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Response of integrated nutrient management on yield and uptake of nutrients in chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was carried out during the winter season of 2022-23, at the Research farm, Department of Soil Science and Agricultural Chemistry, AKS University, Sherganj, Satna (M.P.) to ascertain the influence of integrated nutrient management on yield and uptake of nutrients in chickpea. The experiment consisted of ten treatments *i.e.*, T_1-Control, T_2- 100% RDF, T_3- 100% RDF + FYM @ 2 t/ha, T_4- 100% RDF + Vermicompost @ 4 t/ha, T_5 100% RDF + Rhizobium + PSB (10 ml/kg seed), T_6- 75% RDF, T_7- 75% RDF + FYM @ 2 t/ha, T_8- 75% RDF + Rhizobium + PSB (10 ml/kg seed), T_9 50% RDF + FYM @ 2 t/ha + Vermicompost @ 4 t/ha, T_{10}- 50% RDF + Rhizobium + PSB (10 ml/kg seed). The experiment was laid out in a randomized block design with three replications. Results revealed that yield attributes such as the number of pods per plant, number of seeds per pod, 1000 seed weight and grain yield were found significantly higher under T_4 (100% RDF + Vermicompost 4 t/ha). Similarly, higher uptake of N, P, K and Zn was observed when 100% RDF + Vermicompost 4 t/ha was incorporated.

Keywords: Chickpea, gram, Integrated nutrient management, uptake

Introduction
Chickpea (*Cicer arietinum* L.) is a major *rabi* season pulse crop grown throughout the world. It is a highly nutritious pulse and places third in the importance list of the food legumes that are cultivated throughout the world. The seeds of the chickpea plant contain an excellent nutritional value due to their high protein content (18–22%), moderate fat content (4–10%), and presence of vital minerals (such as calcium, phosphorus, and iron). It is cultivated in an area of 98.86 lakh ha with a total production of 107.37 lakh tons and productivity of 1086 kg ha^{-1} contributing 34% and 45% in area and production respectively in India (Anon., 2022) [1]. Madhya Pradesh is the largest producer of chickpea in India. Integrated Nutrient Management (INM) involves efficient and judicious use of all the major components of plant nutrient sources. The integrated supply and use of plant nutrients from chemical fertilizer and organic manures has been found to produce higher crop yield than when each is applied alone. This increase in crop productivity results from their combined effect, the synergistic effect, that helps improve the chemical, physical and biological properties of soil and consequently the soil organic matter and nutrient status to a large extent balance nutrient supply to crops of cropping systems and with no or minimal deleterious effect on the environment. Integrated nutrient management ensures higher productivity, reduces expenditures on expensive fertilizer inputs, improves soil's physical properties and the efficiency of added nutrients, and simultaneously ensures excellent soil health; it is also an environment-friendly practice (Kumpawat, 2010, Singh and Singh, 2017) [5, 10]. The INM technology enriches agricultural crops with all essential nutrients, increases production, and sustains productivity & fertility of soil. The basic objective of integrated nutrient management is to make as far as possible, a balanced nutrient supply to crops that maintains and also improves the soil fertility health for sustained high productivity on a long-term basis. The increasing fertility of soil and crop productivity through the use of chemical or synthetic fertilizers has often affected negatively biogeochemical cycles. Also, the usage of fertilizer causes leaching and run-off of nutrients, especially nitrogen (N) and phosphorus (P) resulting in the degradation of the environment.

Materials and Methods
The investigation was carried out during the rabi season of 2022-23 at Research Farm, Department of Soil Science and Agricultural Chemistry, AKS University, Satna.

The experiment was laid out in Randomized Block Design with ten treatments i.e., T_1-Control, T_2- 100% RDF, T_3- 100% RDF + FYM @ 2 t/ha, T_4- 100% RDF + Vermicompost @ 4 t/ha, T_5-100% RDF + Rhizobium + PSB (10 ml/kg seed), T_6- 75% RDF, T_7- 75% RDF + FYM @ 2 t/ha, T_8- 75% RDF + Rhizobium + PSB (10 ml/kg seed), T_9 50% RDF + FYM @ 2 t/ha + Vermicompost @ 4 t/ha, T_{10}- 50% RDF + Rhizobium + PSB (10 ml/kg seed). These treatments were replicated thrice. The soil of the experimental field was in clay loam, having a pH of 6.99, EC of 2.7 dSm^{-1}, OC of 0.66% and available N, P, K and Zn of 229.9, 8.93, 179.80 and 0.54 kg ha^{-1}. The variety JG-14 was sown at the rate of 80 kg ha^{-1} keeping a spacing of 30 cm between rows and 10 cm between plants. Fertilizers were administered as per the treatments. Nitrogen through urea and phosphorus and potassium were given through SSP and MOP as basal doses during sowing. Five plants from each plot were randomly selected to record the observations on different parameters, and then they were subjected to statistical analysis by following Fisher's method (1947) of Analysis of Variance. The significance of various treatments was judged by comparing the calculated "F" value with Fisher's "F" value at 5% probability level.

Result and Discussion

The findings on the influence of INM on different parameters such as yield attributes and yield, as well as the uptake by the seed and stover, have been furnished in Table 1 and Fig. 1. The yield attributes of chickpea were significantly influenced by the use of integrated nutrient management. A significantly higher number of pods per plant (27.93), number of seeds per pod (2.00) and 1000 seed weight (236.67 g) were registered with the utilization of treatment T_4 (100% RDF + Vermicompost @ 4 t/ha). All of these parameters (except 1000 seed weight) were at par with treatment T_5 (100% RDF + Rhizobium + PSB (10 ml/kg seeds) and 1000 seed weight was at par with treatment T_3 (100% RDF + FYM @ 2 t/ha). The influence of INM was also noted on seed yield. The highest seed yield (17.34 q/ha) was recorded in treatment T_4 (100% RDF + Vermicompost @ 4 t/ha) which was at par with treatment T_5 (100% RDF + Rhizobium + PSB (10 ml/kg seeds). All the aforementioned parameters were lowest under control. Better pods per plant and seed per pod could be due to an enhanced supply of nutrients which led to effective dry matter partitioning, resulting in greater pods/ plant and number of seeds per pod. The significant increase in test weight due to the application of T_4 (100% RDF + Vermicompost @ 4 t/ha) might be on account of better uptake and translocation of nutrients, resulting in bold seed formation by increasing the size and weight of grains. The higher number of yield attributes from the application of T_4 100% RDF + Vermicompost @ 4 t/ha may be owing to the increased supply of primary as well as secondary and micronutrients which helped to increase dry matter production and its effective partitioning to the economic sink. Variation in pods $plant^{-1}$, grains pod^{-1} and test weight of chickpea as affected by the use of vermicompost and chemical fertilizers has also been reported by Das *et al*. (2002) [3], Gupta (2004) [4], Prasad *et al.* (2005) [8], Ali *et al*. (2010) [2], Patel and Thanki (2020) [6].

The uptake of nutrients was significantly influenced by different treatments of integrated nutrient management. The utilization of T_4 (100% RDF + Vermicompost @ 4 t/ha) significantly increased the uptake of N (59.23 kg/ha) by seed while uptake by stover (46.85 kg/ha) was higher in T_5 (100% RDF + Rhizobium + PSB (10 ml/kg seed)). The increased uptake of P by seed (13.40 kg/ha) and by stover (13.65 kg/ha) was registered with the application of T_4 (100% RDF + Vermicompost @ 4 t/ha). Similarly, the application of T_4 (100% RDF + Vermicompost @ 4 t/ha) significantly increased the uptake of K (9.67 kg/ha) by seed while uptake by stover (94.95 kg/ha) was higher in T_5 (100% RDF + *Rhizobium* + PSB (10 ml/kg seed)). The increased uptake of Zn by seed (0.13 kg/ha) and by stover (0.14 kg/ha) was registered with the application of T_4 (100% RDF + Vermicompost @ 4 t/ha). The least uptake of these nutrients resulted from control plots. The increased uptake of nitrogen, phosphorus, potassium and zinc in chickpea resulting from these treatments, can be attributed to the availability of sufficient nutrients which were supplied through the application of chemical fertilizers as well as organic fertilizers like vermicompost as well as *Rhizobium* and PSB. These findings are in agreement with those reported by Poi *et al.* (1998) [7], Sarawsi (1999) [9], Das *et al.* (2002) [3] and Gupta *et al.* (2004) [4].

Table 1: Yield attributes, yield and uptake of N, P, K and Zn as influenced by integrated nutrient management in chickpea

Treatments	Yield attributes and yield				Uptake by seed (kg/ha)				Uptake by stover (kg/ha)			
	Number of pods per plant	Number of seeds per pod	1000 seed weight (g)	Seed yield (q/ha)	N	P	K	Zn	N	P	K	Zn
T_1	22.67	1.03	206.67	9.33	37.03	4.72	5.4	0.08	26.67	5.52	47.04	0.07
T_2	25.67	1.67	216.67	15.44	55.23	9.70	9.34	0.10	40.48	11.32	87.01	0.12
T_3	25.93	1.73	220.00	14.41	56.23	12.29	9.67	0.12	40.89	12.59	94.28	0.12
T_4	27.93	2.00	236.67	17.34	59.23	13.40	9.66	0.13	46.78	13.65	94.95	0.14
T_5	26.53	1.80	206.67	16.04	55.31	11.06	9.48	0.11	46.85	11.25	82.80	0.12
T_6	23.73	1.40	215.00	10.75	57.36	11.58	7.57	0.09	44.38	11.04	76.90	0.09
T_7	25.53	1.67	206.67	12.11	58.93	6.74	9.32	0.10	46.49	9.10	82.22	0.09
T_8	24.87	1.57	213.33	12.98	45.69	9.08	10.00	0.10	39.43	10.66	87.54	0.09
T_9	24.53	1.30	210.00	11.42	46.38	7.89	10.13	0.08	38.99	11.05	91.85	0.08
T_{10}	24.00	1.17	210.00	11.45	48.36	7.89	10.36	0.08	37.74	9.72	89.54	0.08
S.Em ±	0.70	0.18	5.80	1.13	2.98	0.97	0.90	0.01	2.45	0.95	5.63	0.01
C.D. (p= 0.05)	2.09	0.54	17.24	3.34	8.87	2.88	2.68	0.03	7.29	2.82	16.73	0.03

T_1: Control, T_2: 100% RDF, T_3: 100% RDF + FYM @ 2 t/ha, T_4: 100% RDF + Vermicompost @ 4 t/ha, T_5: 100% RDF + Rhizobium + PSB (10 ml/kg seed), T_6: 75% RDF, T_7: 75% RDF + FYM @ 2 t/ha, T_8: 75% RDF + *Rhizobium* + PSB (10 ml/kg seed), T_9: 50% RDF + FYM @ 2 t/ha + Vermicompost @ 4 t/ha, T_{10}: 50% RDF + Rhizobium + PSB (10 ml/kg seed)

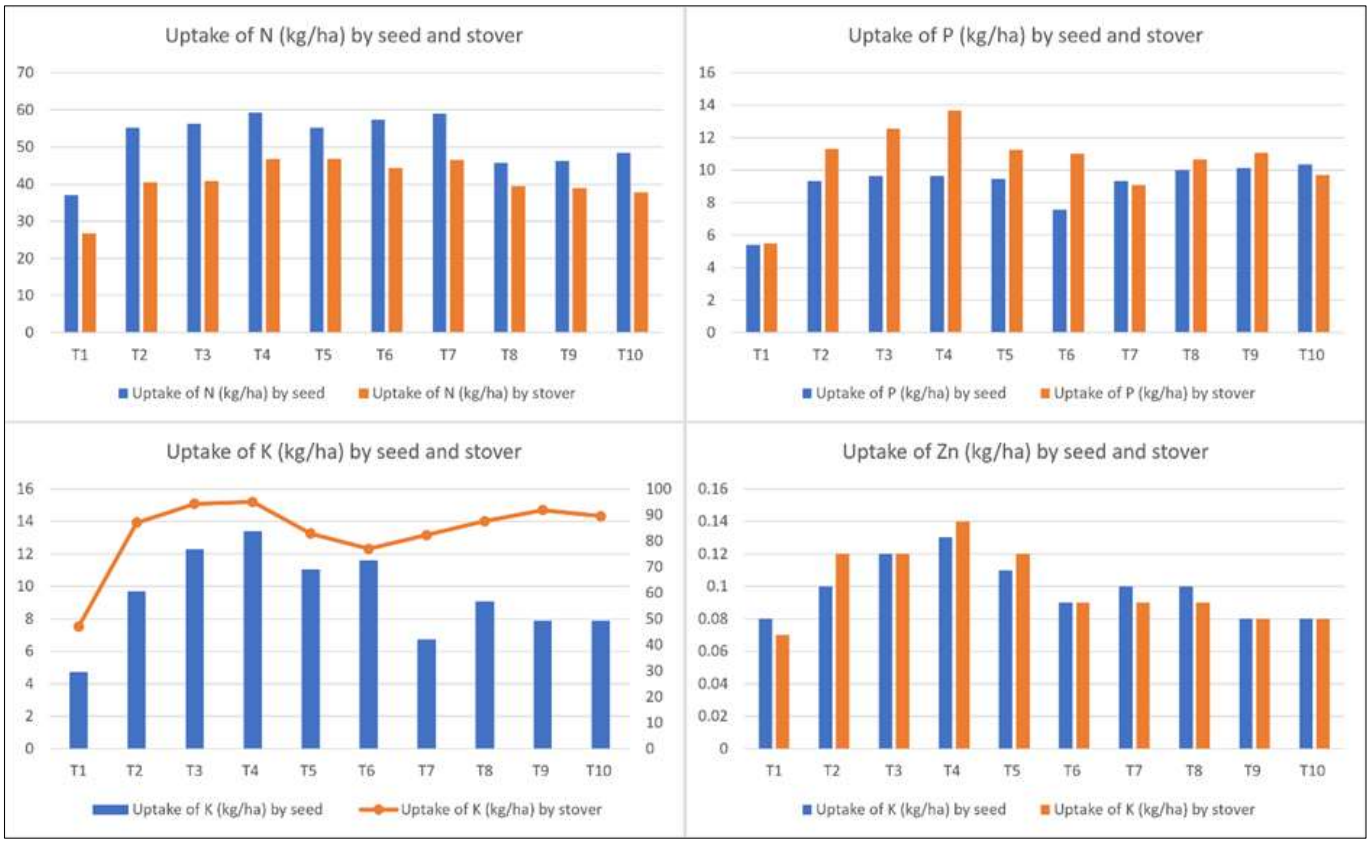

Fig 1: Uptake of N, P, K and Zn as influenced by integrated nutrient management in chickpea

Conclusion

Based on the one-year experiment, it may be concluded that the incorporation of 100% RDF + Vermicompost 4 t/ha appreciably enhanced the yield attributes and yield of chickpea and the uptake of N, P, K and Zn in seed and straw of chickpea, was also higher under the same treatment; therefore, the incorporation of 100% RDF + Vermicompost 4 t/ha was found to be beneficial for improving the fertility status of the soil as well as the yield and quality of chickpea.

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