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Effect of nutrient management on growth, yield and economics of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted on Effect of integrated nutrient management in chickpea (*Cicer arietinum* L.) at Post Graduate Research Farm, college of Agriculture, Dhule (Maharashtra) during *rabi* season 2021-22. The experiment was laid out in randomized block design with three replications. The nine treatments included T_1 -Absolute Control (No any fertilizer), T_2 -100% RDF (25:50:30 N : P_2O_5 : K_2O kg ha^{-1}), T_3 - 100% RDF + FYM 5 tonne ha^{-1} + *Rhizobium*+ PSB, T_4 -75% RDF + FYM 1.25 tonne ha^{-1} + *Rhizobium* + PSB, T_5 - 75% RDF + Vermicompost 0.75 tonne ha^{-1} + *Rhizobium* + PSB, T_6 -75% RDF + Neem cake 125 kg ha^{-1} + *Rhizobium* + PSB, T_7 -50% RDF + FYM 2.5 tonne ha^{-1} + *Rhizobium* + PSB, T_8 - 50% RDF + Vermicompost 1.5 tonne ha^{-1} + *Rhizobium* + PSB, T_9 - 50% RDF + Neem cake 250 kg ha^{-1} + *Rhizobium* + PSB. Among the different integrated nutrient management treatments, 100% RDF + FYM 5 tonne ha^{-1} + *Rhizobium*+ PSB (T_3) recorded significantly higher almost all growth characters *viz*., plant height, plant spread, number of branches, dry matter $plant^{-1}$, yield attributes, yield, gross monetary returns and net monetary returns than other integrated nutrient management treatments.

Keywords: Chickpea, nutrient management, growth, yield

Introduction
Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops which is known as a complete protein because they contain all nine essential ammino acids, which are building blocks that helps our bodies function properly. It is also an excellent source of non-animal and they are great source for vegetarians and vegans.

The indiscriminate use of chemical fertilizers has resulted in the extinction of important soil fauna and flora. Organic manures change the physical behaviour of the soil and improve the efficacy of added fertilizers. Organic manures not only provide a higher concentration of various nutrients, but they also contain helpful microbes such as nitrogen-fixing bacteria, mycorrhizae, and growth-promoting compounds that benefit crops. Biofertilizers might be a great addition to fertilizers. Fertilizers such as nitrogen and phosphorus are the most critical and costly inputs in crop production. A sufficient supply of chemical fertilizers is strongly linked to plant growth and development.

Rhizobium and phosphate solubilizing bacteria (PSB) play a vital role in N_2-fixation and P solubilization. The use of *Rhizobium* and PSB has been found to improve chickpea productivity. Auxins and gibberellin hormones are released by biofertilizers that live in the root zone, which encourage plant growth and nutrient intake. *Rhizobium* inoculation can boost pulse crop grain yields by 10% to 15%. By mineralizing organic phosphorus molecules, phosphate solubilizing bacteria (PSB) have a constant ability to improve the availability of phosphates to plants.

Nitrogen is necessary for plant growth and development. It is a component of chlorophyll, protoplasm, nucleic acids, and protein, which are the building blocks of all proteins, including enzymes, which control all biological processes. In pulses, phosphorus plays an important role in energy storage and transfer. Early in their existence, plants' reproductive parts require an adequate amount of phosphorus. Phosphorus is regarded as the pioneer plant nutrient required by leguminous crops which increases rhizobial activity and root nodule formation, enabling for increased nitrogen fixation in root nodules. Potassium is a macronutrient that promotes root growth and plant vitality, as well as preventing lodging and increasing crop tolerance to pests and diseases.

Materials and Methods

The field experiment was conducted in the *rabi* season of year 2021-22. Climatologically, this area falls in the sub-tropical region at the North. Generally, monsoon commences by third week of June and retreats at the end of September with the average annual rainfall of 607 mm. Experiment consisted of nine treatments laid out in randomized block design with three replications. The treatments consist of Absolute Control (No any fertilizer) (T_1), 100% RDF (25:50:30 N : P_2O_5 : K_2O kg ha^{-1}) (T_2), 100% RDF + FYM 5 tonne ha^{-1} + *Rhizobium*+ PSB (T_3), 75% RDF + FYM 1.25 tonne ha^{-1} + *Rhizobium* + PSB (T_4), 75% RDF + Vermicompost 0.75 tonne ha^{-1} + *Rhizobium* + PSB (T_5), 75% RDF + Neem cake 125 kg ha^{-1} + *Rhizobium* + PSB (T_6), 50% RDF + FYM 2.5 tonne ha^{-1} + *Rhizobium* + PSB (T_7), 50% RDF + Vermicompost 1.5 tonne ha^{-1} + *Rhizobium* + PSB (T_8), 50% RDF + Neem cake 250 kg ha-1 + Rhizobium + PSB (T_9). The seed of chickpea variety Phule Vikram was sown on 17th November 2021 at spacing of 30 x 10 cm^2 using seed rate 70 kg ha^{-1}. The required quantity of fertilizers *viz.*, FYM, vermicompost, neem cake, urea, SSP, MOP was measured by weighing balance at the time of preparation of manures and fertilizers according to treatments. The crop was grown with recommended package of practices and was harvested at maturity on 13th March 2022. The data recorded were statistically analyzed by using technique of analysis of variance and significance was determine as given by Panse and Sukhatme (1985) [10] for Randomized Block Design. Standard error of mean (S.E.m. ±) was worked out for each factor and interaction. Whenever the results were significant, the critical difference (C.D.) at 5 per cent level of significance was work out and presented. The data were also presented in tabulated form with suitable graphical illustration and figures at appropriate places.

Results and Discussion

Effect of nutrient management practices on growth of chickpea

Growth studies

The observations regarding the growth *viz*., plant height (cm), plant spread(cm), number of branches and total dry matter accumulation (g) $plant^{-1}$ were significantly influenced by different integrated nutrient management treatments. The growth characters were observed significantly higher under 100% RDF + FYM 5 tonne ha^{-1} + *Rhizobium* and PSB treatment (T_3) than in the rest of the nutrient management treatments in the study, while it was recorded significantly lowest in absolute control (T_1) treatment.

This increase in growth parameters with increased fertilizer doses might be due to the availability of sufficient nutrients by mineralization of basic organic and inorganic sources of nutrient at proper growth stages of crop This facilitated the availability of required nutrients for the luxurious and healthy growth of chickpea. The better nutrition to the plant resulted more plant height (cm), plant spread (cm), number of branches, dry matter $plant^{-1}$ (g) which resulted in better light interception and accumulation of more photosynthesis thus produced higher dry matter production. The findings were analogous to those obtained by Jakhar *et al*., (2020) [2], Kumar *et al*., (2019) [5], Mohanvel *et al*., (2021) [8] and Nawale *et al*., (2009) [8]

Yield attributes and yield

The important yield contributing characters like the number of pods $plant^{1}$, weight of pods $plant^{-1}$, the weight of grain pod $^{-1}$, test weight (g) was significantly more under 100% RDF + FYM 5 tonne ha^{-1} + *Rhizobium* and PSB treatment (T_3) that other integrated nutrient management treatments.

The grain and straw yield of chickpea was found to be significantly higher (32.00 and 39.62 qt ha^{-1}, respectively) in 100% RDF + FYM 5 tonne ha^{-1} + *Rhizobium* and PSB treatment (T_3). The grain and straw yield are lowest under nutrient management treatment (T_1).

This can be attributed to increase in fertilizer doses which improved LAI and might have resulted in higher production of photosynthates and their translocation to sink (yield attributes), which results to the better yield attributes. Also, adequate supply of NPK that played a vital role in physiological and developmental processes in plant life and the favorable effect of these important nutrients might have accelerated the growth processes that in result increased seed yield and straw yield of the crop. This is due to efficient utilization of essential nutrients which was reflected in production of higher seed and straw yield. These results were in agreement with the findings of Nemade *et al*., (2017) [9], Singh *et al*., (2017) [13], Kumar *et al*., (2018) [6], Kumar *et al*., (2019) [5] and Patel *et al*., (2020) [11].

Table 1: Plant height (cm), plant spread (cm), number of branches $plant^{-1}$, and dry matter $plant^{-1}$ (g) of chickpea as influenced by different treatments

Treatment Details		At harvest			
		Plant height (cm)	Plant spread (cm)	Number of branches $plant^{-1}$	Dry matter $plant^{-1}$ (gm)
T_1	Absolute Control (No any fertilizer)	43.44	23.47	12.81	14.07
T_2	100% RDF (25:50:30 N: P_2O_5: K_2O kg ha^{-1})	54.31	32.15	22.34	24.99
T_3	100% RDF + FYM 5 tonne ha^{-1}	56.46	33.81	24.16	26.93
T_4	75% RDF + FYM 1.25 tonne ha^{-1}	49.94	28.60	18.17	20.52
T_5	75% RDF + Vermicompost 0.75 tonne ha^{-1}	52.18	30.48	20.49	23.04
T_6	75% RDF + Neem cake 125 kg ha^{-1}	50.88	29.50	19.29	21.79
T_7	50% RDF + FYM 2.5 tonne ha^{-1}	45.56	25.20	14.56	16.01
T_8	50% RDF + Vermicompost 1.5 tonne ha^{-1}	47.81	26.95	16.36	18.57
T_9	50% RDF + Neem cake 250 kg ha^{-1}	46.67	26.11	15.42	17.29
	S.E.m. ±	0.68	0.55	0.58	0.64
	C. D. @ 5%	2.05	1.64	1.73	1.92
	General mean	49.69	28.47	18.18	20.36

Note: (*Rhizobium* and PSB is common in T_3 to T_9)

Table 2: Number of pods plant^{-1}, weight of pods plant^{-1}, weight of grain pod $^{-1}$, 100 seed weight (g), grain yield (qt ha^{-1}) and straw yield (qt ha^{-1})

Treatment Details		Number of pods plant $^{-1}$	Weight of pods plant^{-1} (g)	Weight of grain plant^{-1} (g)	Test weight (g)	Grain yield (qt ha^{-1})	Straw yield (qt ha^{-1})
T_1	Absolute Control (No any fertilizer)	55.54	9.30	9.19	15.91	18.63	24.41
T_2	100% RDF (25:50:30 N: P_2O_5: K_2O kg ha^{-1})	73.03	17.47	15.32	20.72	27.36	33.88
T_3	100% RDF + FYM 5 tonne ha^{-1}	76.23	18.77	16.45	21.65	32.00	39.62
T_4	75% RDF + FYM 1.25 tonne ha^{-1}	65.90	13.83	12.77	18.73	23.91	30.05
T_5	75% RDF + Vermicompost 0.75 tonne ha^{-1}	69.71	16.16	14.18	19.79	25.90	32.12
T_6	75% RDF + Neem cake 125 kg ha^{-1}	67.77	14.95	13.42	19.23	24.86	31.08
T_7	50% RDF + FYM 2.5 tonne ha^{-1}	58.93	10.59	10.32	16.84	20.26	26.14
T_8	50% RDF + Vermicompost 1.5 tonne ha^{-1}	62.56	12.51	11.63	17.78	22.28	28.29
T_9	50% RDF + Neem cake 250 kg ha^{-1}	60.74	11s.53	10.95	17.30	21.27	27.22
	SE(m)	0.97	0.43	0.38	0.30	0.46	0.58
	C. D. @ 5%	2.91	1.29	1.13	0.91	1.38	1.76
	General mean	65.60	13.90	12.69	18.66	24.05	30.31

Note: (*Rhizobium* and PSB is common in T_3 to T_9)

Economics

The data recorded in Table 3 showed that the among different integrated nutrient management treatments, the application of 100 % RDF + FYM 5 tonne ha^{-1} + *Rhizobium* + PSB (T_3) recorded significantly maximum gross monetary returns of ₹ 132754 ha^{-1} and net monetary returns of ₹ 87298 ha^{-1} during *rabi* 2021-22 as compared to other integrated nutrient management treatments. The maximum cost of cultivation recorded in treatment 50 % RDF + vermicompost 1.5 tonne ha^{-1} + *Rhizobium* + PSB (T_8) than rest of nutrient management treatments and the benefit cost ratio of chickpea fertilized with 100 % RDF + FYM 5 tonne ha^{-1} + *Rhizobium* + PSB (T_3) was found significantly superior (2.92) as compared to other nutrient management treatments. These confirm with findings Singh *et al.,* (2019) [12], Patel *et al.,* (2020) [11] and Mohanvel *et al.,* (2021) [7].

Table 3: Economics studies of chickpea as influenced by various treatment

Treatments	Cost of cultivation (₹ ha^{-1})	Gross monetary return (₹ ha^{-1})	Net monetary return (₹ ha^{-1})	B:C ratio
T_1 : Absolute Control (No any fertilizer)	35450	77449	41999	2.18
T_2 : 100% RDF (25: 50: 30 N: P_2O_5: K_2O kg ha^{-1})	39176	113505	73997	2.90
T_3 : 100% RDF + FYM 5 tonne ha^{-1}	45456	132754	87298	2.92
T_4 : 75% RDF + FYM 1.25 tonne ha^{-1}	40025	99246	59221	2.48
T_5 : 75% RDF + Vermicompost 0.75 tonne ha^{-1}	44525	107454	62929	2.41
T_6 : 75% RDF + Neem cake 125 kg ha^{-1}	40275	103170	62895	2.56
T_7 : 50% RDF + FYM 2.5 tonne ha^{-1}	41343	84177	42834	2.04
T_8 : 50% RDF + Vermicompost 1.5 tonne ha^{-1}	49593	92515	42922	1.87
T_9 : 50% RDF + Neem cake 250 kg ha^{-1}	41093	88346	47253	2.15
S.E.m. ±		1427.19	1724.18	0.08
C. D. @ 5%		4281.57	5172.54	0.24
General Mean	41882	99846	57928	2.39

Note: (*Rhizobium* and PSB is common in T_3 to T_9)

Conclusion

Based on the results of the investigation, it could be concluded that among the different management treatments used in the experiment application of 100 % RDF + FYM 5 tonne ha^{-1} + *Rhizobium*+ PSB should be adopted for higher growth, yield, and net monetary returns of chickpea than other nutrient management treatments.

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