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Influence of Microbial inoculants and Molybdenum on yield and Economics of Chickpea (*Cicer arietinum* L.)

ABSTRACT

In *Rabi* 2022, a research study was conducted at Crop Research Farm, SHUATS, Prayagraj to investigate the "Influence of Microbial inoculants and Molybdenum on Yield and Economics of Chickpea (*Cicer arietinum* L.)". The study included biofertilizer and three levels of Molybdenum (0.5, 1.0 and 1.5 kg/ha). The experiment was designed using a randomized block design with 10 treatments, each replicated thrice. The soil in the experimental area was sandy loam with pH (7.8), Organic Carbon (0.43%), Available N (181.58 kg/ha), Available P (15.45 kg/ha) and Available K (197.64 kg/ha). The results indicated that the higher seed yield (1638.35 kg/ha), stover yield (3539.00 kg/ha), gross return (105101.20 INR/ha), net return (71599.20 INR/ha) and benefit-cost ratio (2.14) were observed in treatment 9, which involved the seed inoculation of *Rhizobium* and PSB along with the soil application of Molybdenum 1.0 kg/ha.

Key words: Chickpea, Biofertilizer, Molybdenum, Yield and Economics.

INTRODUCTION

Pulses are the second most important group of crops worldwide. The English word pulse is taken from the Latin *puls*, meaning pottage or thick pap. Pulse is an important source of protein (approximately 21-25%) (Tiwari and Shing, 2012).

Chickpea (*Cicer arietinum* L.) is the most important *rabi* (winter) season food legume crop. In India chickpea area 9.85 million hectare, with 11.99 MT production and 1217 kg/ha productivity in 2020-2021. (Anonymous, 2020). In India Madhya Pradesh leading state in area and production of chickpea. In Uttar Pradesh, it is cover 8.24 million hectare and production 9.97 million tonnes with the productivity 1.08 t/ha in 2020–2021 (GOI, 2021). Gramme productivity is directly regulated by biotic and abiotic variables, with weed playing a significant role. During 2020-21, chickpea a had a lion's share of 49.3% in the total pulses production. Chickpea contains 18-22 per cent protein, 52-70 per cent carbohydrate, 4-10 per cent fat and sufficient quantity of minerals, calcium, phosphorus, iron and vitamins (Ali *et al.,* 2003). It also contains 50% Oleic and 40% Linolic acid. It can fix about N 25-30 kg/ha

through symbiosis (Reddy and Reddy, 2005) and these minimize dependency on chemical fertilizers.

Usage of biofertilizers - a category of organic fertilisers is an environmentally secure method of fertilisation. Commonly used microorganisms as biofertilizer are *Rhizobium*, Phosphate solubilizing bacteria (PSB), Pseudomonas, Blue green algae and Plant growth promoting Rhizobacteria (PGPR). Biofertilizers augment the biochemical processes in soil such as nitrogen fixation, phosphorus solubilization and mobilization, zinc solubilization, production of plant growth promoting substances and pathogen control. Biofertilizers provide an attractive, ecologically sound means of fertilization and economically judicious (Patel *et al.,* 2013) and are important for making agriculture more sustainable. *Rhizobium* and phosphate solubilizing bacteria (PSB) assume a countless importance on account of their dynamic role in N_2-fixation and P solubilizations. *Rhizobium* and PSB use has been beneficial for increasing chickpea productivity (Rudresh *et al.*, 2005).

Micronutrients play an important role in increasing yield of chickpea. Through their impact on the plant itself and on the symbiotic nitrogen-fixing process, micronutrients also play a significant role in boosting the output of pulses and oilseed legumes. If soil have Mo deficient then chickpea produced smaller flower size, lesser number flowers and many of them fail to open or to mature and finally this leads to decreases grain yield (Ahlawat *et al*., 2007). Roy *et al*., (2006) says that Mo is directly related to N fixation by legumes. The availability of Mo is relatively poor when the pH of the soil is in the very slight to medium acid range. Soil and foliar application are effective practices for the implementation of some micronutrients (Roy *et al*., 2006). This research was designed to study the effect of *Rhizobium*, PSB and different levels of Molybdenum dosages on chickpea yield and economics.

Materials and Methods

The field experiment was conducted during the *rabi* season-2022 at CRF, Department of Agronomy in SHUATS, Prayagraj. The location of the experiment was 25^0 39' 42'' N latitude, 81^0 67' 56'' E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in randomized block design and comprised of Biofertilizer and Molybdenum with ten treatments and each was replicated thrice. Each plot was 9 m^2 or 3m x 3m size. The treatments are T_1 : Control, T_2 : *Rhizobium* + Molybdenum 0.5 kg/ha, T_3 : *Rhizobium* + Molybdenum 1.0 kg/ha, T_4 : *Rhizobium* + Molybdenum 1.5 kg/ha, T_5 : PSB + Molybdenum 0.5 kg/ha, T_6 : PSB + Molybdenum 1.0 kg/ha, T_7 : PSB + Molybdenum 1.5

kg/ha, T_8 : *Rhizobium* + PSB + Molybdenum 0.5 kg/ha, T_9 : *Rhizobium* + PSB + Molybdenum 1.0 kg/ha, T_{10} : *Rhizobium* + PSB + Molybdenum 1.5 kg/ha. All pots were fertilized with the basal dose of 20 kg N/ha, 50 kg P_2O_5/ha and 20 kg K_2O/ha in the form of Urea, SSP and Muriate of Potash, respectively. Seeds were treated with the respective *Rhizobium sp*. and PSB inoculants by following the standard procedure and sown on 5th Nov. 2022 with seed rate of 80 kg/ha at spacing 30 cm x 10 cm. Ammonium Molybdate, as a source of Molybdenum (Mo) were applied in the soil according to the selected concentration in their respective plots. Ammonium Molybdate are applied at the time of sowing. In interculture operations one hand weeding was done manually with *Khurpi* at 25 DAS followed by second manual weeding was done at 45 DAS to minimize the crop weed competition. At 30-35 days after sowing nipping was done removing the tips of the younger plant. Chickpea crop required two irrigations one after sowing and second at pre flowering stage. For different observations samples of soil and plant were taken before and after harvest of crop, like collection of soil samples (0-15 cm depth), processing of collected soil samples, analysis of processed samples for their physico-chemical properties, collection of plant samples at different intervals *viz*. 20, 40 60 and 80 DAS. Seed and stover yield were also observed at maturity and both seed and stover samples of chickpea collected from each plot. All agronomic practices are followed in order in the crop period. "Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined by Gomez and Gomez. Critical Difference (CD) values were calculated wherever the 'F' test was found significant at 5 percent level" (Gomez and Gomez, 1984).

III. RESULTS AND DISCUSSION

1. Yield Attributes:

A. Seed yield (kg/ha)

Significantly higher seed yield (1638.35 kg/ha) (Table 1) was observed in treatment 9 [*Rhizobium* + PSB + Molybdenum 1.0 kg/ha], which was superior over all other treatments. This result similarly finding by increase in seed yield due to Mo application along with *Rhizobium* and PSB might be due to enhanced nodulation and BNF, N and other complementary elements assimilation as a consequence of favourable effect of Mo and Mo-Fe on nitrogenase activity in nodules and nitrate reductase activity in plant system (Gupta, S. C. and Gangwar, S. 2012).

B. Stover yield (kg/ha)

Significantly higher stover yield (3539 kg/ha) (Table 1) was observed in treatment 9 [*Rhizobium* + PSB + Molybdenum 1.0 kg/ha], which was superior over all other treatments. Similar result was reported by (Manohar *et al*., 2022).

2. Economics

A. Gross return (INR/ha)

Maximum (INR 105101/ha) (Table 2) gross return was obtained with the application of treatment 9 [*Rhizobium* + PSB + Molybdenum 1.0 kg/ha] while the lowest (INR 79318.07/ha) gross return was obtained with application of Treatment 1 (Control) as compared to all other treatments.

B. Net returns (INR/ha)

Maximum (71599.20 INR/ha) (Table 2) net return was obtained with the application of treatment 9 [*Rhizobium* + PSB + Molybdenum 1.0 kg/ha], while the lowest (50988.07 INR/ha) net return was obtained with application of treatment 1 (Control) as compared to all other treatments.

C. Benefit Cost ratio (B:C)

Benefit Cost ratio (2.14) (Table 2) was found to be highest in treatment-9 [*Rhizobium* + PSB + Molybdenum 1.0 kg/ha] and the minimum benefit cost ratio (1.53) was found to be in treatment-4 [*Rhizobium* + Molybdenum 1.5 kg/ha] as compared to all other treatments.

CONCLUSION

Form the results, it can be concluded that chickpea with seed inoculation of *rhizobium* and PSB along with the soil application of Molybdenum 1.0 kg/ha recorded highest seed yield, stover yield and Benefit: Cost ratio.

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Table 1: Effect of Microbial inoculants and Molybdenum on yield of Chickpea

S.No.	Treatment combination	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Harvest Index (%)
1.	Control (NPK 20-50-20 kg/ha)	1201.29	3045.85	28.28
2.	*Rhizobium* + Molybdenum 0.5 kg/ha	1441.67	3166.67	31.29
3.	*Rhizobium* + Molybdenum 1.0 kg/ha	1333.74	3098.00	30.10
4.	*Rhizobium* + Molybdenum 1.5 kg/ha	1411.36	3159.33	30.98
5.	PSB + Molybdenum 0.5 kg/ha	1317.78	3072.00	30.02
6.	PSB + Molybdenum 1.0 kg/ha	1341.64	3138.30	30.11
7.	PSB + Molybdenum 1.5 kg/ha	1418.25	3168.00	30.92
8.	*Rhizobium* + PSB + Molybdenum 0.5 kg/ha	1511.94	3267.00	31.55
9.	*Rhizobium* + PSB + Molybdenum 1.0 kg/ha	1638.35	3539.00	31.64
10.	*Rhizobium* + PSB + Molybdenum 1.5 kg/ha	1552.76	3454.00	31.01
	F-test	S	S	NS
	SEm(±)	41.15	95.67	0.91
	CD (p=0.05)	122.25	284.21	-

Table 2: Effect of Microbial inoculants and Molybdenum on Economics of Chickpea

S.No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	Benefit: Cost ratio
1.	Control (N:P:K 20-50-20 kg/ha)	28330.00	79318.07	50988.07	1.79
2.	*Rhizobium* + Molybdenum 0.5 kg/ha	30986.00	92746.66	61760.66	1.99
3.	*Rhizobium* + Molybdenum 1.0 kg/ha	33482.00	86644.76	53162.76	1.59
4.	*Rhizobium* + Molybdenum 1.5 kg/ha	35978.00	91092.95	55114.95	1.53
5.	PSB + Molybdenum 0.5 kg/ha	31026.00	85663.66	54637.66	1.76
6.	PSB + Molybdenum 1.0 kg/ha	33482.00	87268.16	53786.16	1.61
7.	PSB + Molybdenum 1.5 kg/ha	36018.00	91503.79	55485.79	1.54
8.	*Rhizobium* + PSB + Molybdenum 0.5 kg/ha	31006.00	96997.13	65991.13	2.13
9.	*Rhizobium* + PSB + Molybdenum 1.0 kg/ha	33502.00	105101.20	71599.20	2.14
10.	*Rhizobium* + PSB + Molybdenum 1.5 kg/ha	35998.00	100109.81	64111.81	1.78

Rate of 1 kg Ammonium Molybdate- 2600/-

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