			Test weight (g)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Bio-fertilizers									
No inoculation	10.45	10.50	10.47	6.42	7.07	6.75	219.9	220.4	220.2
Rhizobium	9.44	9.49	9.47	7.23	8.03	7.63	219.0	219.4	219.2
PSB	9.96	10.10	10.02	7.92	8.80	8.36	220.0	220.2	220.0
VAM	10.19	10.47	10.33	8.37	9.10	8.74	220.1	220.5	220.3
Rhizobium+PSB+VAM	12.66	13.82	13.75	10.37	10.95	10.66	224.3	224.4	224.4
SEm at (±)	0.12	0.15	0.09	0.12	0.18	0.18	0.12	0.10	0.08
CD at (0.05)	0.36	0.44	0.25	0.36	0.52	0.51	0.34	0.30	0.23
Homo-brassinolide									
No spray	9.57	9.72	9.64	7.67	8.34	8.01	221.3	221.6	219.3
Pre-flowering	9.91	10.07	9.99	8.05	8.69	8.37	219.6	219.9	219.7
Pre-flowering + pod development	12.35	12.43	12.39	10.48	11.33	10.91	222.8	223.3	223.0
SEm at (±)	0.09	0.12	0.07	0.09	0.14	0.07	0.09	0.08	0.06
CD at (0.05)	0.28	0.34	0.20	0.27	0.40	0.20	0.26	0.23	0.17

Yield and harvest index

The inoculation of bio-fertilizer exerted significant effect on grain yield, husk yield, stalk yield and harvest index of chickpea during both the years (Table 3). The highest grain yield (21.93 q ha^{-1} , 22.39 q^{-1} and 22.16 q ha^{-1}) was produced in crop receiving the treatment of Rhizobium + PSB + VAM, whereas lowest grain yield (14.45 q ha^{-1}, 14.86 q ha^{-1} and 14.65 q ha^{-1}) was obtained from the no inoculated plot during in 2018-19 and 2019-20 and pooled of two years respectively.

The percentage increase in grain yield with Rhizobium + PSB + VAM, VAM, PSB and Rhizobium was 59.46%, 39.59%, 35.23% and 17.14 % over no inoculation in respect of pooled of two years (Table 3). Inoculations of Rhizobium + PSB + VAM recorded higher grain yield of 22.39 q ha^{-1} during 2nd year followed by VAM (19.71 q ha^{-1}), PSB (19.26 q ha^{-1}), Rhizobium (17.07 q ha^{-1}) and no inoculation (16.88 q ha^{-1}). Similar trend was found during 1st year also. Inoculations of Rhizobium + PSB + VAM recorded significantly higher husk yield, stalk yield and harvest index (%) as compared to no inoculation, Rhizobium, PSB and VAM inoculations during both the years. The highest husk yield (7.78 q ha^{-1}, 7.94 q ha^{-1} and 7.86 q ha^{-1}) and harvest index (35.82%, 37.01% and 36.15%)was produced in crop receiving the treatment of Rhizobium + PSB + VAM, whereas lowest husk yield (5.99 q ha^{-1}, 6.13 q ha^{-1} and 6.06 q ha^{-1}) and harvest index (33.54%, 33.40% and 33.72%) was obtained from the no inoculated plot during 2018-19 and 2019-20 and pooled of two years respectively. The percentage increase in stalk yield with Rhizobium + PSB + VAM, VAM, PSB and Rhizobium was 43.99%, 28.26%, 24.46% and 12.10 % over no inoculation in respect of pooled of two years. This increase in grain yield, stalk yield and harvest index might be due to higher number of grains $plant^{-1}$ and effect of biofertilizer

Table 3: Grain yield, husk and stalk yield and harvest index as influenced by treatments

Treatments	Grain yield (qha^{-1})			Husk yield (qha^{-1})			Stalk yield (qha^{-1})			Harvest index (%)		
	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled	2018-19	2019-20	Pooled
Bio-fertilizers												
No inoculation	16.47	16.88	16.67	5.99	6.13	6.06	24.95	25.39	25.16	33.54	33.40	33.72
Rhizobium	16.73	17.07	16.89	4.56	4.65	4.61	25.73	26.16	25.94	32.65	32.77	32.68
PSB	18.95	19.26	20.0	5.11	5.23	5.17	28.68	28.92	28.80	33.37	33.52	33.42
VAM	19.59	19.71	19.65	5.22	5.26	5.24	29.80	29.57	29.68	33.39	33.65	33.51
Rhizobium+PSB+VAM	21.93	22.39	22.16	7.78	7.94	7.86	35.25	35.44	35.34	35.82	37.01	36.15
SEm at (±)	0.22	0.17	0.14	0.05	0.07	0.04	0.51	0.45	0.34	0.09	0.11	0.25
CD at (0.05)	0.63	0.51	0.40	0.14	0.20	0.11	1.48	1.30	0.96	0.26	0.32	0.71
Homo-brassinolide												
No spray	16.15	16.48	16.32	6.33	6.44	6.38	26.75	27.15	26.95	34.61	34.77	34.69
Pre-flowering	16.36	16.70	16.53	4.99	5.09	5.04	28.35	28.64	28.49	32.82	33.01	33.86
Pre-flowering + pod development	20.46	20.76	20.61	5.46	5.59	5.53	31.14	31.09	31.11	35.45	35.75	35.75
SEm at (±)	0.17	0.13	0.11	0.04	0.05	0.03	0.39	0.35	0.26	0.07	0.09	0.19
CD at (0.05)	0.49	0.39	0.31	0.12	0.14	0.08	1.13	1.01	0.74	0.20	0.26	0.54

inoculations. It is well known that PSB produce vitamins and IAA, GA like growth substances (Satter and Gaur, 1987). These growth factors in combination with better nutritional condition due to increased availability of phosphorus in soil might have played a role increasing the grain yield, husk yield, stalk yield and harvest index (%). On the other hand, VAM not only supplies essential nutrients but also water to plants resulting in better growth that led to increasing grain yield, husk yield, stalk yield and harvest index (%). Shinde (2008), Yadav and Shrivastava (2017) and Pramanik and Singh (2003) were recorded similar findings. The spraying of homo-brassinolide also exerted significant effect on grain yield, husk yield, stalk yield and harvest index of chickpea during both the years (Table 3). The highest grain yield (20.46 q ha^{-1}, 20.76 q ha^{-1} and 20.61 q ha^{-1}) was produced in crop receiving the treatment of twice sprayings of homo-brassinolide at pre-flowering and pod development, whereas lowest grain yield (16.15 q ha^{-1}, 16.48 q ha^{-1} and 16.32 q ha^{-1}) was obtained from the no spraying plot during 2018-19 and 2019-20 and pooled of two years respectively. The percentage increase in grain yield with pre-flowering + pod development and preflowering was 30.00% and 15.59 % over no spraying in respect of pooled of two years. Spraying of homobrassinolide at pre-flowering + pod development stages recorded higher grain yield of 20.76 q ha^{-1} during 2nd year followed by pre-flowering (18.72 q ha^{-1}) and no spraying (16.48 q ha^{-1}). Similar trend was found during 1st year also. Sprayings of homobrassinolide at pre-flowering and pod development recorded significantly higher husk yield, stalk yield and harvest index (%) as compared to no spraying and pre-flowering during both the years. The highest husk yield (7.48 q ha^{-1}, 7.61 q ha^{-1} and 7.55 q ha^{-1}) and harvest index (35.45%, 35.75% and 35.75%)was recorded in crop receiving the treatment of preflowering + pod development, whereas lowest husk yield (6.33 q ha^{-1}, 6.44 q ha^{-1} and 6.38 q ha^{-1}) and harvest index (34.61%, 34.77% and 34.69%) was obtained from the no spraying plot during 2018-19 and 2019-20 and pooled of two years respectively. The percentage increase in stalk yield with pre-flowering + pod development and pre-flowering stage was 24.79% and 14.28 % over no inoculation in respect of pooled of two years (Table 3). The increase in yield due to application of homo-brassinolide was in consonance with the findings of Prakash et al., (2018) and Pramanik et al.(2010). Based on the above results and discussion, following conclusion can be drawn that inoculation of Rhizobium + PSB + VAM as well as two spraying of homo-brassinolide at pre-flowering + pod development stages had a significant influence on plant height, yield parameters, yield and harvest index.

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