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Interaction effect of different levels of potassium and varieties on performance of chickpea

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Abstract
Judicious use of fertilizers particularly potassium is essential for obtaining the maximum yield of chickpea. So, the present study was carried out to assess the interaction effect of different levels of potassium and varieties on performance of chickpea. The present investigation consisted four levels potassium (K_1-0, K_2-30, K_3- 60 & K_4-90 kg potash ha^{-1}) and three varieties (V_1-Udai, V_2 - Awarodhi and V_3 - KWR-108) observation recorded on growth, yield attributes and yield. The present investigation revealed that the maximum fresh weight and dry weight of plant at flowering and maturity stage, number of seeds per plant, grain weight per plant, grain and straw yield were recorded in K_4 treatment (90 kg potassium ha^{-1}) and variety V_3 (KWR-108). However, maximum number of primary and secondary branches per plant, fresh weight of plant, dry weight, number of pods per plant, number of seeds per plant, weight of pod per plant, biological, grain and straw yield were recorded unfertilized plot K_1 (0 kg potassium ha^{-1}) and variety V_1 (Udai). Thus, for obtaining maximum yield and profit from chickpea, KWR-108 variety should be grown with 90 kg potassium ha^{-1}.

Keywords: chickpea, grain yield, interaction effect potassium levels and varieties

Introduction
Among the pulses, chickpea (*Cicer arietinum* L.) is the third most important legume in the world. India alone contributes more than 62-67% of the total global production. However, India generally imports 2 million tonnes of pulse every year from Turkey, Australia, Canada and USA. To make up this short fully supply besides of course, further demand from a burgeoning population, at least 23.38 million tonnes of pulses are required by 2015 which is expected to touch 29.30 million tonnes by 2020. This necessitates an annual growth rate of 4.2 per cent in pulse production Girma (2015) [1].

The productivity of chickpea is low because it is grown on receding soil moisture during *rabi* season, and farmers do not apply fertilizers being a legume crop. The yield gap of chickpea may be attributed to improper agro-technology used by the farmers. Among production inputs, fertilizer plays a key role in enhancing productivity levels. Pulse crop fix atmospheric N, the prominent mechanism to meet their N requirement, however, recommendation on phosphorous is made in all states. However, K application is generally neglected, resulting to serious depletion of soil K reserves. Chickpea removes about 49.6 kg K_2O tonnes^{-1} grain higher than nitrogen (46.3 kg tonnes^{-1} grain) and phosphorous (8.4 kg tonnes^{-1} grain) (Velayutham and Reddy, 1987) [7]. Potassium influences the water economy and crop growth through its effects on water uptake, root growth, maintenance of turgor, transpiration and stomatal regulation. Its essentiality is proven in its multiple roles in assisting and facilitating plant process. It mainly functions like a conveyer of electrical charge in the plant cell and acts as catalysts for many of the enzymatic processes in the plant that are necessary for plant processes. It acts like a 'spark-plug' for the activation of over 60 enzymes in the plant system. Potassium is a key nutrient in the plants tolerance to stress such as high/low temperatures, drought, disease and pest occurrences. It has a critical role to play in osmo-regulation-regulation of water use in plants and most importantly regulates opening and closing of stomata which affect transpiration cooling and carbon dioxide uptake for photosynthesis. Potassium is a mono-atomic ion that enters the plant in an atomic form without passing through the microbial cycle. It is borrowed element from the soil and must be returned to the soil at the end of the plant cycle. Since chickpea is normally cultivated on relatively poor soil on residual soil moisture, it becomes imperative to study the effect of potassium on growth, yield, quality, soil fertility and

economics (Goud *et al*. 2014) [2]. Singh *et al.* (1995) [6] revealed that potassium has an important role under different environment in major plant processes such as photosynthesis, respiration, enzyme activation, osmoregulation and yield of crop. Hence, potassium is an important component balanced fertilizer use strategy.

Materials and Methods

Experimental details and site description

The present experiment was carried out during *Rabi* 2014-15 at Students' Instructional Farm (SIF), Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (U.P.), India. The field was well leveled and irrigated by tube well. The farm is situated in the west Northern part of Kanpur city under sub tropical zone in 5th Agro-climatic zone (Central Plain Zone). Farm is falling in alluvial belt of Gangetic plain of U.P. between 25056' N to 28058' N latitude and 79031' E to 80034' E longitudes and at an elevation of 125.9 meter from maean sea level. The total rainfall received during the crop period was 23.3 mm. The soil of experimental field was slightly alkaline in reaction with 7.9 pH, low in organic carbon (0.32%) and low in available nitrogen (180.4 kg ha^{-1}), phosphorus (18.4 kg ha^{-1}) and medium in potassium (290 kg/ha). All the soil properties were analyzed as per the standard procedures. The experiment consist of 12 treatments combinations which were laid out in Randomized Block Design with three replications. The investigation retained four potassium level (0, 30, 60, 90 kg ha^{-1}) and 3 varieties (Udai, Awarodhi and KWR-108).

Data collection

The various observations on growth and yield attributes (fresh weight of plant, dry weight of plant, number of seed $plant^{1}$ and grain weight $plant^{1}$) were recorded as per standard procedure. Moreover, yields viz., grain and straw yield (q/ha) was worked out in different plot of the experimental field.

Statistical analysis

The data on various parameters were exposed to statistically analyze as drew by Panse and Sukhatme, 1967 [3]. The treatment variances were tested by using "F" test and critical differences (at 5 per cent probability).

Results and Discussion

Interaction effect on fresh and dry weight of plant at flowering and maturity stage

The data pertaining to fresh and dry weight of plant at flowering and maturity stage showed significant difference under different level of potassium level and varieties except dry weight at flowering stage did not showed significantly.

Table 1: Interaction effect of levels of potassium and varieties on fresh weight of chickpea

Varieties	Fresh weight (g) at flowering stage					Fresh weight (g) at maturity stage				
	Level of potassium					Level of potassium				
	K1	K2	K3	K4	Mean	K1	K2	K3	K4	Mean
V1	15.76	17.43	18.43	20.98	18.15	28.07	32.24	38.51	40.62	34.86
V2	16.37	17.67	19.06	21.43	18.63	30.76	35.42	37.34	42.10	36.40
V3	17.06	17.81	20.02	22.58	19.37	33.65	37.16	40.95	43.61	38.84
Mean	16.40	17.64	19.17	21.66		30.83	34.94	38.93	42.11	
Factors		SE(m)		C.D.		SE(m)		C.D		
Factor A		0.07		0.22		0.11		0.33		
Factor B		0.08		0.26		0.13		0.38		
Factor (AxB)		0.15		0.45		0.22		0.66		

Table 2: Interaction effect of levels of potassium and varieties on dry weight of chickpea

Varieties	Fresh weight (g) at maturity stage					Dry weight (g) at maturity stage				
	Level of potassium					Level of potassium				
	K1	K2	K3	K4	Mean	K1	K2	K3	K4	Mean
V_1	3.78	4.98	5.66	6.02	5.11	19.26	23.55	25.17	26.46	23.61
V_2	4.30	5.35	6.00	6.34	5.50	21.27	24.45	25.77	26.90	24.60
V_3	4.41	5.39	5.58	6.86	5.63	22.76	24.81	26.06	27.81	25.36
Mean	4.16	5.24	5.84	6.40		21.10	24.27	25.67	27.06	
Factors		SE(m)		C.D.		SE(m)		C.D		
Factor A		0.05		0.16		0.08		0.24		
Factor B		0.06		0.18		0.09		0.28		
Factor(AxB)		0.10		N.S.		0.16		0.49		

The above Table showed that, fresh and dry weight $plant^{-1}$ significantly differ under different potassium levels and varieties at flowering and maturity stage. The significantly highest fresh (22.58 and 6.86 g) and (43.61 and 27.81 g) weight were found in interaction $K_4 \times V_3$ (90 kg potassium ha^{-1}× KWR-108) followed by interaction $K_4 \times V_2$ (21.43 and 6.34 g) and (42.10 and 26.90 g) which was significantly superior to interaction $K_4 \times V_1$ (20.98 and 6.02 g) and (40.62 and 26.46 g). While the minimum fresh (15.76 and 3.78 gm) and dry (28.07 and 19.26 g) weight of plant was recorded in interaction control $K_1 \times V_1$ (0 Kg potassium ha^{-1} × Udai). These observations might be due to enhanced availability of plant nutrients, photosynthetic activity, followed by efficient transfer of metabolites and subsequent accumulation of these metabolites in the seed with the resulting in the all yield attributing character. Almost similar results were reported by Rajiv *et al*. (2005) [4].

Interaction effect on number of seeds per $plant^{-1}$

The data pertaining to number of seeds per plant was influenced by different treatments, showed significantly difference under different levels of potassium and varieties under observations is present Table 3.

Table 3: Interaction effect of levels of potassium and varieties on number of seeds plant^{-1}

Varieties	Number of seeds plant $^{-1}$				
	Level of potassium				
	K_1	**K_2**	**K_3**	**K_4**	**Mean**
V_1	63.01	71.68	74.70	78.42	71.95
V_2	67.42	73.69	76.01	80.30	74.35
V_3	69.33	74.01	77.33	84.01	76.17
Mean	66.59	73.13	76.01	80.91	
Factors	SE(m)±				C.D.
Factor(A)	0.05				0.14
Factors(B)	0.05				0.17
Factor(A×B)	0.09				0.29

The above table showed that, the number of seeds plant^{-1}significantly differ under different potassium levels and varieties. The significantly highest number of seeds (84.01) was found in interaction $K_4 \times V_3$ (90 Kg potassium ha^{-1}× KWR-108) followed by interaction $K_4 \times V_2$ (80.30) which was significantly superior to interaction $K_4 \times V_1$ (78.42). While the minimum number of seeds plant^{-1} (63.01) was recorded in interaction $K_1 \times V_1$ (0 Kg potassium ha^{-1}×Udai). Almost similar result was reported by Girma (2015) [1].

4.2.4.3 Interaction effect on grain weight plant^{-1}

Perusal of data showed that weight of grains plant^{-1} was obtained (15.56 g) in interaction K_4x V_3 (90 kg potassium ha^{-1} x KWR 108) which was significantly higher than interaction K_4xV_2 (14.73 g) and K_4x V_1 (90 14.33 g), respectively. However, significantly lower values of grains weight plant^{-1} was recorded in interaction K_1xV_1 (11.06 g) plot (control). Almost similar results were reported by Rajiv *et al*. (2005) [4].

Table 4: Interaction effect of levels of potassium and varieties on grain weight plant^{-1}

Varieties	Grain weight plant $^{-1}$				
	Level of potassium				
	K_1	**K_2**	**K_3**	**K_4**	**Mean**
V_1	11.06	13.36	13.67	14.33	13.10
V_2	12.00	13.63	13.63	14.73	13.50
V_3	12.70	13.83	13.73	15.56	13.95
Mean	11.92	13.61	13.68	14.88	
Factors	SE(m)±			C.D.	
Factor (A)	0.10			0.29	
Factors (B)	0.11			0.34	
Factor (A×B)	0.59			0.20	

Yields

Significantly maximize the grain and straw yield was with the application of 90 kg potassium ha^{-1} (K_4) 18.80 and 19.13 q ha^{-1}, which was significant and superior to other potassium level treatments like, K_3 (15.46 & 15.74 q ha^{-1}) and K_2 (14.00 & 14.46 q ha^{-1}). The magnitude of increase in yield average was to be 37.02 per cent over the control. However, the significantly minimum grain and straw yield (11.84 & 12.58 q ha^{-1}) was recorded in the control K_1 (0 kg potassium ha-1). Reduction of potassium doses reduced these yield may be supported by growth and yield parameter like plant population, plant height, number of branches, dry matter plant^{-1}, seed plant^{-1}, seed weight plant^{-1} and 100 seed weight, which are maximized at 90 kg potassium ha^{-1}. It is also clear from that data that an application of potassium with increasing doses also increased grain yield. The yield increased in K_4 by margin of K_3 (3.34 q ha-1), K_2 (4.80 q ha^{-1}) and K_1 (6.96 q ha^{-1}), respectively. Thus, this dose performed better in the of respect growth, yield attributes and yield of chickpea.

Table 5: Mean grain yield and straw yield as influenced by various treatments

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Potassium level		
K_1	11.84	12.58
K_2	14.00	14.46
K_3	15.46	15.74
K_4	18.80	19.13
SE(m) ±	0.17	0.27
CD at 5%	0.50	0.82
Varieties		
V1	14.33	14.66
V2	14.87	15.31
V3	15.87	16.46
SE(m) ±	0.14	0.24
CD at 5%	0.43	0.71

Grain yield (15.8.7 q ha^{-1}), straw yield (16.46 q ha^{-1}) were significantly higher in KWR-108 variety. However, the minimum grain (14.33 q ha^{-1}) and straw (14.66 q ha^{-1}) yield were achieved in Udai variety. It was attributed by yield attributes is general and seed weight^{-1} in particular. Whereas, maximum harvest index (49.38 %) recorded in variety KWR-108 which did not affect significant each other. Similar results were reported by Sekeroglu *et al*. (1991) and Girma (2015) [1].

Conclusion

On the basis of present experiment on sandy loam soil of central U.P. under irrigated condition. It can be concluded that application of 90 kg ha^{-1} proved better in respect of growth, yield attributes and yield of chickpea. Moreover, in the interaction K_4xV_3 (90 kg potassium ha^{-1} x KWR108) was produce higher grain yield (20.40 q ha^{-1}). Thus for obtaining maximum yield and profit from chickpea, KWR-108 variety should be grown with 90 kg potassium ha^{-1}.

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