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Degala Anandamai
M.Sc. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

Umesha C
Assistant Professor, Department of Agronomy, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

P Ravi Kumar
M.Sc. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Degala Anandamai
M.Sc. Scholar, Department of Agronomy, NAI, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of potassium and sulphur levels on yield attributes and economics of chickpea (*Cicer arietinum* L)

Degala Anandamai, Umesha C and P Ravi Kumar

Abstract
The field experiment was conducted during *rabi* 2020 at Central Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science, Prayagraj (U.P.). To study the Effect of potassium and sulphur levels on yield attributes and economics of chickpea (*Cicer arietinum* L.). The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice. The treatment consists of of 3 levels of potassium *viz.* K_1 (20 kg/ha), K_2 (25 kg/ha), K_3 (30 kg/ha) and 3 levels of Sulphur *viz.* S_1 (10 kg/ha), S_2 (15 kg/ha) and S_3 (20 kg/ha) as basal application. The results revealed that yield parameters *viz.* test weight (27.41 g), seed yield (31.16 q/ha), haulm yield (36.33 q/ha), harvest index (46.17%) were recorded superior with the application of 25 kg/ha Potassium + 20 kg/ha Sulphur. The highest gross returns (128300 INR/ha), net returns (95950 INR/ha) and B:C ratio (2.96) were recorded with the treatment 25 kg/ha Potassium + 20 kg/ha Sulphur.

Keywords: Chickpea, potassium, sulphur, yield, economics

Introduction
Pulses are the important crops in our country and main source of vegetable protein. Pulses are easily digestible and cheaper has high biological values. Among pulses, chickpea is a most important *rabi* crop with high acceptability and wider use (Singh, 2011). Gram seeds serve as the main source of protein in the balanced diet and protein obtained from gram is cheaper than the protein obtained from animal origin.

Chickpea (*Cicer arietinum* L.) belongs to the genus *Cicer*, family *fabaceae*. The origin of crop is considered in Western Asia from where it spread in India and other part of world by Ali and Kumar (2001) [1]. Chickpea is a good source of protein, which is deficient in the diet of Indian people. Chickpea contains protein (18-22%), carbohydrate (52-70%), fat (4-10%) and sufficient quantity of minerals, calcium, phosphorus, iron and vitamins.

Potassium mainly effects the nodulation of pulse crop thus increases the seed yield through better fixation of nitrogen. It is one of the major elements taken up by the plant. Plants absorb Potassium in larger amounts as compared to other minerals except nitrogen. It helps in formation of proteins and chlorophyll. Potassium is a key nutrient in the plants which is tolerance to stress such as high/low temperatures, drought, disease and pest occurrences. Though, it is not a constituent of organic structures but it regulates enzymatic activities, translocation of photosynthates and considerably improves seed yield of chickpea if applied as a fertilizer Samiullah and Khan (2003) [9].

Sulphur, in chickpea, mainly influences the protein content as it helps in conversion of nitrogen into protein in pulse crops. Sulphur also improves the S containing amino acid in crop where it directly influencing the nutritional qualities. It is also necessary for chlorophyll formation and enhance the biosynthesis of oil and metabolism of carbohydrates, proteins and fats and thus now-a-days sulphur is being considered as the fourth major nutrient element after NPK. An adequate supply of mineral nutrients to legumes enhances nitrogen fixation Ganeshamurthy *et al*., (2000) [4]. With respect to above factors the present investigation was carried to find out the Effect of potassium and Sulphur levels on yield attributes and economics of chickpea (*Cicer arietinum* L.)

Materials and Methods
The experiment was conducted during *rabi* season 2020, at the Crop Research farm, Department of Agronomy, SHUATS, Prayagraj (U.P).

The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (7.5), low in available N (228.59 kg/ha), high in available P (29.80 kg/ha), medium in available K (125.21 kg/ha). The treatment consists of levels of potassium and sulphur. The experiment was laid out in Randomised Block Design. The two factors potassium and sulphur has three levels *i.e.* potassium @ 20, 25 and 30 kg/ha and sulphur @ 10, 15 and 20 kg/ha respectively comprising of nine treatment combinations each replicated thrice. Treatments were randomly arranged in each replication, divided into twenty seven plots. The recommended dose of 20 kg N and 40 kg P per ha was applied according to treatment details through urea and DAP along with different levels of potassium and sulphur. Five random plants were selected from each plot to record observations on plant growth attributes. Similarly, five random plant samples were collected from each plot at the time of harvest for recording observations on plant yield attributes. Experimental data collected was subjected to statistical analysis by adopting Fishers method of Analysis of Variance (ANOVA) as outlined by Gomez and Gomez (1984) [5]. Critical Difference (CD) value were calculated whenever the 'F' test was found significant at 5% level.

Results and Discussion

The Yield and Yield parameters like pods/plant (No.), test weight (g), seed yield (q/ha), haulm yield (q/ha) and harvest index (%) were significantly affected by application of potassium and sulphur at harvest where as the number seeds/pod was found to be non-significant.

Number of pods/plant

The data in Table No.4 represents that significantly maximum number of pods/plant (24.27) was recorded in 25 kg/ha Potassium + 20 kg/ha Sulphur. However, 20 kg/ha Potassium + 20 kg/ha Sulphur (23.50), 25 kg/ha Potassium + 10 kg/ha Sulphur (22.50), 25 kg/ha Potassium + 15 kg/ha Sulphur (23.00) and 30 kg/ha Potassium + 15 kg/ha Sulphur (22.90) were statistically at par with 25 kg/ha Potassium + 20 kg/ha Sulphur.

Since K is found to influence the total chlorophyll and carotenoid contents of the leaves. It may also directly and/or indirectly improve crop yield through increased photosynthesis, resulted in vigorous growth and consequently produce higher number of pods per plant and also providing better nutrition throughout the growth period and availability of potassium at pod formation stages which help in formation of more number of pods per plant by Senthurpandian *et al.*, (2008).

Number of seeds/pod

The data related to number of seeds/pod was presented in Table No. 4. Maximum number of seeds per pod (1.35) at harvest was recorded with treatment 25 kg/ha Potassium + 20 kg/ha Sulphur, while the effect of treatments were found to be non-significant.

Test weight (g)

Yield attributes in Table No.4 represents that significantly test weight (27.41 g) was recorded in 25 kg/ha Potassium + 20 kg/ha Sulphur. However, 20 kg/ha Potassium + 20 kg/ha Sulphur (25.70g), 25 kg/ha Potassium + 10 kg/ha Sulphur (24.80 g), 25 kg/ha Potassium + 15 kg/ha Sulphur (25.22g) and 30 kg/ha Potassium + 20 kg/ha Sulphur (25.21 g) were statistically at par with 25 kg/ha Potassium + 20 kg/ha Sulphur.

Higher 100-seed weight may be the result of enhanced photosynthetic activity, followed by efficient transfer of metabolites and subsequent accumulation of these metabolites in the seed with the resultant increase in the size and weight of individual seed. Similar findings also recorded by Farhad *et al*., (2010) [3]

Seed yield (q/ha)

The analysed data presented in Table No.4 represents that significantly maximum seed yield (31.16 q/ha) was recorded in 25 kg/ha Potassium + 20 kg/ha Sulphur. However, 20 kg/ha Potassium + 20 kg/ha Sulphur (27.45 q/ha) and 25 kg/ha Potassium + 15 kg/ha Sulphur (26.83 q/ha) were statistically at par with 25 kg/ha Potassium + 20 kg/ha Sulphur.

This may be due fact that potassium are reported to enhance the absorption of native as well as added major nutrient such as N and P which might have been attributed to improvement in yield**..** The increase in grain and straw yield due to Sulphur application might be attributed to its low availability in experimental soils. The synergistic effect of S may be due to utilization of large quantities of nutrients through well-developed root system which might have resulted in better plant development and ultimate yield Kumar *et al*., *(*2012) [12].

Haulm yield (q/ha)

The data in Table No.4 represents that significantly maximum haulm yield (36.33 kg/ha) was recorded in 25 kg/ha Potassium + 20 kg/ha Sulphur. However, 20 kg/ha Potassium + 10 kg/ha Sulphur (31.33 q/ha), 20 kg/ha Potassium + 20 kg/ha Sulphur (34.83 q/ha), 25 kg/ha Potassium + 10 kg/ha Sulphur (32.96 q/ha). 25 kg/ha Potassium + 15 kg/ha Sulphur (34.33 q/ha), 30 kg/ha Potassium + 15 kg/ha Sulphur (32.65 q/ha) and 30 kg/ha Potassium + 20 kg/ha Sulphur (31.60 q/ha) were statistically at par with 25 kg/ha Potassium + 20 kg/ha Sulphur.

The improvement in the haulm yield might be due to indirect and positive role of potassium in formation and proliferation of lateral and fibrous roots, which increases the root absorbing surface area for nutrients, which in turn promotes the growth parameters and ultimately enhanced the Haulm yield Chavan *et al., (*2012) [2].

Harvest Index (%)

The analysed data presented in Table No.4 represents that the highest Harvest Index was recorded in Potassium 25 kg/ha + Sulphur 20 kg/ha (46.17%). However, the treatment Potassium 25 kg/ha + Sulphur 15 kg/ha (43.86%), Potassium 20 kg/ha + Sulphur 20 kg/ha (44.08%) and Potassium 30 kg/ha + Sulphur 15 kg/ha (44.73%) was noticed statistically at par with Potassium 25 kg/ha + Sulphur 20 kg/ha.

This could be attributed due to better root proliferation, higher root development, increased availability and uptake of nutrients, energy transformation and metabolic processes in plant Hussain *et al*, (2011) [7] reported that different potassium levels significantly influenced the yield and yield contributing parameters.

Economics

The data in Table No.4 represents The highest gross returns (128300 INR./ha), net returns (95950 INR/ha) and B:C ratio (2.96) were recorded with the treatment 25 kg/ha Potassium + 20 kg/ha Sulphur.

Gross returns, net returns and B: C ratio increased significantly due to successive increase in varying levels of potassium in chickpea with application of 25kg/ha Potassium. This might be attributed to higher seed and Stover yields obtained with comparatively less cost than additional income under these treatments. Similarly results were also reported by Goud *et al*., (2014) [6]. Successive increase in sulphur rates up to 20 kg/ha. Significantly increased gross and net returns. This might be due to maximum recovery from application of sulphur with less expenditure and higher seed and Stover yields obtained from these treatments. The results are in conformity with the work of Srinivasa *et al*., (2010) and Srinivasulu *et al*., (2014).

Table 1: Effect of potassium and sulphur on Yield and Yield attributes of chickpea.

S. No.	Treatments	Pods/plant (No.)	Seeds/pod (No.)	Test weight (g)	Haulm yield (q/ha)	Seed yield (q/ha)	Harvest Index (%)
1.	20 kg/ha Potassium + 10 kg/ha Sulphur	22.05	1.26	24.34	31.33	23.60	42.96
2.	20 kg/ha Potassium + 15 kg/ha Sulphur	22.00	1.12	22.12	26.33	19.00	41.91
3.	20 kg/ha Potassium + 20 kg/ha Sulphur	23.50	1.33	25.70	34.83	27.45	44.08
4.	25 kg/ha Potassium + 10 kg/ha Sulphur	22.50	1.20	24.80	32.96	22.80	40.88
5.	25 kg/ha Potassium + 15 kg/ha Sulphur	23.00	1.33	25.22	34.33	26.83	43.86
6.	25 kg/ha Potassium + 20 kg/ha Sulphur	24.27	1.35	27.41	36.33	31.16	46.17
7.	30 kg/ha Potassium + 10 kg/ha Sulphur	19.00	1.18	24.20	27.33	19.00	41.00
8.	30 kg/ha Potassium + 15 kg/ha Sulphur	22.90	1.32	23.52	32.65	24.73	44.73
9.	30 kg/ha Potassium + 20 kg/ha Sulphur	19.20	1.18	25.21	31.60	23.00	38.06
	F-test	S	NS	S	S	S	S
	S.Em±	0.65	0.11	0.90	192.48	208.54	1.06
	CD (0.05)	1.95	0.34	2.69	577.10	625.19	3.16

Table 2: Effect of potassium and sulphur on economics of chickpea

S. No.	Treatments	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	20 kg/ha Potassium + 10 kg/ha Sulphur	31350	97533	66183	2.11
2.	20 kg/ha Potassium + 15 kg/ha Sulphur	31800	78633	46833	1.47
3.	20 kg/ha Potassium + 20 kg/ha Sulphur	32250	106050	73800	2.28
4.	25 kg/ha Potassium + 10 kg/ha Sulphur	31450	94497	63047	2.00
5.	25 kg/ha Potassium + 15 kg/ha Sulphur	31900	110766	78867	2.47
6.	25 kg/ha Potassium + 20 kg/ha Sulphur	32350	128300	95950	2.96
7.	30 kg/ha Potassium + 10 kg/ha Sulphur	31550	78733	47183	1.49
8.	30 kg/ha Potassium + 15 kg/ha Sulphur	32000	102198	70198	2.19
9.	30 kg/ha Potassium + 20 kg/ha Sulphur	32450	95160	62710	1.93

Conclusion

From the above experiment it is concluded that sowing of Chickpea with the application of Potassium 25 kg/ha along with Sulphur 20 kg/ha has been found to be more productive and remunerative.

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