Original Research Article

"Influence of Microbial inoculant and Molybdenum on Yield and Economics of Chickpea (*Cicer arietinum* L.)"

ABSTRACT

In *Rabi* 2023, a research study was conducted at Crop Research Farm, SHUATS, Prayagraj to investigate the "Influence of Microbial inoculant and Molybdenum on yield and Economics of Chickpea (*Cicer arietinum* L.)". The study included biofertilizer and three 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 results indicated that the higher grain 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 inoculation of *Rhizobium* and PSB along with the Molybdenum 1.0 kg/ha.

Key words: Chickpea, biofertilizer, molybdenum, yield, economics.

INTRODUCTION

Pulses (grain legumes) 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, 2020-221)**. 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 and Kumar, 2003)**. It also contains 50% Oleic and 40% Linolic acid. It can fix about N

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25-30 kg/ha through symbiosis **(Reddy and Reddy, 2005)** and these minimize dependency on chemical fertilizers.

An environmentally secure method of fertilisation is emerging: biofertilizers, a category of organic fertilisers. Commonly used microorganisms as biofertilizer are Rhizobia, phosphate solubilizing bacteria (PSB) 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 studied how applying *Rhizobium*, PSB and Molybdenum affected chickpea yield and economics.

Materials and Methods

The filed experiment was conducted during the rabi season of 2023 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. 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. The sowing of seed was carried out using 80 kg/ha seed rate of chickpea and spacing is 30 X 10 cm. Seeds were

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treated with the respective *Rhizobium sp*. inoculants by following the standard procedure. Ammonium Molybdate, as a source of Molybdenum (Mo) were applied in the soil according to the selected concentration in their respective plots. 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. Grain and straw yield were also observed at maturity and both grain and straw 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)**.

Treatment Combination

1. Control (N:P:K 20-50-20 kg/ha)
2. *Rhizobium* + Molybdenum 0.5 kg/ha
3. *Rhizobium* + Molybdenum 1.0 kg/ha
4. *Rhizobium* + Molybdenum 1.5 kg/ha
5. PSB + Molybdenum 0.5 kg/ha
6. PSB + Molybdenum 1.0 kg/ha
7. PSB + Molybdenum 1.5 kg/ha
8. *Rhizobium* + PSB + Molybdenum 0.5 kg/ha
9. *Rhizobium* + PSB + Molybdenum 1.0 kg/ha
10. *Rhizobium* + PSB + Molybdenum 1.5 kg/ha

Result and Discussion

Seed yield (kg/ha)

The significant and higher seed yield (1638.35 kg/ha) [Table 1] was observed in treatment 9 [*Rhizobium* + PSB + Molybdenum 1.0 kg/ha], which was significant superior over rest of the treatments. However, treatment 10 [*Rhizobium* + PSB + Molybdenum 1.5 kg/ha] (1552.76 kg/ha) was found to be statically at par with the treatment-9. This result similarly finding by increase in seed yield due to Mo application along with *Rhizobium* + PSB might be due to enhanced nodulation and BNF, N and other complementary elements assimilation as a

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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)**.

Stover yield (kg/ha)

The significant and 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. However, the treatment 10 [*Rhizobium* + PSB + Molybdenum 1.5 kg/ha] (3454 kg/ha) and treatment 8 [*Rhizobium* + PSB + Molybdenum 0.5 kg/ha] (3267 kg/ha) was founded to be statistically at par with treatment 9. Similar result was reported by **(Manohar *et al.*, 2022)**.

Harvest Index (%)

The data revealed highest harvest index (31.64%) [Table 1] was recorded in Treatment 9 [*Rhizobium* + PSB + Molybdenum 1.0 kg/ha], thought there was no significant difference among the treatment.

Economics

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 other treatments.

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 other treatments.

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 other treatments.

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CONCLUSION

It is concluded the treatment 9 with the combination of *Rhizobium* and PSB with the application of Molybdenum (1.0 kg/ha) was found significantly more productive. It is also recorded that maximum Benefit cost ratio (2.14) as compared to other treatment combinations.

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Table 1: Effect of Microbial inoculant 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	-

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

S.No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C
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

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