

Original Research Article

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

ABSTRACT

In *Rabi* 2023, a research 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 experiment was designed in randomized block design with ten treatments, each replicated thrice with two biofertilizers (*Rhizobium* and PSB) and three Molybdenum dosages (0.5, 1.0 and 1.5 kg/ha). The results indicated that the higher grain yield (1638.35 kg/ha), stover yield (3539.00 kg/ha), gross returns (105101.20 ₹/ha), net returns (71599.20 ₹/ha) and benefit-cost ratio (2.14) were observed in treatment with seed treatment of *Rhizobium* and PSB along with the soil application of Molybdenum @ 1.0 kg/ha.

Keywords: Chickpea, Biofertilizer, Molybdenum, Yield and Economics.

I. INTRODUCTION

Pulses are the second most important crops in world. The 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 an important *rabi* season food legume crop in India. In 2020-2021, chickpea was cultivated in area of 9.85 million hectare contributing 11.99 MT production with productivity of 1217 kg/ha which had a lion's share of 49.3% in the total pulses production. (Anonymous, 2020). In India Madhya Pradesh leading state in area and production of chickpea. (ADD SECOND AND THIRD LEADING STATES) In Uttar Pradesh, it is cover 8.24 million hectare and production 9.97 million tonnes with the productivity 1.08t/ha in 2020-2021 (GOI, 2020-2021). (INCLUDE IN REFERENCES) 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 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) which are important for making agriculture more sustainable. Rhizobium and phosphate solubilizing bacteria (PSB) assume a countless importance on account of their dynamic role in N₂-fixation and P solubilization. Rhizobium and PSB use has been beneficial for increasing chickpea productivity (Rudresh *et al.*, 2005).

Molybdenum play an important role in increasing yield of chickpea by direct impact on plant itself and on the symbiotic nitrogen-fixing process. Roy *et al.*, (2006) says that Mo is directly related to N fixation by legumes. Mo also play a significant role in boosting the output of pulses and oilseed legumes. The plants from Mo deficient soil produces small size of flowers, lesser number flowers and flowers fail to open or to mature and finally this leads to decreases grain yield (Ahlawat *et al.*, 2007). 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.

II. Materials and Methods

The field experiment was conducted during the *rabi* season -2023 at CRF, Department of Agronomy, SHUATS, Prayagraj. The location of the experiment was 25° 39' 42" N latitude, 81° 67' 56" E longitude and at an altitude of 98 m above mean sea level. The experiment was laid out in randomized block design with ten treatments comprising of Biofertilizers and Molybdenum dosages and each was replicated thrice with 3m x 3m plot size. The treatments are T₁: Control, T₂: Rhizobium + Molybdenum @ 0.5 kg/ha, T₃: Rhizobium + Molybdenum @ 1.0 kg/ha, T₄: Rhizobium + Molybdenum @ 1.5 kg/ha, T₅: PSB + Molybdenum @ 0.5 kg/ha, T₆: PSB + Molybdenum @ 1.0 kg/ha, T₇: PSB + Molybdenum @

1.5 kg/ha, T₈ : *Rhizobium* and PSB + Molybdenum @ 0.5 kg/ha, T₉ : *Rhizobium* and PSB + Molybdenum @ 1.0 kg/ha, T₁₀ : *Rhizobium* and PSB + Molybdenum @ 1.5 kg/ha. All plots were fertilized with the basal dose of 20 kg N/ha, 50 kg P₂O₅/ha and 20 kg K₂O/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 @ 80 kg/ha seed rate with spacing is 30 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. All agronomic practices are followed in order in the crop period. Grain and straw yield were observed at maturity from each plot. 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).

1. ADD THE LOCATION MAP OF EXPERIMENTAL PLOT AS A FIGURE

2. ADD THE INITIAL SOIL PHYSIO-CHEMICAL PROPERTIES OF LOCATION

3. ADD THE COSTS INCURRED FOR EVERY TREATMENT (FOR EXAMPLE : COST OF BIOFERTILIZER, COST OF AMMONIUM MOLYBATE, LABOUR COST, OPERATIONAL COST ETC.,)

4. INCLUDE THE TIME OF APPLICATION OF MOLYBDENUM TO SOIL

III. Result and Discussion

1. Yield Attributes :

A. Seed yield (kg/ha)

This significantly higher seed yield (1638.35 kg/ha) (Table. 1) was observed in T₉ (*Rhizobium* and PSB + Molybdenum @ 1.0 kg/ha), over rest of the treatments. However, T₁₀ (*Rhizobium* and PSB + Molybdenum @ 1.5 kg/ha) (1552.76 kg/ha) was found performed better after the T₉. This results might be due to seed treatment of *Rhizobium* + PSB along with Mo application 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 which put forth for better growth parameters and increased the seed yield (Gupta and Gangwar, 2012).

B. Stover yield (kg/ha)

The significantly higher stover yield (3539 kg/ha) (Table. 1) was observed in T₉ (*Rhizobium* and PSB + Molybdenum @ 1.0 kg/ha) which was superior over all other treatments. The treatments T₁₀ (*Rhizobium* and PSB + Molybdenum @ 1.5 kg/ha) (3454 kg/ha) and T₈ (*Rhizobium* and PSB + Molybdenum @ 0.5 kg/ha) (3267 kg/ha) was founded to be statistically at par with each other and well performed over all other treatments after best treatment (T₉). The increase in straw was might be that seed treatment of *Rhizobium* + PSB along with Mo application enhanced nodulation and BNF, where nutrients were readily available to plants which enhanced the growth parameters like plant height, LAI, dry matter production that directly increase in the straw yield of the crop. Similar result was reported by (Manohar *et al.*, 2022).

C. Harvest Index (%)

The experimental data revealed highest harvest index (31.64%) (Table. 1) was recorded in Treatment T₉ (*Rhizobium* and PSB + Molybdenum @ 1.0 kg/ha) and there was nosignificant difference among the treatments.

1. INCLUDE DISCUSSION FOR HARVEST INDEX

2. Economics :

A. Gross returns (INR/ha)

Maximum gross returns (105101 ₹/ha) (Table. 2) was obtained with the T₉ (*Rhizobium* and PSB + Molybdenum @ 1.0 kg/ha) while the lowest gross returns (₹79318.07/ha) was obtained with application of Treatment T₁ (Control) as compared to other treatments.

B. Net returns (INR/ha)

The highest net returns (71599.20 ₹/ha) (Table. 2) was recorded with T₉ (*Rhizobium* and PSB + Molybdenum @ 1.0 kg/ha) and the lowest net returns (50988.07 ₹/ha) was observed with treatment T₁ (Control) as compared to other treatments.

C. Benefit Cost ratio (B:C)

Benefit Cost ratio (2.14) (Table. 2) was found to be highest in treatment T₉ (*Rhizobium* and PSB + Molybdenum @ 1.0 kg/ha) and the minimum benefit cost ratio (1.53) was found with the treatment T₄ (*Rhizobium* + Molybdenum @ 1.5 kg/ha).

1. INCLUDE DISCUSSION FOR GROSS RETURNS, NET RETURNS AND B:C RATIO

CONCLUSION

It is concluded the treatment T₉ (Seed treatment of *Rhizobium* and PSB + Soil application of Molybdenum @ 1.0 kg/ha) was found significantly more productive and environmental friendly in sustaining the soil health. By the usage of biofertilizers will reduce the cost of cultivation by low cost inputs which gain more yield and increase in monetary returns for farming community.

Meaning of colours used by reviewer

YELLOW : Indicates corrections made by reviewer.

RED : Indicates the points should be included in appropriate places.

UNDER PEER REVIEW

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

S.No.	Treatments	Seed Yield (kg/ha)	Stover Yield (kg/ha)	Harvest Index (%)
1.	T ₁ : Control (NPK 20-50-20 kg/ha)	1201.29	3045.85	28.28
2.	T ₂ : <i>Rhizobium</i> + Molybdenum @ 0.5 kg/ha	1441.67	3166.67	31.29
3.	T ₃ : <i>Rhizobium</i> + Molybdenum @ 1.0 kg/ha	1333.74	3098.00	30.10
4.	T ₄ : <i>Rhizobium</i> + Molybdenum @ 1.5 kg/ha	1411.36	3159.33	30.98
5.	T ₅ : PSB + Molybdenum @ 0.5 kg/ha	1317.78	3072.00	30.02
6.	T ₆ : PSB + Molybdenum @ 1.0 kg/ha	1341.64	3138.30	30.11
7.	T ₇ : PSB + Molybdenum @ 1.5 kg/ha	1418.25	3168.00	30.92
8.	T ₈ : <i>Rhizobium</i> and PSB + Molybdenum @ 0.5 kg/ha	1511.94	3267.00	31.55
9.	T ₉ : <i>Rhizobium</i> and PSB + Molybdenum @ 1.0 kg/ha	1638.35	3539.00	31.64
10.	T ₁₀ : <i>Rhizobium</i> and 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.	Treatments	Cost of cultivation (₹/ha)	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
1.	T ₁ : Control (NPK 20-50-20 kg/ha)	28330.00	79318.07	50988.07	1.79
2.	T ₂ : <i>Rhizobium</i> + Molybdenum @ 0.5 kg/ha	30986.00	92746.66	61760.66	1.99
3.	T ₃ : <i>Rhizobium</i> + Molybdenum @ 1.0 kg/ha	33482.00	86644.76	53162.76	1.59
4.	T ₄ : <i>Rhizobium</i> + Molybdenum @ 1.5 kg/ha	35978.00	91092.95	55114.95	1.53
5.	T ₅ : PSB + Molybdenum @ 0.5 kg/ha	31026.00	85663.66	54637.66	1.76
6.	T ₆ : PSB + Molybdenum @ 1.0 kg/ha	33482.00	87268.16	53786.16	1.61
7.	T ₇ : PSB + Molybdenum @ 1.5 kg/ha	36018.00	91503.79	55485.79	1.54
8.	T ₈ : <i>Rhizobium</i> and PSB + Molybdenum @ 0.5 kg/ha	31006.00	96997.13	65991.13	2.13
9.	T ₉ : <i>Rhizobium</i> and PSB + Molybdenum @ 1.0 kg/ha	33502.00	105101.20	71599.20	2.14
10.	T ₁₀ : <i>Rhizobium</i> and PSB + Molybdenum @ 1.5 kg/ha	35998.00	100109.81	64111.81	1.78

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