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Effect of different tillage practices and nutrient management on growth and yield of chickpea (*Cicer arietinum* L.)

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Abstract

The field experiment entitled "Effect of different tillage practices and nutrient management on growth and yield of chickpea" was conducted during *Rabi* season, 2023 at Crop Research Farm in the Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. The experiment layout was in Randomized Block Design (RBD) with 10 treatments and replicated thrice. Application of Reduced tillage + 75% RDF + FYM + Biofertilizer produces highest plant height (46.83 cm), maximum number of nodules/plant (21.71) and higher plant dry weight (34.85 g), maximum number of pods/plant (47.65), maximum number of grains/pod (1.91), higher seed yield (1535.18 kg /ha), straw yield (3193.10 kg /ha).

Keywords: Chickpea, Biofertilizer, tillage, growth and yield.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is world's third most important pulse crop and the premier pulse crop of India, popularly known as gram or Bengal gram is mainly grown in Rabi season. It contains about 21.1% protein, 61.5% carbohydrate, 4-5% fat, 0.49% lysine, 0.04% tryptophane and 0.11% methionine. It is rich in calcium, phosphorus, iron, niacin, vitamin-B and vitamin-C. It leaves contain malic acid which is very useful for stomach ailments and blood purification. It being a pulse crop enriches the soil through symbiotic nitrogen fixation.

Chickpea grain is a rich source of dietary protein, minerals, vitamins, and dietary fiber (Wood and Grusak 2007). It is cultivated mostly in arid and semiarid regions around the world, with temperatures between 5 and 25 °C and annual rainfall of 200–600 mm, on rainfed soils

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(sandy to silt loam) with residual moisture (Chibarabada *et al.* 2017). In the tropics, chickpea is grown in winter, while in temperate climates it is a summer or spring crop (Gaur *et al.* 2010).

India had 10.17 million hectares area under chickpea cultivation with production of 11.35 million tonnes and productivity of 1116 kg /ha (GOI 2023-24). In Rajasthan, chickpea grown in 2.46 million hectares area with production 2.66 million tonnes and average productivity of 1080 kg /ha (GOI 2023-24).

The intensive tillage increases soil compaction, disrupts aggregates stability and productivity of soil, decreased the retentive capacity and transportation of water and solutes apart from exacerbating losses due to run-off erosion (Goddard *et al.* 2008). Thus, conservation agriculture-based cultivation practices are a viable option for enhancing soil nutrient dynamics as well effective to check land degradation. The major benefits of conservation tillage are i) reduce costs owing to savings in fuel and labour ii) timely planting of succeeding crops resulting in more yield advantage iii) saving of irrigation water iv) improved input–use efficiencies and build–up in soil organic carbon (Gupta and Sayre, 2007; Saharawat *et al.* 2010; Parihar *et al.* 2016).

Fertilizers are an important tool of modern agriculture and need to be acknowledged as it limits nutrient mining which arises when crop removes more nutrients than are replenished by the farmers or natural processes. Imbalance use of fertilizers notably farmers fertilizer practice (FFP) causes fertilizer application (input) to fall short of its removal (output) which lead to soil fertility degradation and caused a reduction in yield potential of a crop. Nutrient management is a dynamic process and need to focus on its balanced application. Site-specific nutrient management through 'nutrient expert' (NE–SSNM) guided tools emphasizes on supplying the nutrient as and when needed strives to enable farmers to adjust fertilizer use to meet the deficit between the nutrient demand of a high-yield crop and the nutrient supply from naturally occurring indigenous sources in soil. The nutrient expert for hybrid maize developed by the International Plant Nutrition Institute (IPNI), is a new computer-based decision support tool that enables researchers, extension experts and agronomist to quickly develop field specific fertilizer recommendation for chickpea (Witt *et al.* 2009). Site-specific nutrient management practices combined with proper crop

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establishment practices would help farmers attained high yield coupled with higher profitability both in short and medium run.

MATERIALS AND METHODS

This experiment was laid out during the *Rabi* season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 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 Which consisting of ten treatments with T_1 – Conventional tillage + 100% RDF, T_2 – Conventional tillage + 75% RDF + FYM @ 5 t ha^{-1}, T_3 – Conventional tillage + 75% RDF + FYM + Biofertilizer, T_4 - Zero tillage + 100% RDF, T_5 - Zero tillage + 75% RDF + FYM @ 5 t ha^{-1}, T_6 - Zero tillage + 75% RDF + FYM + Biofertilizer, T_7 - Reduced tillage + 100% RDF, T_8 - Reduced tillage + 75% RDF + FYM @ 5 t ha^{-1}, T_9 - Reduced tillage + 75% RDF + FYM + Biofertilizer, T_{10} - Control (RDF 20-50-20).The soil in the experimental area was sandy loam with pH (8.0), Organic Carbon (0.42%), Available N (180.58 kg /ha), Available P (15.54 kg/ha), and Available K (198.67 kg /ha). Seeds are sown at a spacing of 30×10 cm^2 to a seed rate of 80 kg /ha. The recommended dose of nitrogen (20 kg /ha), phosphorus (50 kg /ha) and potassium (20 kg /ha) and Biofertilizer and phosphorus were applied as per the treatments. Data recorded on different aspects of crop, *viz.,* growth, yield attributes were subjected to statistically analysis by analysis of variance method. (Gomez and Gomez, 1976) and economic data analysis mathematical method.

RESULTS AND DISCUSSION

Growth Parameters

Plant height (cm)

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The data revealed that a significantly and higher plant height (46.83 cm) was recorded in T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer). However, the T_6 (Zero tillage + 75% RDF + FYM + Biofertilizer (46.11 cm), T_3 (Conventional tillage + 75% RDF + FYM + Biofertilizer) (45.05 cm), T_8 (Reduced tillage + 75% RDF + FYM @ 5 t ha^{-1}) (46.09 cm), T_2 (Conventional tillage + 75% RDF + FYM @ 5 t ha^{-1}) (43.23 cm), T7 (Reduced tillage + 100% RDF) (42.77 cm) were found to be statistically at par with T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) in (Table 1).

Significant increase in plant height with *Rhizobium* and PSB might be due to increase in uptake of N and P by the plants, which might be due to more N-fixation and P-solubilization through micro-organisms Singh *et al*. (2018). Further application of phosphorus (60 kg /ha) may be due to the stimulating effect of phosphorus on plant process as phosphorus is a major constituent of plant cell nucleus and growing root tips which help in cell division and root elongation which results in vigorous growth of plants and extension root system leading to increase in growth parameters. Similar findings were observed by Choudhary *et al*. (2005)

Number of nodules/plants

The data revealed that a significant and maximum number of nodules/plant (21.71) was recorded in T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer). However, T_6 (Zero tillage + 75% RDF + FYM + Biofertilizer) (21.25) T_3 (Conventional tillage + 75% RDF + FYM + Biofertilizer) (20.31), T_7 (Reduced tillage + 100% RDF) (20.25) and T_8 (Reduced tillage + 75% RDF + FYM @ 5 t ha^{-1}) (19.91) were found to be statistically at par with T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) in (Table 1).

Significant and maximum number of nodules/plants was with application of *Rhizobium*, increase the number of nodules by availability of nitrogenase enzyme PSB facilitates the nodule formation by proper development of nodules by increasing availability of phosphorus through the mobilizing the unavailable phosphorus present in soil Singh *et al*. (2018).

At harvest the significant and maximum number of nodules per plant was with application of phosphorus (50 kg /ha) might be due to with increased levels of P function in most of the physiological and metabolic processes resulting in increased growth and development, resulting in higher plants height. Similar result was also reported by Yumnam *et al*. (2018).

Plant dry weight

The data revealed that significant and maximum plant dry weight (34.85 g) was recorded in T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer). However, the T_6 (Zero tillage + 75% RDF + FYM + Biofertilizer) (33.81 g), T_3 (Conventional tillage + 75% RDF + FYM + Biofertilizer) (32.09 g), T_7 (Reduced tillage + 100% RDF) (32.07) and T_5 (Zero tillage + 75% RDF + FYM @ 5 t ha^{-1}) (31.18 g) was statistically at par with T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) in (Table 1).

Significant and maximum number of dry weight was with application of *Rhizobium*, increase the dry matter by availability of nitrogenase enzyme PSB increasing the Dry matter production from advanced growth stages to at harvest in which seed treatment with *Rhizobium* had fixed atmospheric nitrogen in the soil into available forms and PSB increased availability of phosphates to plants by mineralizing organic phosphorus compounds. The results are in accordance with Singh *et al.* (2018). Further application of phosphorus (60 kg /ha) being an energy bond compound and its major role is transformation of energy essential for almost all metabolic processes photosynthesis, respiration, cell elongation and cell division, activation of amino acids for synthesis of protein and carbohydrate metabolism which ultimately increase all the growth attributes and dry weight of plants. Similar results have been reported by Singh *et al.* (2010).

Number of pods/plant

The data revealed that T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) was recorded significant and maximum number of pods/plant (47.65) which was superior over all other treatments. However, the T_6 (Zero tillage + 75% RDF + FYM + Biofertilizer) and T_3 (Conventional tillage + 75% RDF + FYM + Biofertilizer) T_5 (Zero tillage + 75% RDF + FYM @ 5 t ha^{-1}), T_7 (Reduced tillage + 100% RDF), T_4 (Zero tillage + 100% RDF) and T_8 (Reduced tillage + 75% RDF + FYM @ 5 t ha^{-1}), was found to be statistically at par with the T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) (Table 2).

Significant and higher number of pods/plants was with the application of phosphorus which it might be the reason of moderate plant nutrients availability due to which the plant produces more pods/plant as compare to other treatments and also phosphorus strongly

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increases the reproduction of the plants i.e., flowering and fruiting. These results were similar with that of Abid *et al.* (2017).

Number of seeds/pods:

The data revealed that T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) was recorded significant and maximum number of seeds/pod (1.91) which was superior over all other treatments. However, the T_6 (Zero tillage + 75% RDF + FYM + Biofertilizer), T_3 (Conventional tillage + 75% RDF + FYM + Biofertilizer) and T_5 (Zero tillage + 75% RDF + FYM @ 5 t ha^{-1}) was found to be statistically at par with the T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer in (Table 2).

Significant and higher number of seed/plants was with the application of phosphorus which it might be the reason of moderate plant nutrients availability due to which the plant produces a greater number of seed/pods is a genetically controlled character and the difference among genotypes was due to their different genetic ability for this parameter. Similar results also reported by Rahman *et al.* (2013).

Seed Yield (kg/ha):

The data revealed that T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) was recorded significantly maximum Seed yield (1535.18 kg/ha) which was superior over all other treatments. However, the T_6 (Zero tillage + 75% RDF + FYM + Biofertilizer), T_3 (Conventional tillage + 75% RDF + FYM + Biofertilizer) were found to be statistically at par with the T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) in (Table 2).

Significant increase in seed yield might be due to the Dual inoculation of *Rhizobium* can increase seed yield in pulse crop up to 10 to 15% while PSB increase availability of insoluble phosphorous into soil. Results were similar to Singh *et al*. (2018). Further seed yield was with application of phosphatic fertilizer therefore provided balance nutrition to the crop which resulted in higher seed yield of lentil. Phosphorus also increased the photosynthesis and translocation of assimilates to different plant parts for enhanced growth and yield attributing characters of the crop as observed in number of pods per plant and number of seeds per pod. In the later stage, the excess assimilates stored in the leaves was translocated towards sink development which ultimately contributed to higher seed yield. These findings were supported by Choubey *et al.* (2013).

Stover yield (kg/ha):

The data revealed that T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) was recorded significantly maximum Stover yield (3193.10 kg/ha) which was superior over all other treatments. However, the T_6 (Zero tillage + 75% RDF + FYM + Biofertilizer), T_3 (Conventional tillage + 75% RDF + FYM + Biofertilizer), T_4 (*Rhizobium* + phosphorus 40 kg/ha)) and T_8 (Reduced tillage + 75% RDF + FYM @ 5 t ha^{-1}) and T_5 (Zero tillage + 75% RDF + FYM @ 5 t ha^{-1}) was found to be statically at par with T_9 (Reduced tillage + 75% RDF + FYM + Biofertilizer) in (Table 2).

Significant increase in stover yield with Dual inoculation of *Rhizobium*, PSB increase in nitrogen availability in soil leads to increase in content of nitrogen in seed and increase in P availability through solubilization of insoluble native P and production of plant growth promoting substances. Results were similar to (Singh *et al.* 2014). Significant and higher stover yield was with application of phosphorus might have contributed for better growth of plant as expressed in terms of plant height, number of nodules/plants, dry weight, which improved nutrient uptake, resulted increased in stover yield. Similar findings were reported by Choubey *et al.* (2013).

CONCLUSION:

Based on the above findings it can be concluded that Chickpea with Reduced tillage along with the application of 75% RDF + FYM + Biofertilizer (T_9) recorded highest plant height, no. of nodules, dry weight, no. of pods/plant, no. of seeds/pod, seed yield and stover yield.

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S.No.	Treatment combinations	At 80 DAS		
		Plant height (cm)	Number of nodules/plant	Dry weight (g/plant)
1.	Conventional tillage + 100% RDF	42.41	18.58	28.58
2.	Conventional tillage + 75% RDF + FYM @ 5 t ha^{-1}	43.23	18.71	27.40
3.	Conventional tillage + 75% RDF + FYM + Biofertilizer	45.05	20.31	32.09
4.	Zero tillage + 100% RDF	42.06	19.11	30.72
5.	Zero tillage + 75% RDF + FYM @ 5 t ha^{-1}	40.64	18.38	31.18
6.	Zero tillage + 75% RDF + FYM + Biofertilizer	46.12	21.25	33.80
7.	Reduced tillage+ 100% RDF	42.77	20.25	32.07
8.	Reduced tillage+ 75% RDF + FYM @ 5 t ha^{-1}	44.07	19.91	30.40
9.	Reduced tillage+ 75% RDF + FYM + Biofertilizer	46.83	21.71	34.85
10.	Control (NPK 20-50-20 kg/ha)	37.83	17.91	26.40
	F-test	S	S	S
	SEm(±)	1.48	0.60	1.30

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CD (p=0.05)		3.98	1.80	3.84

Table: 1 Effect of different tillage practices and nutrient management on growth of Chickpea.

Table: 2 Effect of different tillage practices and nutrient management on yield and yield attributes of Chickpea.

S.No.	Treatment combination	Number of pods/plants	Number of seeds/pod	Seed Yield (kg/ha)	Stover Yield (kg/ha)
1.	Conventional tillage + 100% RDF	42.51	1.51	1161.76	2800.94
2.	Conventional tillage + 75% RDF + FYM @ 5 t ha^{-1}	41.11	1.45	1193.66	2841.34
3.	Conventional tillage + 75% RDF + FYM + Biofertilizer	46.25	1.65	1381.01	3084.90
4.	Zero tillage + 100% RDF	44.91	1.45	1243.43	2923.02
5.	Zero tillage + 75% RDF + FYM @ 5 t ha^{-1}	43.85	1.58	1353.78	2951.59
6.	Zero tillage + 75% RDF + FYM + Biofertilizer	46.71	1.78	1414.54	3141.38
7.	Reduced tillage+ 100% RDF	43.71	1.51	1200.95	2911.14

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8.	Reduced tillage+ 75% RDF + FYM @ 5 t ha^{-1}	44.45	1.38	1292.85	3039.70
9.	Reduced tillage+ 75% RDF + FYM + Biofertilizer	47.65	1.91	1535.19	3193.10
10.	Control (NPK 20-50-20 kg/ha)	39.51	1.31	1143.40	2712.21
	F-test	S	S	S	S
	SEm(±)	1.30	0.10	52.70	87.88
	CD (p=0.05)	3.78	0.30	160.55	265.05

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