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Vaishali Singh
Department of Soil Science and Agricultural Chemistry, AKS University, Satna, Madhya Pradesh, India

Atul Kumar Singh
Department of Soil Science and Agricultural Chemistry, AKS University, Satna, Madhya Pradesh, India

Harshit Gautam
Department of Soil Science and Agricultural Chemistry, AKS University, Satna, Madhya Pradesh, India

Anurag Shukla
Department of Soil Science and Agricultural Chemistry, AKS University, Satna, Madhya Pradesh, India

Corresponding Author:
Vaishali Singh
Department of Soil Science and Agricultural Chemistry, AKS University, Satna, Madhya Pradesh, India

Studies on potassium application in relation to yield and uptake of nutrients (N, P, K and Zn) in chickpea (*Cicer arietinum* L.)

Vaishali Singh, Atul Kumar Singh, Harshit Gautam and Anurag Shukla

Abstract
A field experiment was carried out during the winter (*Rabi*) season of 2022-23, at the Experimental field, Department of Soil Science and Agricultural Chemistry, AKS University, Satna (M.P.) to find out the effect of Potassium in Relation to Yield and uptake of Nutrients in Chickpea Crop (*Cicer arietinum* L.).The experiment consisted of ten treatments *i.e*., T_1 (Control), T_2 (5 Kg K_2O /ha), T_3 (15 Kg K_2O/ha), T_4 (25 Kg K_2O/ha), T_5 (35 Kg K_2O/ha), T_6 (45 Kg K_2O/ha), T_7 (55 Kg K_2O/ha), T_8 (65 Kg K_2O/ha), T_9 (75 Kg K_2O/ha), T_{10} (85 Kg K_2O/ha). The experiment was laid out in a Randomized block design with three replications. The results revealed that yield attributes and yield were significantly influenced by different potassium levels. There was a marked increase in number of pods per plant (31.00), number of seed per pod (1.80), 1000 seed weight (236.67 g) and seed yield (18.09 q/ha) with the application of 85 kg K/ha. Similarly, plots fertilized with 85 kg K/ha had higher uptake of N, P, K and Zn by both seed and stover of chickpea.

Keywords: Chickpea, gram, uptake, potassium

Introduction
Chickpea (*Cicer arietinum* L.) is a major legume crop cultivated for its edible seeds legume of the genus *Cicer*, family *Fabaceae* (*Leguminoceae*), and subfamily *Papilionaceae*. In India chickpea occupies 10.17 million ha area, with a production of 11.35 million tonnes registering a productivity of 1116 kg/ha. In Madhya Pradesh, chickpea crop occupied 0.62 million hectares area, 0.85 million tonnes of production and 1371 kg/ha productivity. Rajasthan has the highest area (24.21%) under chickpea, followed by Maharashtra (22.82%), Madhya Pradesh (18.94%), Karnataka (10.27%), Uttar Pradesh (6.10%) and Andhra Pradesh (4.56%). Seeds of chickpea contain 22- 24 % protein, which is higher than cereals by many folds.
Potassium is involved in many physiological processes such as photosynthesis, photosynthetic translocation, protein and starch synthesis, water energy relations, translocation of assimilates and activation of a number of enzymes. Potassium is the most abundant cation in the cytoplasm and has an outstanding role in plant–water relations. The high availability of K enhances root development, producing more branching and lateral roots. Potassium (K) is the most abundant inorganic cation, and it is important for ensuring optimal plant growth (White and Karley, 2010) [7]. The crucial importance of K in quality formation confirms its role in promoting the production of photosynthates and their transport to storage organs such as fruits, grains and tubers and enhancing their conversion into starch, protein, vitamins and oil. With a shortage of K, many metabolic processes are affected like the rate of photosynthesis and the rate of translocation and enzyme systems (Marschner, 2002) [4].

Materials and Methods
During the *rabi* season of the year 2022-23, a field experiment was conducted at the Experimental field, Department of Soil Science and Agricultural Chemistry, AKS University, Satna (M.P.). The soil present in the experimental plot had a Sand clay loam texture, a neutral pH (6.98), a medium content of organic carbon (0.66%) and low available nitrogen (229.9 kg/ha) and available phosphorus (8.94 kg/ha), medium potassium (179.8 kg/ha) and zinc content was (0.54 kg/ha). The experimental design included ten treatments *viz*., T_1 (Control), T_2 (5 Kg K_2O /ha), T_3 (15 Kg K_2O/ha), T_4 (25 Kg K_2O/ha), T_5 (35 Kg K_2O/ha), T_6 (45 Kg K_2O/ha), T_7 (55 Kg K_2O/ha), T_8 (65 Kg K_2O/ha), T_9 (75 Kg K_2O/ha), T_{10} (85 Kg K_2O/ha). The treatments were assessed using a Randomized Block Design with three replications.

The application of fertilizer was conducted using a standardized dosage of 20 kg N/ha. Potassium was applied in accordance with treatments. The application of nutrients, namely nitrogen (N), phosphorus (P), potassium (K), was carried out using urea, Single super phosphate (SSP) and muriate of potash (MOP), respectively. The chickpea variety known as "JG-36" was sown on 22/10/2022, with a spacing of 30 × 10 cm and a seed rate of 80 kg per hectare. The crop was cultivated using a comprehensive set of established agricultural methods and protective measures, which were implemented in a timely manner as per their specific requirements. The statistical analysis was conducted on the experimental data pertaining to yield and nutrient content, in order to determine the level of significance.

Results and Discussion

The results revealed that yield attributes and yield were significantly influenced by different potassium levels. There was a marked increase in number of pods per plant (31.00), number of seed per pod (1.80), 1000 seed weight (236.67 g) and seed yield (18.09 q/ha) with the application of 85 kg K/ha. However, number of seed per pod was comparable with the T_9, T_8, T_6, T_5 and T_4. Similarly, 1000 seed weight was at par with T_2. The minimum values for yield attributes and yield were registered from control plots. The higher yield attributes are the result of improved growth due to the availability of more nutrients. The higher seed yield in the treatment might be due to improvement in the entire yield contributing characters *viz*. number of pods/plants and seed index. Similar results have been reported by Mondal *et al.* (2005) [5], Rathore *et al.* (2013) [6], Ganga *et al.* (2014) [1], Kumar *et al*. (2018) [3] and Jadeja *et al*. (2019) [2].

The data with respect to uptake of nutrients by seed and stover of chickpea indicate that plots fertilized with 85 kg K/ha had considerably higher uptake of N (63.33 and 50.00 kg N/ha, respectively), P (12.33 and 14.63 kg P/ha, respectively), K (11.67 and 91.67 kg K/ha, respectively) and Zn (0.12 and 0.13 kg Zn/ha, respectively) which were comparable with T_9, T_8, T_7, T_6 and T_5. The minimum uptake of the above-mentioned nutrients was seen under control treatment. The higher uptake of nutrients could be due to the presence of nutrients in greater quantity. In addition, completely developed roots may also have been involved in higher uptake of nutrients. Similar results have also been reported by Mondal *et al*., (2005) [5].

Table 1: Yield attributes, yield and uptake of N, P, K and Zn by chickpea as influenced by different potassium levels.

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	23.87	1.03	206.67	11.09	43.88	6.00	6.37	0.08	31.67	7.33	60.20	0.08
T_2	24.00	1.17	220.00	12.11	51.69	8.00	7.90	0.08	43.08	7.67	65.00	0.09
T_3	24.47	1.30	210.00	12.98	52.88	9.00	8.74	0.09	43.10	8.33	74.22	0.09
T_4	24.60	1.57	213.33	13.33	54.28	10.00	9.34	0.09	43.66	7.67	75.00	0.10
T_5	24.87	1.67	206.67	13.41	55.78	10.08	10.00	0.10	44.91	10.33	78.33	0.11
T_6	25.40	1.67	216.67	13.25	56.00	10.85	10.50	0.10	45.39	11.00	83.21	0.11
T_7	25.67	1.40	215.00	12.62	56.67	11.39	10.83	0.10	46.05	11.33	84.33	0.11
T_8	26.13	1.73	206.67	15.44	57.34	11.62	11.00	0.11	46.67	12.00	83.33	0.12
T_9	24.47	1.60	210.00	13.86	58.37	11.67	11.34	0.12	48.33	12.33	90.00	0.12
T_{10}	31.00	1.80	236.67	18.09	63.33	12.33	11.67	0.12	50.00	14.63	91.67	0.13
S.Em ±	1.07	0.11	5.80	0.86	2.76	0.96	0.76	0.01	2.74	1.54	4.33	0.01
C.D. (p= 0.05)	3.19	0.32	17.24	2.55	8.21	2.85	2.26	0.02	8.15	4.57	12.88	0.02

T_1 (Control), T_2 (5 Kg K_2O /ha), T_3 (15 Kg K_2O/ha), T_4 (25 Kg K_2O/ha), T_5 (35 Kg K_2O/ha), T_6 (45 Kg K_2O/ha), T_7 (55 Kg K_2O/ha), T_8 (65 Kg K_2O/ha), T_9 (75 Kg K_2O/ha), T_{10} (85 Kg K_2O/ha).

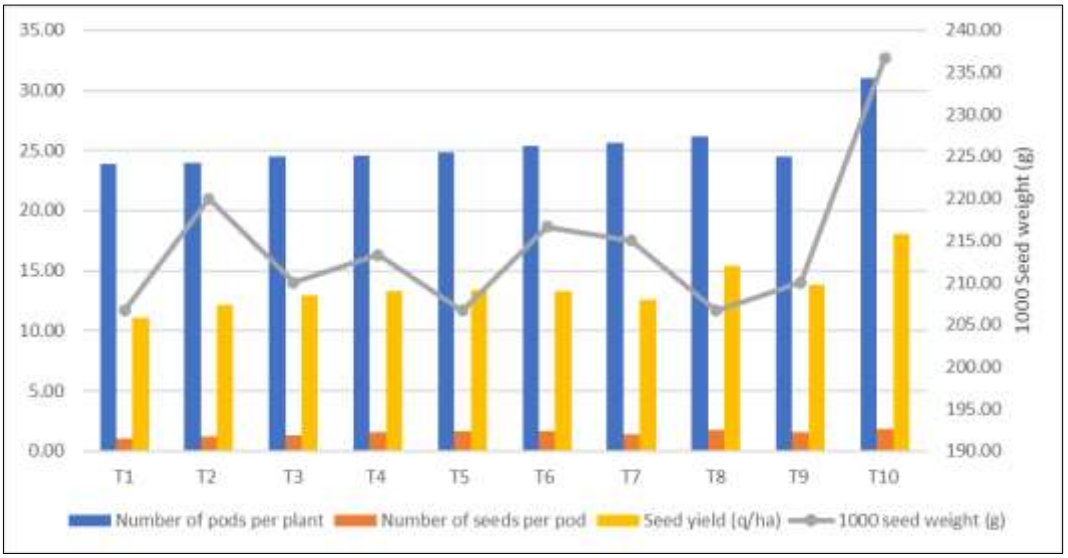

Fig 1: Yield attributes and yield of chickpea as influenced by different potassium levels.

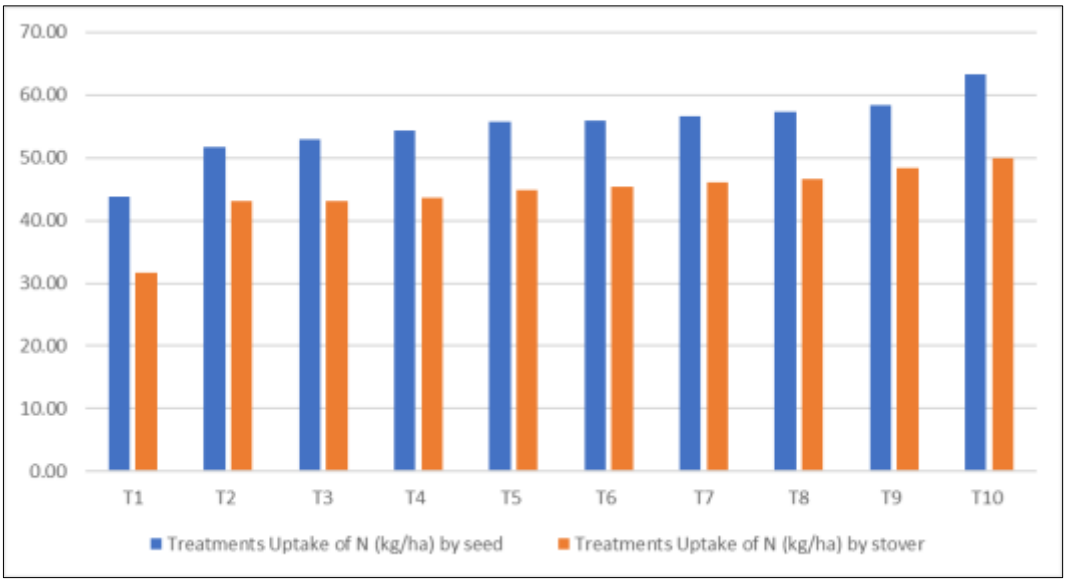

Fig 2: Uptake of N (kg/ha) by chickpea as influenced by different potassium levels.

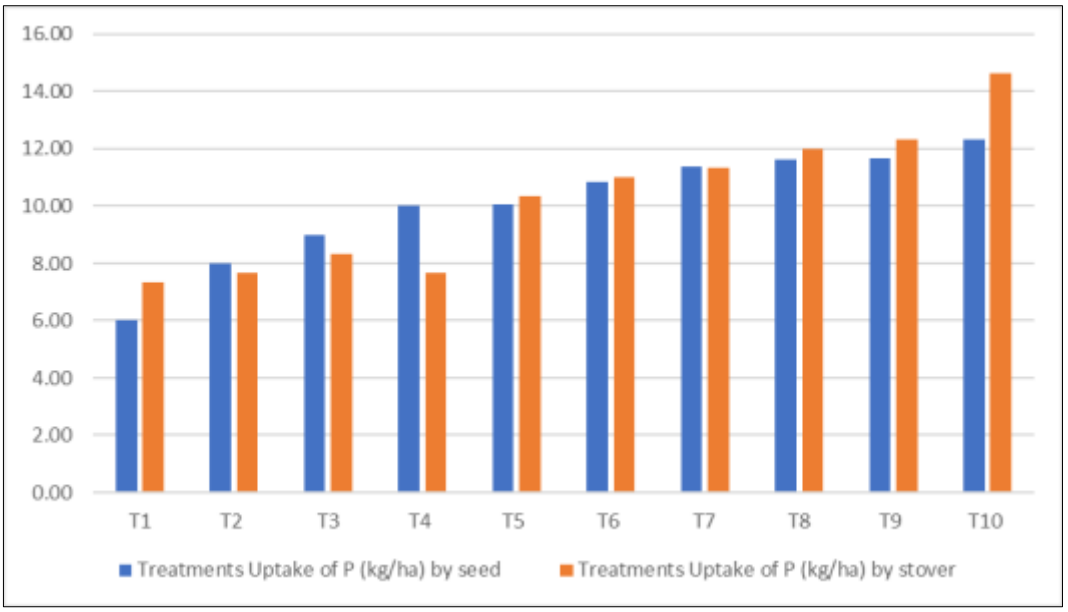

Fig 3: Uptake of P (kg/ha) by chickpea as influenced by different potassium levels.

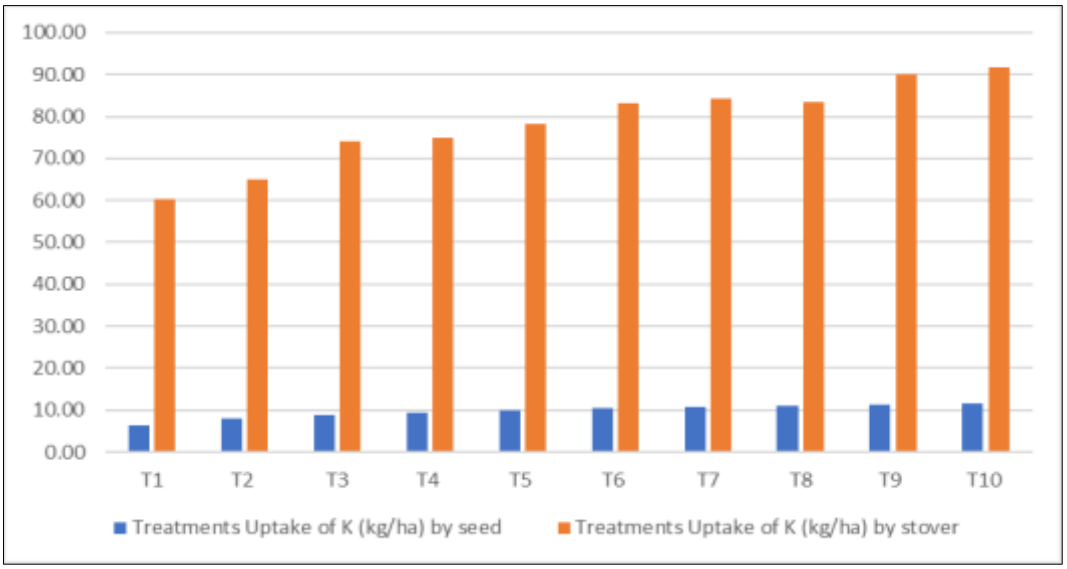

Fig 4: Uptake of K (kg/ha) by chickpea as influenced by different potassium levels.

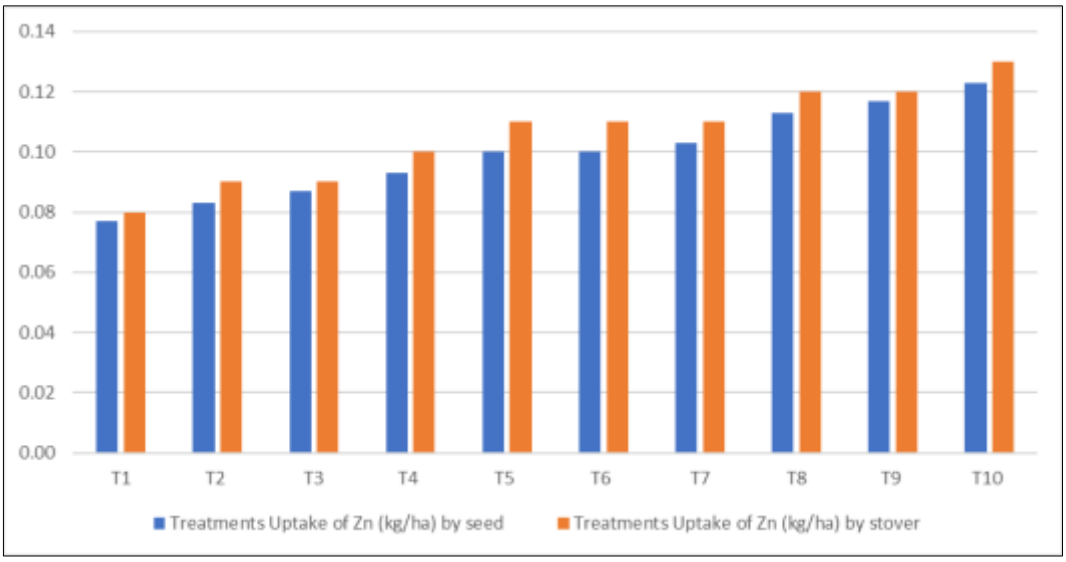

Fig 5: Uptake of Zn (kg/ha) by chickpea as influenced by different potassium levels.

Conclusion

On the basis of results summarized in the past it may be concluded that use of T_{10} (85 kg K_2O/ha) was proven to be most effective with regard to yield attributes and nutrient uptake of chickpea. Among the treatments T_{10} was found to be most useful and it caused paramount increased in yield *i.e*., 18.09 q/ha. Besides it was also briefed that highest level of K brought maximum uptake of N, P, K and Zn in seed of chickpea.

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