

Effect of rhizobium inoculation with different levels of inorganic fertilizers on yield, nutrient content & uptake of chickpea (*Cicer arietinum* L.)

Abstract

The field experiment was conducted during Rabi season of 2021-22, to study the effect of combination of biofertilizer and different level of inorganic fertilizers on yield, quality, nutrient content & uptake of chickpea (*Cicer arietinum* L.) at pot culture farm of Department of Soil Science & Agricultural Chemistry of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur (U.P.). The experiment comprises of eight treatments T₁ (Control), T₂ (RDF 75%), T₃ (RDF 100%), T₄ (RDF 125%), T₅ (Rhizobium), T₆ (RDF 75% + Rhizobium), T₇ (RDF 100% + Rhizobium), T₈ (RDF 125% + Rhizobium) in randomized block design with four replications. The chickpea variety RVG-202 is grown by adopting various agronomic practices. The result revealed that among all the treatments, RDF 125% + Rhizobium (T₈) treatment recorded maximum yield, highest nutrient content & uptake in grain and stover of chickpea. It also shows that the seed inoculated with rhizobium increases yield, nutrient content & uptake as compared to un-inoculated seed.

Keywords: Chickpea, Nitrogen, Phosphorus, Potassium, Rhizobium and Yield

1. Introduction:

Chickpea (*Cicer arietinum* L.) is important cool and Rabi season self pollinated crop. Chickpea commonly known as bengalgram or gram & locally channa is the most important & unique pulse crop of India because of its use in the variety of food products like snacks, sweet etc. It is widely cultivated in India, Australia, Pakistan, Turkey, Myanmar and Ethiopia. Chickpea have medicinal property & is used for blood purification and germinated seed are recommended to cure scurvy disease. Chickpea has one of the highest nutritional compositions of any dry edible legume. According to the international crops research institute for the semi arid tropics (ICRISAT) chickpea seed contains 21.1% protein, 64% total carbohydrates, 47% starch, 4.5% fat, 6.2% crude fiber, 6 % soluble sugar and 3% ash. The mineral component is high in phosphorus (340 mg per 100 g), calcium (190 mg per 100 g), magnesium (140 mg per 100g), iron (7 mg per 100 g) and zinc (3 mg per 100 g), niacin.

Nitrogen plays an imperative role in synthesis of chlorophyll, protoplasm, nucleic acid, protein, amino acids and other organic compounds which add to the building units of proteins in the plant system. Phosphorus is one of the most important major nutrients of plant and chickpea varieties also respond significantly to its application. Phosphorus play important role in energy transfer and protein metabolism and also associated with increased root growth and early maturity of crops (Siag, 1995). Phosphate fertilization of chickpea promotes growth, nodulation and enhances yield. Phosphorus imparts hardness to shoots, improves grain quality, regulates the photo-synthesis, governs physio-bio-chemical processes and also helps in root enlargement, nodule production and thereby increasing nitrogen fixation (Siag *et al.*, 1995). Potassium is an

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essential macro nutrient for plant that enhances root growth and makes plant vigor, helps prevent lodging and enhances crop resistance to pests and diseases. Potassium is very effective in the nodulation of pulse crops thus increases the seed yield through better fixation of nitrogen (Rajput, 2018). Rhizobium inoculation helps to improve nodulation, plant growth and grain yield. Rhizobium inoculated pulse crop produces a 10–15% higher grain yield than a crop that has not been inoculated (Fatima, *et al.*, 2008).

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2. Materials and Methods:

2.1 Experimental Site:

The field experiment was conducted at pot culture farm of Department of Soil Science & Agricultural Chemistry of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur (U.P) during *Rabi* season of 2021-22, under central plain zone.

2.2 Geographical Situation:

Geographically, district “Kanpur Nagar” lies between the parallels of 25.26⁰ and 26.58⁰ N latitude, and 79.31⁰ and 80.34⁰ E longitude. It is situated on elevation of 124 meters above the sea level in the alluvial belt of Gangatic plains of central Uttar Pradesh.

2.3 Climate:

The climate of Kanpur is sub-tropical with hot dry summer and severe cold winter. The annual precipitation is about 800 mm mostly received during rainy season, with occasional showers in winter from early November to the end of March. The maximum temperature during the experiment ranged from 15 to 40 °C while minimum ranged from 4.5 to 18 °C. Mean relative humidity ranged from 50 to 85 %.

2.4 Experimental Detail

The experiment comprises of eight treatments T₁ (Control), T₂ (RDF 75%), T₃ (RDF 100%), T₄ (RDF 125%), T₅ (Rhizobium), T₆ (RDF 75% + Rhizobium), T₇ (RDF 100% + Rhizobium), T₈ (RDF 125% + Rhizobium) in randomized block design with four replications. The recommended dose of fertilizer to chickpea is 20-30 kg N ha⁻¹, 40-60 kg P₂O₅ ha⁻¹ & 17-25 kg K ha⁻¹ (if soil low in K) were applied as per treatments through DAP and urea and MOP. The chickpea variety RVG-202 was sown with seed rate of 80- 100 kg ha⁻¹ at spacing of 30 cm x 10 cm. The seed was treated with rhizobium before sowing at the rate of 20-25 gm of rhizobium per kg of seed. As per procedure seed was dry under shade for 6-8 hrs. The production of each plot collected separately and packed in bags carefully avoiding contamination. The grains & straw of each bag were then weighed and recorded in kg per net plot and there after computed as q ha⁻¹. The biological yield is the sum of grain and straw yield. The harvest index is computed by following formula -

$$H.I = \frac{\text{Grain yield}}{\text{biological yield}} \times 100$$

The chemical analysis of plants for the nutrient content was done when grain and straw samples were collected from each plot at harvest to analyze nitrogen, phosphorous and potassium concentration (%) and their uptake (kg ha⁻¹). The plant material was oven dried (70± 50C for 72 hours) and ground separately and then subjected for analysis. Plant analysis for the determination of nutrient content in grain and stover were done with the standard procedures viz., Nitrogen concentration in plant (both grain and straw) was determined by Kjeldahl's method (Jackson, 1973), Phosphorus by colorimetric method (Jackson, 1973), Potassium by flame photometer (Jackson, 1973). The uptake of nitrogen, phosphorus, potassium and were done by the following formula-

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\% \text{ NorPorKcontent} \times \text{yield (kg ha}^{-1}\text{)}}{100}$$

The data reported was analyzed statistically with standard procedure of ANOVA technique. The standard errors of mean were calculated in each item of investigation and critical differences (CD) at 5% level were worked out for comparing the treatment mean wherever 'F' test was found significant Chandel (1998).

3. Result and Discussion

3.1 Grain and Stover yield

Application of combination of rhizobium and different levels of inorganic fertilizers significantly influenced the grain and stover yield of chickpea. It is evident from the data given in Table 1 that the maximum grain and stover yield was observed with application of RDF 125% along with seed inoculation by rhizobium (T₈) gave the highest grain yield (18.35 q ha⁻¹) & stover yield (25.69 q ha⁻¹), which were superior to rest of the treatments, while minimum was recorded in control (T₁). Seed inoculation with rhizobium increases the grain and stover yield as compared to un-inoculated. The increase in grain and stover yield due to adequate supply of available nutrients to crop resulting in better growth and development eventually reflected into better grain and stover yield. The increase in yields with bio-fertilizers was mainly due to the increase in almost all growth and yield contributing characters, which eventually lead to a significant increase in grain and stover yields. Similar result was also reported by Singh A. *et al.* (2021), Sharma (2001), Patel *et al.* (2007), Patel H.A. *et al.*, (2020), kantar *et al.* (2003), Prasad *et al.*, (2005), Gupta (2006), Kumar *et al.*(2014).

3.2 Biological yield

Biological yield is influenced by application of combination of biofertilizer and different level of inorganic fertilizers. It is evident from the data given in Table 1 that maximum biological

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yield (44.04 q ha⁻¹) was recorded with application of RDF 125% along with seed inoculation by rhizobium (T₈) and minimum biological yield was observed in control (T₁). Similar result was also reported by **Patel H.A. et al. (2020)**.

3.3 Nitrogen Content and uptake

The higher value of nitrogen content in grain and stover (Table 2) was noticed with the application of 125% recommended dose of fertilizer (RDF) along with seed inoculation by rhizobium (T₈) followed by RDF 100% + rhizobium (T₇), RDF125% (T₄), RDF75% + rhizobium(T₆). The lowest values of nitrogen content in grain and stover were observed in control (T₁) where no fertilizer was given to chickpea. Similar finding was also reported by **Singh A. et al. (2021), Jain et al. (2005) and Kumar et al. (2014)**.

The nitrogen uptake in grain and stover of chickpea (Table 3) was significantly influenced in all the treatments over control by application of combination of rhizobium and different level of inorganic fertilizer. Application of RDF125% + rhizobium (T₈) showed the highest uptake of N in grain and stover, followed by RDF 100% + rhizobium (T₇), RDF125% (T₄), RDF75% + rhizobium (T₆). However, minimum N uptake in grain and stover was observed in control (T₁). This is due to higher nitrogen fixing capacity of plant roots. Similar result was also reported by **Singh A. et al. (2021), Kharche et al. (2006) and Kumar et al. (2014)**.

3.4 Phosphorus content and uptake

The data related to phosphorus content in grain and stover of chickpea presented in Table 2. The phosphorus content in grain and stover was influenced by application of combination of rhizobium and different level of inorganic fertilizers. Maximum P content in grain and stover was recorded with T₈ (RDF125% + *Rhizobium*) followed by RDF100% + rhizobium (T₇), RDF 125% (T₄), RDF75% + rhizobium (T₆) and the lowest values of phosphorus content in grain and stover were observed with control (T₁). Almost similar result was also reported by **Singh A. et al. (2021), Jain and Singh (2003), Dadgale et al. (2011) and Kumar et al. (2014)**.

The significantly higher phosphorus uptake (Table 3) by grain and stover was noticed with the application of T₈ (RDF125% + *Rhizobium*) followed by RDF100% + rhizobium (T₇), RDF125% (T₄) and minimum phosphorus uptake was reported at control (T₁). Similar result was also reported by **Singh A. et al. (2021), Kalipada and Singh (2003), Thenua et al. (2010) and Kumar et al. (2014)**.

3.5 Potassium content and uptake

The data related to potassium content in grain and stover of chickpea presented in Table 2. The potassium content in grain and stover was influenced by application of combination of rhizobium and different level of inorganic fertilizers. Maximum K content was noted with T₈ (RDF125% + *Rhizobium*) followed by T₇ (100% RDF + *Rhizobium*) and minimum at control (T₁). Almost similar result was also reported by **Singh A. et al. (2021), Singh and Prasad (2008), Murari et al. (2013) and Kumar et al. (2014)**.

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The uptake of potassium in grain and stover (Table 3) of chickpea was also influenced with application of rhizobium and different level of inorganic fertilizer. The highest uptake of K in grain and stover of chickpea was recorded with treatment T₈ (RDF 125% + *Rhizobium*) followed T₇ (RDF 100% + *Rhizobium*) and minimum at control (T₁). Similar result was also reported by Singh A. *et al.* (2021), Sahu *et al.* (2008), Meena and Sharma (2010), and Jangir *et al.* (2017) and Kumar *et al.* (2014).

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Table 1: Effect of treatments on grain & stover yield of chickpea

Treatments	Grain yield (q ha ⁻¹)	Stover yield (q ha ⁻¹)	Biological yield (q ha ⁻¹)
T ₁ : control	12.25	19.96	32.21
T ₂ : RDF 75%	14.10	21.99	36.09
T ₃ : RDF 100%	14.85	22.72	37.57
T ₄ : RDF 125%	16.24	23.71	39.95
T ₅ : Rhizobium	13.42	21.47	34.89
T ₆ : RDF75% + Rhizobium	15.62	23.43	39.05
T ₇ : RDF100% + Rhizobium	17.44	24.93	42.37
T ₈ : RDF125% + Rhizobium	18.35	25.69	44.04
S. Em ±	0.38	0.51	0.84
C.D. at 5%	1.14	1.51	2.49

Table 2: Effect of treatments on nutrient content in grain & stover

Treatments	Nutrient content in grain & stover (%)					
	Grain			Stover		
	N	P	K	N	P	K
T ₁ : control	3.05	1.15	0.51	1.88	0.21	1.63
T ₂ : RDF 75%	3.16	1.21	0.54	1.97	0.24	1.68
T ₃ : RDF 100%	3.22	1.23	0.57	2.02	0.26	1.70
T ₄ : RDF 125%	3.44	1.26	0.63	2.20	0.30	1.77
T ₅ : Rhizobium	3.10	1.18	0.53	1.92	0.23	1.66
T ₆ : RDF75% + Rhizobium	3.32	1.25	0.60	2.11	0.28	1.73
T ₇ : RDF100% + Rhizobium	3.50	1.30	0.65	2.29	0.33	1.81
T ₈ : RDF125% + Rhizobium	3.58	1.34	0.69	2.38	0.35	1.86
S. Em ±	0.077	0.027	0.012	0.071	0.012	0.045
C.D. at 5%	0.227	0.079	0.035	0.211	0.035	0.133

Table 3: Effect of treatments on nutrient uptake on grain & stover

Treatments	Nutrient uptake in grain & stover (kg ha ⁻¹)					
	Grain			Stover		
	N	P	K	N	P	K
T ₁ : control	37.36	14.08	6.24	37.52	4.19	32.53
T ₂ : RDF 75%	44.55	17.06	7.61	43.32	5.27	36.94
T ₃ : RDF 100%	47.81	18.26	8.46	45.89	5.90	38.62
T ₄ : RDF 125%	55.86	20.46	10.23	52.16	7.11	41.96
T ₅ : Rhizobium	41.60	15.83	7.11	41.22	4.93	35.64
T ₆ : RDF75% + Rhizobium	51.85	19.52	9.37	49.43	6.56	40.53
T ₇ : RDF100% + Rhizobium	61.04	22.67	11.33	57.08	8.22	45.12
T ₈ : RDF125% + Rhizobium	65.69	24.58	12.66	61.14	8.99	47.78
S. Em ±	1.012	0.60	0.373	0.917	0.139	0.969
C.D. at 5%	2.99	1.78	1.103	2.7	0.411	2.869

4. Conclusion

From the result obtained with the following experiment it may concluded that application of different combination of rhizobium and inorganic fertilizers showed positive influence on yield, nutrient content & uptake of chickpea. Since the application of 125% RDF along with seed inoculation by rhizobium showed significantly higher results than rest of treatments so it is advisable to use rhizobium along with inorganic fertilizers to reduce the excessive use of inorganic fertilizers and to achieve higher yield as well as higher nutrient content and uptake of chickpea.

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