The Pharma Innovation Journal 2022; SP-11(8): 1742-1747

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(8): 1742-1747

www.thepharmajournal.com
Received: 01-05-2022
Accepted: 04-06-2022

AH Chauhan
Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, S. D. Agricultural University, S. K. Nagar, Gujarat, India

RD Shinde
Assistant Professor, Department of Soil Science and Agricultural Chemistry, AAU Jabugam, Gujarat, India

JC Shroff
Associate Professor, Department of Agronomy, Anand Agricultural University, Anand, Gujarat, India

KR Bhuriya
M.Sc. Department of Soil Science and Agricultural Chemistry, Anand Agricultural University, Anand, Gujarat, India

Corresponding Author
AH Chauhan
Ph.D. Scholar, Department of Soil Science and Agricultural Chemistry, S. D. Agricultural University, S. K. Nagar, Gujarat, India

Effect of potassium and zinc on yield and nutrient content of chickpea

AH Chauhan, RD Shinde, JC Shroff and KR Bhuriya

Abstract
A field experiment entitled "Effect of potassium and zinc on yield and nutrient content of chickpea and fractions of potassium and zinc in soil" was carried out on Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand during rabi season of the year 2020-21. The experiment comprising nine treatment combinations consisted of three levels of potassium (0, 20 and 30 kg/ha) and three levels of zinc (0, 2.5 and 5.0 kg/ha). These treatments were evaluated in Randomized Block Design (factorial) with four replications. Results of the experiment revealed that seed yield and hulm yield were significantly influenced by different levels of potassium and zinc. The treatment K_2 (40 kg K_2O/ha) significantly increased seed yield (2334 kg/ha) and haulm yield (3767 kg/ha) of chickpea than other treatments except treatment K_1 (20 kg K_2O/ha) in case of haulm yield. Among different levels of zinc, significantly maximum seed yield (2251 kg/ha), haulm yield (3689 kg/ha) of chickpea were found under the treatment Z_2 (5.0 kg Zn/ha) which remained at par with the treatment Z_1 (2.5 kg Zn/ha). The interaction effect of different levels of potassium and zinc was significant seed yield (2504 kg/ha) was remarkably increased by the treatment combinations of K_2Z_2 (40 kg K_2O and 5.0 kg Zn/ha) than rest of the treatments excluding treatment combinations K_1Z_2 (20 kg K_2O and 5.0 kg Zn/ha) and K_2Z_1 (40 kg K_2O and 2.5 kg Zn/ha). The treatment K_2 (40 kg K_2O/ha) significantly increased the N, P, K and S contents in chickpea seed and haulm than other levels of potassium except treatment K_1 (20 kg K_2O/ha) in case of N and P contents in seed and N content in haulm. The Zn content in seed and haulm was significantly increased with treatment Z_2 (5.0 kg Zn/ha) and was remained at par with treatment Z_1 (2.5 kg Zn/ha). The overall results showed that combined application of K_2O at 40 kg/ha and zinc at 2.5 kg/ha found to be beneficial for achieving higher yield of chickpea as well as nutrient contents of chickpea.

Keywords: Potassium, zinc, yield, nutrient content, chickpea

Introduction
Chickpea (*Cicer arietinum* L.) is the crop belongs to legume family and third most important pulse crop in the world after dry bean and dry peas. It is a self-pollinated true diploid ($2n=2x=16$) cool season crop that ranks second in area and third in production among the pulses worldwide. India contributes about 65% of global area with 68% of global production of chickpea. India is the largest producer as well as importer of the leguminous crops. India ranks first in production of chickpea in world contributing 25-28 per cent world's total crop production but low in productivity of chickpea. India generally imports 2 million tons of pulse every year. India is the major chickpea producing country with 106 lakh ha area with the production of more than 111 lakh tons and productivity of 1056 kg/ha. It is basically grown in the dried region of India. In Gujarat, it is grown in about 2.95 lakh ha area with the production of 3.62 lakh tons and productivity of 967 kg/ha (Anonymous, 2018) [1].

Amongst the leguminous crops, chickpea occupies an important position due to its nutritious value (17-23% protein) in large vegetarian population of the country. Chickpea seed contains 20-30% protein, about 40% carbohydrates, 3-6% oil, 6% crude fiber and 3% ash (Gil *et al.*, 1996) [10]. Its protein quality is better than that of most other legume crops (Jukanti *et al*., 2012 and Siddique *et al.*, 2012) [15, 35]. As with other legumes, chickpeas have ability to fix 80-120 kg of nitrogen per hectare through symbiotic nitrogen fixation (Papastylianous, 1987) [21].

Potassium (K) is one of the 17 vital nutrients required for the growth and reproduction of crops. It plays an important role in maintenance of cellular organization by regulating permeability of cellular membranes and keeping protoplasm in proper degree of hydration by stabilizing emulsion of high colloidal properties. Potassium has a great buffering action and stabilizes various enzymes system. It regulates photosynthesis, protein synthesis and stomatal movement in crops. Among essential nutrient elements, Potassium is the third major element taken up by the plants.

Plants absorb it in larger amounts as compared to other mineral elements except nitrogen. It has utmost importance for imparting drought and disease resistance and has synergistic effect on crops with nitrogen and phosphorus (Das, 1999) [7]. Higher yields and crop quality can be obtained at optimal N: K nutritional ratios. It is an essential macronutrient required for proper development of plants. Potassium has been considered as the “quality element” for crop production. Pulse growing Agroecological region of India vary widely in their K supplying capacity. Based on the number of field studies, it can be suggested that the application of 20- 40 kg K_2O/ha and foliar application of 1-2% of KNO_3 is beneficial for higher pulse production (Ali and Srinivasa Rao, 2001) [2].

Most of the Potassium in soil exists in various insoluble rocks, minerals and sedimentary materials. Based on its availability to plants, soil potassium can be classified into three main groups *i.e.*, unavailable, readily available and slowly available K. The bulk of soil potassium (about 98% of total K) usually exists in unavailable form and is found in primary (micas and feldspars) and secondary (illite group) clay minerals (Attoe and Truog, 1945) [3]. The readily available K constitutes only 1-2% of total K and exists in soil in two forms, *viz*., solution and exchangeable K adsorbed on soil colloidal surface (Brady and Well, 2002) [4]. It is not a constituent of organic structures, but regulates enzymatic activities (over 60 enzymes require K for activation), translocation of photosynthesis and considerably improves seed yield of chickpea if applied as a fertilizer (Samiullah and Khan, 2003, Singh *et al*., 1994 and Verma, 1994) [25, 32, 34].

Among the micronutrients, zinc plays a vital role in plant growth and development. Zinc has been the micronutrient needed by crops especially pulses in sufficiently large quantity. Zinc also catalyses the biosynthesis of indole acetic acid, acting as metal activator of the enzyme, there by ultimately increasing the crop yield. The plants exhibited lower rate of protein synthesis and protein accumulation under zinc deficiency. Zinc also plays important role in physiological process of plants through synthesis of hormones essential for growth and reproduction. Zinc plays an important role in metabolism both in plants as well as in animals by acting as essential component of enzyme, RNA, electron carrier *etc*., and acts as a functional, structural and regulatory cofactor of a large number of enzymes. The accumulation of zinc in edible parts of plant serves as zinc source for primary consumers. Unfortunately, about 50% of Indian soils are deficient in zinc and expected to further increase up to 63% by 2025 which imparting zinc malnutrition in population especially in children (Shukla *et al*., 2014) [29], (Singh, 2010) [36] reported that one third of the world population is at the risk of zinc malnutrition due to inadequate dietary intake of zinc resulting from wide spread hidden hunger of zinc in seeds and feeds. Also, the intensive cropping systems of high yielding varieties have led to depletion of micronutrients, especially zinc.

Material and Methods

A field experiment was carried out on Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during rabi season of the year 2020-21. The soil of the experimental plot was loamy sand in texture, alkaline in reaction, low in organic carbon and available nitrogen, medium in available phosphorus, potassium and zinc. The experiment comprising nine treatment combinations consisted of three levels of potassium (0, 20 and 40 kg/ha) and three levels of zinc (0, 2.5 and 5.0 kg/ha). These treatments were evaluated in Randomized Block Design (factorial) with four replications. The fertilizer application was done with fixed dose of nitrogen at 20 kg/ha and phosphorus at 40 kg/ha. Potassium and Zinc application was done according to the treatments. The nutrient of N, P, K and Zn were applied by using source of Urea, DAP, MOP and Zinc Sulphate respectively. The chickpea variety “Gujarat Gram 5” was sowing in first fourth night of November with spacing of 45 m × 10 m and seed rate of 60 /kg/ha. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required. The experimental data recorded for yield and nutrient content were statistically analyzed for level of significance.

Results and Discussion

Effect of potassium and zinc on seed and haulm yield of chickpea

Seed yield

Effect of potassium

The results indicated that the different levels of potassium significantly influenced the seed yield of chickpea. The treatment of Application of 40 kg K_2O/ha (K_2) produced significantly the highest seed yield of chickpea (2334kg/ha) than rest of the treatments. 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) [19], Rathore *et al.* (2013) [22], Ganga *et al.* (2014) [9], Kumar *et al.* (2018) [18] and Jadeja *et al.* (2019) [13].

Effect of zinc

The results showed that the seed yield of chickpea was differed significantly with different levels of zinc. Remarkably higher seed yield (2251 kg/ha) was recorded with the treatment containing application of 5.0 kg Zn/ha (Z_2) which was being at per with the treatment Z_1 (2.5 kg Zn/ha). The increase in seed yield might be may be due to more photosynthetic activity, uptake of nutrients, photosynthate translocation from source to sink and higher reproductive activity. Similar results were obtained by Sangwan and Raj (2004) [26], Singh *et al.*, (2012) [31], Shivay *et al.* (2014) [28], Singh *et al.* (2016) [30], Krishna *et al.* (2017) [16], Kuldeep *et al.* (2018) [17] and Davara Monali *et al.* (2019) [8].

Interaction effect

The interaction between different levels of potassium and zinc influenced significantly on seed yield of chickpea

Among the different treatment combinations, the treatment combination K_2Z_2 (40 kg K_2O and 5.0 kg Zn/ha) produced significantly maximum seed yield of chickpea (2504 kg/ha) than rest of the treatment combination but was found to be statistically at par with treatment combination K_1Z_2 (20 kg K_2O and 5.0 kg Zn/ha) and K_2Z_1 (40 kg K_2O and 2.5 kg Zn/ha) was recorded seed yield (2444 kg/h and 2406kg/ha).

The increase in yield ascribed attributed to the reason that potassium along with zinc possibly increased the concentrations of N, P and K ions of soil solution and ultimately affected vigorous root development of plant leading to higher photosynthesis to the sink which in turn resulted in better development of yield. The results are in agreement with those reported by Sutaria *et al.* (2013) [33] in forage sorghum, Maleki *et al.* (2014) [20] in maize.

Haulm yield
The data on haulm yield of chickpea as influenced by different levels of potassium and zinc effect along with statistical inferences are furnished in Table

Effect of potassium
The results recorded in Table 1 indicated that the haulm yield of chickpea differed significantly due to different levels of potassium. The treatment receiving an application of 40 kg K_2O/ha (K_2) recorded maximum haulm yield (3767 kg/ha) over control but was found to be at par with treatmentK_1 (20kg K_2O/ha).

The positive effect of potassium on haulm yield of chickpea might be because of potassium helps in the resistance to crops against pests and diseases, which, in turn, increased the yield. Potassium also make a pronounced role in carbohydrates synthesis, photosynthesis cell elongation, stomatal activity and higher nutrient uptake under this level resulted in higher plant height and number of branches per plant and ultimately helped in the realization of higher haulm yield. The results are in conformity with the findings of Ganga *et al.* (2014) [9], Jadeja *et al.* (2016) [14], Ingle *et al.* (2018) [12] and Jadeja *et al.* (2019) [13].

Effect of zinc
The data presented in Table 1 showed that the haulm yield of chickpea was significantly influenced due to different levels of zinc. Significantly the higher haulm yield (3689 kg/ha) was recorded in the treatment Z_2 (5.0 kg Zn/ha) which was remained at par with treatment Z_1 (2.5 kg Zn/ha). Similar results were observed by Chavan *et al.* (2012) [5], Sharma *et al* (2014) [27], Rahman *et al*. (2015) [23] and Kuldeep *et al.* (2018) [17].

Interaction effect
The haulm yield of chickpea did not differ significantly due to Interaction of different levels potassium and zinc (Table 1).

Effect of potassium and zinc on nutrient content in chickpea
Nutrient content in seed
The data furnished in Table 3 indicated that N, P, K and S content in chickpea seed was significantly influenced by different levels of potassium and zinc and their interaction.

Effect of potassium
Different levels of potassium had significantly influenced on N and P content in chickpea seed. The treatment receiving an application of 40 kg K_2O/ha (K_2) obtained significantly higher N content (3.38%) and P content (0.70 %) which was found to be at par with treatment of application of 20 kg K_2O/ha (K_1). were as potassium and sulphur content was found maximum K content (0.86 %) and S content (0.145%) in chickpea seed than rest of the treatments. Similar results have been reported by Chavan *et al.* (2012) [5], Rathore *et al.* (2013) [22] and Chaudhary *et al*. (2017) [6].

While the data pertaining to the effect of potassium on micronutrient (Fe, Mn, Zn and Cu) content in seed did not differ significantly by treatment containing application of potassium.

Effect of zinc
The data presented in Table 3 showed that N, P, K, S and micronutrient content in chickpea seed did not differ significantly due to different levels of zinc. While, different levels of zinc had significantly influenced on Zn content in seed. Significantly higher Zn content (21.54 mg/kg) was found with the treatment Z_2 (5.0 kg Zn/ha) but it was found statistically at par with treatment Z_1 (2.5 kg Zn/ha).

Nutrient content in Hulm
Effect of potassium
The data illustrated in Table 3 indicated that significantly the highest N (1.28 %), P (0.41%), K (1.01 %) and S (0.125 %) content in haulm was recorded with the treatment containing application of 40 kg K_2O/ha (K_2) than other treatments. Similar results were found by Mondal *et al*. (2005) [19] and Ranpariya *et al.* (2017) [24]. While, micronutrient (Fe, Mn, Zn nad Cu) content was recorded non-significant with the different level of potassium treatment.

Effect of zinc
An appraisal of data given in Table 3 revealed that the N, P, K and S and micronutrient (Fe, Mn and Cu) content in chickpea haulm did not differ significantly by the application of different levels of zinc. but in case of zinc treatment receiving application of 5 kg Zn/ha obtained remarkably maximum Zn content (15.68 mg/kg) in haulm over control (Z_0) but was found on same bar of treatment of application of 2.5 kg Zn/ha (Z_1).

Interaction effect
The interaction of different levels of potassium and zinc had not exerted any significant difference in N, P, K S and micronutrient (Fe, Mn, Zn and Cu) content in seed and hulm.

Table 1: Effect of potassium and zinc on seed and haulm yield of chickpea

Treatments	Seed yield (kg/ha)	Haulm yield (kg/ha)
K levels (kg/ha)		
K_0	1734	3102
K_1	2190	3548
K_2	2334	3767
S. Em±	44	97
CD (P = 0.05)	129	282
Zn levels (kg/ha)		
Z_0	1877	3231
Z_1	2130	3498
Z_2	2251	3689
S. Em±	44	97
CD (P = 0.05)	129	282
K × Zn	Sig.	NS
CV (%)	7.33	9.63

Table 2: Interaction effect of potassium and zinc on seed yield of chickpea

K levels (kg/ha)	Seed yield (kg/ha)		
	Zn levels (kg/ha)		
K × Z	Z_0	Z_1	Z_2
K_0	1687	1709	1806
K_1	1851	2276	2444
K_2	2094	2406	2504
S. Em ±	76		
CD (P =0.05)	223		

Table 3: Effect of potassium and zinc on nitrogen and phosphorus content in chickpea

Treatments	N content (%)		P content (%)		K content (%)		S content (%)	
	Seed	Haulm	Seed	Haulm	Seed	Haulm	Seed	Haulm
K levels (kg/ha)								
K_0	3.19	1.14	0.65	0.33	0.79	0.92	0.129	0.097
K_1	3.30	1.23	0.67	0.38	0.83	0.97	0.138	0.114
K_2	3.38	1.28	0.70	0.41	0.86	1.01	0.145	0.125
S. Em±	0.03	0.02	0.01	0.01	0.01	0.01	0.002	0.002
CD (P = 0.05)	0.09	0.05	0.03	0.02	0.02	0.03	0.006	0.005
Zn levels (kg/ha)								
Z_0	3.25	1.19	0.66	0.36	0.81	0.96	0.135	0.109
Z_1	3.28	1.21	0.68	0.37	0.83	0.97	0.137	0.113
Z_2	3.33	1.24	0.69	0.38	0.84	0.97	0.140	0.115
S. Em±	0.03	0.02	0.01	0.01	0.01	0.01	0.002	0.002
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
K × Zn	NS	NS	NS	NS	NS	NS	NS	NS
CV%	3.12	4.47	4.90	5.96	3.57	4.06	4.91	5.45

Table 4: Effect of potassium and zinc on Fe and Mn content in chickpea

Treatments	Fe content (mg/kg)		Mn content (mg/kg)		Zn content (mg/kg)		Cu content (mg/kg)	
	Seed	Haulm	Seed	Haulm	Seed	Haulm	Seed	Haulm
K levels (kg/ha)								
K_0	52.47	74.49	16.30	46.37	19.70	14.64	4.89	7.28
K_1	54.70	76.13	16.55	47.60	20.43	15.12	5.00	7.32
K_2	55.51	77.77	17.00	48.17	20.93	15.21	5.07	7.52
S. Em±	0.88	0.98	0.21	0.55	0.34	0.21	0.05	0.09
CD zP = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Zn levels (kg/ha)								
Z_0	53.45	74.68	16.42	46.98	18.86	14.19	4.91	7.28
Z_1	54.21	76.30	16.64	47.34	20.67	15.10	4.99	7.36
Z_2	55.02	77.41	16.79	47.82	21.54	15.68	5.06	7.48
S. Em±	0.88	0.98	0.21	0.55	0.34	0.21	0.05	0.09
CD (P = 0.05)	NS	NS	NS	NS	0.98	0.62	NS	NS
K × Zn	NS	NS	NS	NS	NS	NS	NS	NS
CV%	5.61	4.47	4.33	4.02	5.70	4.92	3.45	4.16

Conclusion

The treatment receiving application of 40 kg K_2O/ha (K_2) recorded remarkably maximum seed yield of chickpea (2334 kg/ha) over different levels of potassium whereas significantly maximum haulm yield (3767 kg/ha) was recorded with the treatment receiving application of 40 kg K_2O/ha (K_2) as compared to control but remained statistically at par with the treatment receiving application of 20 kg K_2O/ha (K_1).

the different levels of potassium significantly increased the nutrient contents in chickpea except micronutrient contents. The treatment containing application of 40 kgK_2O/ha (K_2) obtained significantly maximum N, P, K and S contents in chickpea seed than other treatments of potassium but was at par with the treatment of application of 20 kg K_2O/ha (K_1) in case of N and P contents in seed. However, the treatment of K_2 (40 kg K_2O/ha) recorded significantly higher N, P, K and S in chickpea haulm in comparison with rest of the treatments. The micronutrient contents *viz.*, Fe, Mn, Zn and Cu content in chickpea seed and haulm did not differ significantly due to various levels of potassium

References

1. Anonymous. District-wise APY of important food and non-food crops in Gujarat State. Directorate of Agriculture, Gandhinagar, Gujarat, 2018, 16p.
2. Ali M, Srinivasa Rao Ch. Role of potassium fertilization in improving productivity of pulse crops. In Proceeding of International Symposium held in New Delhi, India, 2001, 261-267.
3. Attoe OJ, Truog E. Exchangeable and acid soluble K as regards availability and reciprocal relationships. Soil Science Society of Soil America Proceeding. 1945;10:81-86.
4. Brady NC, Well RR. The Nature and Properties of Soils (13th Ed.). Personal Education Pvt. Ltd, New Delhi, 2002.
5. Chavan AS, Khafi MR, Raj AD, Parmar RM. Effect of potassium and zinc on yield, protein content and uptake

of micronutrients on cowpea (*Vigna unguiculata* (L.) Walp.). Agricultural Science Digest- A Research Journal. 2012;32(2):175-177.
6. Chaudhary DG, Parmar JK, Chaudhary SR, Shinde RD. Influence of potassium, zinc and FYM on growth, yield, nutrient contents and uptake by forage maize (*Zea mays* L.) grown on loamy sand soil. International Journal of Chemical Studies. 2017;5(2):39-42.
7. Das PC. Plant Nutrients. In: Manures and Fertilizers (2nd Ed.). Kalyani Publishers, New Delhi, India, 1999, 5-10.
8. Davara, Monali A, Polara KB, Ribadiya, Trupti R, Vadaliya, *et al*. Effect of potassium and zinc on growth, yield and quality of coriander (*Coriandrum sativum* L.). International Journal of Chemical Studies. 2019;7(4):292-295.
9. Ganga N, Singh RK, Singh RP, Choudhury SK, Upadhyay PK. Effect of potassium level and foliar application of nutrient on growth and yield of late sown chickpea (*Cicer arietinum* L.). Environment and Ecology. 2014;32(1A):273-275.
10. Gil J, Nadal S, Luna D, Moreno MT, Haro AD. Variability of some physico-chemical characters in Desi and Kabuli chickpea types. Journal of the Science of Food and Agriculture. 1996;71(2):179-184.
11. Goud VV, Konde NM, Mohod PV, Kharche VK. Response of chickpea to potassium fertilization on yield, quality, soil fertility and economic in vertisols. Legume Research- An International Journal. 2014;37(3):311-315.
12. Ingle AB, Chavan VV, Lawate P, Shek MA. Effect of organic manure and potash fertilizer on yield and yield attributes of soybean (*Glycine max* (L.) Merrill. Journal of Pharmacognosy and Phytochemistry. 2018;7(2):476-478.
13. Jadeja AS, Rajani AV, Kaneriya SC, Hirapa DV, Nutrient Content, Uptake, Quality of Chickpea (*Cicer arietinum* L.) and Fertility Status of Soil as Influenced by Fertilization of Potassium and Sulphur. International Journal of Current Microbiology and Applied Sciences. 2019;8(6):2351-2355.
14. Jadeja AS, Rajani AV, Foram C, Kaneriy ASC, Kavar NR. Soil application of potassium and sulphur and effect on growth and yield components of chickpea (*Cicer arietinum* L.) under South Saurashtra Region of Gujarat. International journal of environmental Science and technology. 2016;5:3172-3176.
15. Jukanti AK, Gaur PM, Gowda CL, Chibbar RN. Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.), British Journal of Nutrition. 2012;108(S1):S11-S26.
16. Krishna KSSR, George PJ. Effect of levels of phosphorus and zinc on growth and yield of Kabuli chickpea (*Cicer kabulium* L.). Journal Pharmacognosy Phytochemistry. 2017;6:013-1016.
17. Kuldeep, Kumawat PD, Bhadu V, Sumeriya HK, Kumar V. Effect of Iron and Zinc Nutrition on Growth Attributes and Yield of Chickpea (*Cicer arietinum* L.) International Journal of Current Microbiology and Applied Sciences. 2018;7(8):2837-2841.
18. Kumar H, Yadav BS, Singh R, Yadav DD, Chahal VP, Yadav R, *et al*. Effect of potassium levels on performance of chickpea (*Cicer arietinum* L.) under different genotypes. International Journal of Chemical Studies. 2018;6(6):1675-1677.
19. Mondal SS, Mandal P, Saha M, Bag A, Nayak S, Sounda G. Effect of potassium and sulphur on the productivity, nutrient uptake and quality improvement of chickpea. Journal of Crop and Weed. 2005;2(1):84-86.
20. Maleki A, Fazel S, Naseri R, Rezaei K, Heydari M. Effect of potassium and zinc sulphate application on grain yield of maize under drought stress conditions. Advances in Environmental Biology. 2014;8(4):890-893.
21. Papastylianous I. Effect of preceding legume or cereal on barley grain and nitrogen yield. The Journal of Agricultural Science. 1987;108(3):623-626.
22. Rathore SS, Chaudhary DR, Vaisya LK, Shekhawat Kapila, Bhatt BP. Schoenite and potassium sulphate: Indigenous potassic fertilizer for rainfeSd groundnut (*Arachis hypogaea* L.) Journal of Academia and Industrial Research. 2013;13(1):222-226.
23. Rahman MM, Adan MJ, Chowdhury MSN, Alil MS, mahabub TS. Effects of Phosphorus and Zinc on the Growth and Yield of Mungbean (BARI mug 6). International Journal of Scientific and Research Publications. 2015;5(2):2250-3153.
24. Ranpariya VS, Polara KB, Hirpara DV, Bodar KH. Effect of potassium, zinc and FYM on content and uptake of nutrients in seed of summer green gram (*Vigna radiata* L.) and post-harvest soil fertility under medium black calcareous soil. International Journal of Chemical Studies. 2017;5(5):1055-1058.
25. Samiullah, Khan NA. Physiological investigation on interactive effect of P and K on growth and yield of chickpea. Indian Journal of Plant Physiology. 2003;8(2):165-170.
26. Sangwan PS, Raj M. Effect of zinc nutrition on yield of chickpea (*Cicer arietinum* L.) under dry land conditions. Indian Journal of Dry land Agriculture Research & Development. 2004;19(1):1-3.
27. Sharma A, Sharma S, Gill PPS. Influence of Nitrogen and Sulphur Application on Nutrient Uptake, Protein content and Yield parameters of Soyabean. Indian Journal of Plant Sciences. 2014;3(2):31-34.
28. Shivay YS, Prasad R, Pal M. Effect of variety and zinc application on yield, profitability, protein content and zinc and nitrogen uptake by chickpea (*Cicer arietinum* L.) Indian Journal of Agronomy. 2014;59(2):317-321.
29. Shukla AK, Tiwari PK. Progress Report of AICRP on Micro- and Secondary Nutrients and Pollutant Elements in Soils and Plants. IISS, Bhopal, 2014.
30. Singh AP, Lal AK, Singh AP. Effect of FYM, potassium and zinc on yield, quality and uptake of nutrients in forage oat in alluvial soil. Annals of Plant and Soil Research. 2016;18(4):338-341.
31. Singh D, Singh H. Effect of phosphorus and zinc nutrition on yield, nutrient uptake and quality of chickpea. Annual of Plant and Soil Research. 2012;14(1):71-74.
32. Singh ON, Singh RS, Singh JP. Supplementing fertilizer potassium to chickpea. Journal of Potash Research. 1994;10:83-85.
33. Sutariya GS, Ramdevputra MV, Ansodaria VV, Akbari KN. Effects of potassium and zinc nutrition on yield and quality of forage sorghum. Indian Journal of Agricultural Research. 2013;47(6):540-544.
34. Verma VK. Response of irrigated chickpea (*Cicer arietinum* L.) to NPK in light soils and its economics. Advances in Plant Science. 1994;7(1):138-142.
35. Farooq M, Hussain M, Wahid A, Siddique KH. Drought

stress in plants: an overview. Plant responses to drought stress, 2012, 1-33.
36. Hoyer WD, Chandy R, Dorotic M, Krafft M, Singh SS. Consumer cocreation in new product development. Journal of service research. 2010 Aug;13(3):283-96.