

Original Research Article

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Studies on the Effect of *Rhizobium* alone or in Combination with Sulphur and Molybdenum on Yield and Uptake of Nutrients of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

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An experiment was conducted at research farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during *Rabi* season 2012-2013, to assess the response of inoculation of *rhizobium* as affected by application of different doses of sulphur and molybdenum on chickpea. Four levels of sulphur (0, 20, 40 and 60 kg ha⁻¹) and molybdenum (sodium molybdate) (0, 2.5, 5.0 and 7.5 kg ha⁻¹) were integrated with rhizobium inoculation as compared with uninoculated control. The result indicated the maximum grain yield (28 q ha⁻¹), stover yield (29.68 q ha⁻¹), N uptake by grain (108.818 kg ha⁻¹) stover (26.578 kg ha⁻¹), P uptake by grain (19.85 kg ha⁻¹) stover (7.758 kg ha⁻¹), S uptake by grain (7.855 kg ha⁻¹) stover (6.295 kg ha⁻¹) and Mo uptake by grain (11.595 g ha⁻¹) stover (2.405 g ha⁻¹) with 5 kg sodium molybdate+ 40 kg sulphur+rhizobium was obtained.

Introduction

Chickpea (*Cicer arietinum* L.) also known by several other names in various countries, such as gram, chana, Bengal gram, pios is the third most important pulse crop after dry bean (*Phaseolus vulgaris*) and dry peas (*Pisum sativum* L.). It is very potential *Rabi* legume which has diversified use such as dal, beson, making for sweets, fresh green human

consumption and feeding for animals. It is considered to have medicinal effect and it is used for blood purification. Chickpea contains 19-26, 52-70 and 4-10 per cent protein, carbohydrate, minerals and vitamins respectively. A number of agriculturally useful micro-organism fixes atmospheric nitrogen either symbiotically or non-symbiotically. *Rhizobium* legumes association (Beijerinck, 1901) constitutes most of the nitrogen fixation

properties. Sulphur is an important constituent of S containing amino acids like Methionine, Cysteine and Cystenine which are building units of proteins and also promotes nodule formation. Molybdenum has been found to play a role in the fixation of atmospheric nitrogen. Molybdenum catalyses the activities of different soil organisms. These results suggested that molybdenum stimulates the process of symbiotic nitrogen fixation and is undoubtedly required for general metabolism (Selman A. Waksman, 1952). Symbiotic association between legume and *rhizobium* converts about 70 million tonnes of atmospheric nitrogen per annum which amounts to about 40 per cent of all biologically fixed nitrogen per year (Burns and Hardy, 1975).

Materials and Methods

An experiment was conducted during *Rabi* season 2012-2013 at research farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur 208002 U.P. India. The field was well leveled and irrigated by tube well. The farm is situated west northern part of Kanpur city under sub tropical zone in agro climatic zone (central plan zone). The climate of Kanpur is semi arid sub tropical type. The soil was loamy in textural classes having pH 7, organic carbon 0.43 %, available N 250.0 kg ha⁻¹, available P 18.0 kg ha⁻¹, available K 75 kg ha⁻¹ and available S 16.0 kg ha⁻¹. The experiment was laid out in randomized block design with four replications. The 8 treatments were T₁ = Control (Uninoculated), T₂ = 2.5 Kg. sodium molybdate + 20 Kg. Sulphur, T₃ = 5.0 Kg. sodium molybdate + 40 Kg. Sulphur, T₄ = 7.5 Kg. sodium molybdate + 60 Kg. Sulphur, T₅ = Control + *Rhizobium*, T₆ = 2.5 Kg. sodium molybdate + 20 Kg. sulphur + *rhizobium*, T₇ = 5 Kg. sodium molybdate + 40 Kg. sulphur + *rhizobium* and T₈ = 7.5 Kg. sodium molybdate + 60 Kg. sulphur + *rhizobium*. The chickpea variety avrodhi was

used with seed rate of 90 kg ha⁻¹. The crop was sown on 12 Nov 2012 and harvested on 17 April 2013. Nutrient content of fertilizer material elemental sulphur 90 % sulphur, sodium molybdate 39 % molybdenum, DAP 18 % N and 46 % P₂O₅. Two irrigation was done as crop was sown in *rabi* season and one hand weeding done at 25 DAS. The uptake of nutrient was worked out in seed and stover of each plot separately. Nutrient contents in seed and stover were multiplied with seed and stover yield of respective treatment plot. Uptake of nutrients was recorded in gram plot⁻¹. Nitrogen and phosphorus uptake was calculated as:

Uptake of nutrients = { % N or P x Yield (gram/micro plot)/100 }.

Results and Discussion

The highest grain and stover yield due to sulphur and molybdenum use 28.20 and 29.68 q ha⁻¹ at level 5.0 kg sodium molybdate + 40 kg sulphur + *rhizobium* was respectively obtained. The sulphur and molybdenum application with *rhizobium* significantly increased the grain and stover yield of chickpea (Table 1). The control treatment showed the grain yield as 18.60 q ha⁻¹ which increased to 22.20, 23.90, 25.40, 26.80 and 28.20 q ha⁻¹ with respective levels at 0 kg sodium molybdate + 0 kg sulphur + *rhizobium*, 5 kg sodium molybdate + 20 kg sulphur, 2.5 kg sodium molybdate + 20 kg sulphur + *rhizobium*, 5 kg sodium molybdate + 40 kg sulphur and 5 kg sodium molybdate + 40 kg sulphur + *rhizobium*, respectively, and thereafter declined the grain yield at 7.5 kg sodium molybdate + 60 kg sulphur + *rhizobium*. Similarly straw yield increased to 23.08, 25.09, 26.67, and 28.40 q ha⁻¹ with respective levels at 0 kg sodium molybdate + 0 kg sulphur + *rhizobium*, 2.5 kg sodium molybdate + 20 kg sulphur, 2.5 kg sodium molybdate + 20 kg sulphur + *rhizobium* and

5.0 kg sodium molybdate + 40 kg sulphur and thereafter declined stover yield of 28.09 and 29.15 q ha⁻¹ at 7.5 kg sodium molybdate + 60 kg sulphur and 7.5 kg sodium molybdate + 60 kg sulphur respectively. The similar results were also obtained by (Agrawal and Sharma, 2005). The significant increase in nitrogen content in grain and stover due to use of sulphur and molybdenum with *rhizobium* was observed. In case of grain nitrogen value of 3.75 percent without inoculation increased to 3.88 per cent with *rhizobium* inoculation. Nitrogen uptake, which is a calculated product of nitrogen content and yield also significantly increased by microbial inoculation. Uninoculation showed grain nitrogen uptake value of 69.980 kg ha⁻¹ while in increased to 108.818 kg ha⁻¹ with *rhizobium*. The maximum nitrogen uptake was recorded 108.818 kg ha⁻¹ at 5.0 kg sodium molybdate + 40 kg sulphur + *rhizobium*. The sulphur and molybdenum with *rhizobium* application significantly increased nitrogen uptake in grain and stover noted as 82.673, 91.015, 102.563 and 108.818 kg ha⁻¹ in grain and 20.113, 22.463, 24.570, 26.578 kg ha⁻¹ in stover at level of 0 kg sodium molybdate + 0 kg sulphur + *rhizobium*, 2.5 kg sodium molybdate + 20 kg sulphur, 2.5 kg sodium molybdate + 20 kg sulphur + *rhizobium* and 5.0 kg sodium molybdate + 40 kg sulphur + *rhizobium*, respectively, also supported by the findings of (Prasad *et al.*, 2004); (Singh and Ram, 1998); (Naza and Abha, 2011).

Phosphorus uptake in grain as 13.09 kg ha⁻¹ at control and 15.65, 16.86, 17.95, 18.94 and 19.85 kg ha⁻¹ at respective levels of 0 kg sodium molybdate + 0 kg sulphur +

rhizobium, 2.5 kg sodium molybdate + 20 kg sulphur, 2.5 kg sodium molybdate + 20 kg sulphur + *rhizobium* and 5.0 kg sodium molybdate + 40 kg sulphur + *rhizobium*, respectively.

Sulphur content in grain and stover varied from 0.190 to 0.280% and from 0.130 to 0.220% respectively. The sulphur content in grain and stover with the combination inoculated treatment increases of sulphur and molybdenum. Increase in the concentration of sulphur, molybdenum and *rhizobium*, respectively has been reported by a number of scientists (Prasad *et al.*, 2004 and Naza and Abha, 2011).

The concentration and uptake of molybdenum increases with increasing doses of sodium molybdate and sulphur with the inoculation of *rhizobium*. The maximum sulphur content and uptake value received through the treatment combination of 5.0 kg. sodium molybdate + 40 kg sulphur + *rhizobium*. The minimum molybdate content and uptake gave by control either inoculated or uninoculated conditions. The results were significant and data are in agreement with several workers (Singh and Ram 1998 and Darpan *et al.*, 2007).

Application of 5.0 kg sodium molybdate + 40 kg sulphur + *Rhizobium* gave the highest grain and stover yield in chickpea crop. The above treatment also gave the highest nutrient contents, uptake values and protein contents. It is recommended that the application of micronutrients, secondary nutrient and biofertilizers are very important for better crop yield of chick pea (*Cicer aritetinum* L.).

Table.1 Effect of sulphur and molybdenum with *rhizobium* inoculation on yield of chickpea and, uptake of nitrogen phosphorus, sulphur and molybdenum grain and stover

Treatments	Yield (q ha ⁻¹)		Nitrogen uptake Kg. ha ⁻¹		phosphorus uptake Kg. ha ⁻¹		Sulphur uptake (Kg. ha ⁻¹)		Molybdenum uptake (g ha ⁻¹)	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
T₁	18.60	19.50	69.980	18.303	13.093	5.475	3.555	2.380	7.115	1.515
T₂	23.90	25.09	91.015	22.463	16.868	6.680	5.505	4.015	7.115	1.975
T₃	26.80	28.40	102.563	24.405	18.948	7.245	6.395	5.085	10.815	2.245
T₄	26.50	28.09	101.303	24.570	18.705	7.125	6.440	4.795	10.655	2.230
T₅	22.20	28.08	82.673	20.113	15.650	5.955	4.370	3.225	8.530	1.815
T₆	25.40	26.67	98.093	24.048	17.958	7.105	5.845	5.235	10.215	2.145
T₇	28.20	29.68	108.818	26.578	19.850	7.758	7.855	6.295	11.595	2.405
T₈	27.50	21.15	106.570	25.717	19.468	7.565	7.160	6.115	11.345	2.205
SE (m) ±	0.456	0.198	1.704	0.267	0.314	0.066	0.163	0.242	0.261	0.046
CD at 5 %	1.350	0.585	5.044	0.789	0.930	0.195	0.330	0.488	0.529	0.095

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