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Response of potassium levels on different varieties of chickpea (*Cicer arietinum* L.) and their production economics

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Abstract
The previous study showed the importance of potassium in legume nutrition. However, the work done on legumes with potassium application is not well recognized in comparison to cereals and other crops. Therefore, keeping these view in mind an experiment was conducted during *Rabi* season of 2013 -14 at SIF of CSAUT Kanpur. Twelve treatments under which 4 Potassium levels *viz.*, K_1, K_2, K_3 and K_4 (0, 30, 60 and 90 kg ha^{-1}) and Three Varieties (Udai, Avarodhi and KWR-108) were tested in factorial randomized block design with three Replications. Significantly highest plant population, number of branches, fresh and dry weight of plant at flowering and maturity, grain yield (18.66 q ha^{-1}), net profit (Rs.29032 ha^{-1}) and B: C ratio (2.00) were recorded under potassium level K_4 (90 kg potassium per ha). The minimum grain yield (11.60 q ha^{-1}), net profit (Rs.9535 ha^{-1}) and B:C ratio (1.36) was received in control treatment K_1 (0 kg potassium per ha). Thus, chickpea variety KWR-108 should be fertilized with 90 kg potassium per ha for achieving maximum yields and profit.

Keywords: chickpea, potassium levels, production economics and varieties

Introduction
Pulses have traditionally been recognized as an indispensible constituent of human diet. Pulse play important role in human diet by their ideally supplementing the cereal rich diet of predominantly vegetarian mass by virtue of their being rich in protein and several amino acids. The case with which they fit into crop production and mixture, their long recognized property of restoration of soil fertility, their capacity of yielding at least something even under marginal and most neglected condition with least inputs and high consumers depend for them have been reason for popularity of pulse among Indian farmers.

India is a major pulse growing country in the world sharing about 25 per cent and 62-67 per cent of the total area and production of the world. India's pulse production during the last five years varied in the range from 11 to 15 million tons. The area, production and productivity of pulse in India during the year of 2013-2014 were 25.23 million ha (*Kharif* 11.25mha and *Rabi* 13.98mha), 19.27 million tons (*Kharif* 7.15 mt and *Rabi* 12.12 mt) and 764 kg ha,$^{-1}$ respectively (Anonymous, 2015). The major pulses producing states are Madhya Pradesh (26.41%) is the largest pulse producing state followed by Maharashtra (16.19 %), Rajasthan (12.82 %), Uttar Pradesh (8.87 %), Andhra Pradesh (8.04 %), Karnataka (7.63 %), Gujrat (3.37 %) and other states (16.67 %).

Potassium (K) is one of the key elements impacting crop production and is the most abundant inorganic cations in plants (Pittaway *et al.*, 2008) [9]. In recent years K deficiency has resulted in a significant decline in food production. Unbalanced fertilizer application and use of nitrogenous (N) and phosphatic (P) fertilizers leads to disproportionate removal of K and thus plants have to rely on soil K reserves. Moreover, potassium is the third major element after nitrogen and phosphorus taken up by the plant. Plants absorb it in larger amounts as compared to other minerals except nitrogen. It has upmost importance for imparting drought and disease resistance and has synergistic effect with nitrogen and phosphorus (Das, 1999) [3].

Materials and Methods
Site description
The present experiment was carried out during *Rabi* 2013-14 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.

Experimental details

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). The sowing of chickpea was done on November 21, 2013 at a row spacing of 40 cm apart with depth 8-10 cm and harvested at second week of April, 10 2014. Nitrogen was applied @ 20 kg per ha and phosphorus was applied @ 50 kg per ha and different quantity of Potassium as per treatment of 0, 30, 60 and 90 kg per ha was given at sowing in furrow with the help of seeding sprout attached in country plough. As per treatment well rotted FYM @ 10 t ha^{-1} was applied by broadcasting method and then mixed with soil there after sowing was done. Weeds are emerged sharply in chickpea, in order suppress them two hand weeding was done first weeding at 30-35 days after sowing and second weeding at 70-72 days after sowing of the crop with the help of *Khurpi* to control the weeds. To provide proper space to each extra plant were removed and wide spaces were filled by sowing the plant at each vacant place. As winter showers occurred at pre flowering and pod filling stages, hence no irrigation.

Data collection

The various observations on plant population, growth attributes (number of branches, fresh weight and dry weight of plant) were recorded as per standard procedure. Moreover, yields viz., grain, straw and biological yield (q/ha) alongwith harvest index 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) [8]. The treatment variances were tested by using "F" test and critical differences (at 5 per cent probability).

Results and Discussion

Plant population

Data in respect of initial and final plant population were not influenced by different treatments but almost similar number of plants population per running meter were counted in both stage of crop. The maximum initial and final plant population was recorded after complete germination and maturity stage 12.02 and 10.02 plants. It was observed that the initial and final plant population was not significantly affected due to different potassium levels under study. It indicates that there was no effect of potassium doses neither on germination of seed nor in mortality of plants. Almost similar result was reported by Kumar *et al*. (2005) [7]. Moreover, initial and final plant population of chickpea was also not found significant under different varieties but almost equal number of plants was counted at both stage of crop. Almost similar result was reported due to germination standards of maximum varieties are similar and viability and purity these three varieties of chickpea (Udai, Avarodhi and KWR-108).

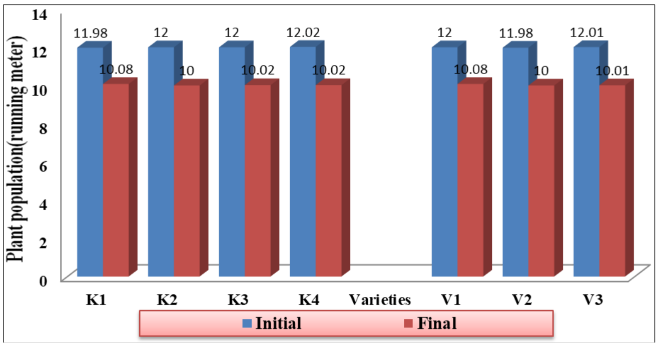

Fig 1: Influenced of potassium levels and varieties in plant population per running meter

Number of branches per plant

The treatment K_4 (90 kg potassium ha^{-1}) was recorded maximum (8.33 and 14.44) and significantly higher number of primary and secondary branches than all over levels of potassium treatments, followed by K_3 (60 kg potassium ha^{-1}) which was also significantly superior to K_2 (30 kg potassium ha^{-1}). However, the minimum number of primary and secondary branches (5.31 and 11.33) was registered in control treatment K_1 (0 kg potash ha^{-1}). It is also clear from the data that number of primary and secondary branches increased significantly with increasing doses of potassium. may be due to availability of nutrients than reduced doses of potassium. Almost similar results were reported by Deolenkar (2005) [4] and Ahmad *et al*. (2015). Moreover, variety V_3 (KWR-108) was registered the maximum (7.15 and 13.25) number of primary and secondary branches which was produced significantly higher number of primary branches than rest of the varieties. However, the minimum (6.50 and 12.42) number of primary and secondary branches was recorded in variety V_1 (Udai). These primary and secondary branches per plant are different due to varieties wise nutrients uptake efficiency with different doses of potassium. Characteristics like nutrient efficiency variety. Almost similar results were reported by Ahmad *et al*. (2015).

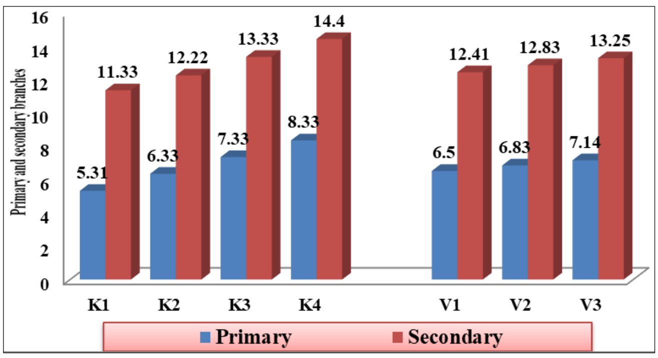

Fig 2: Influenced of potassium levels and varieties on primary and secondary branches

Fresh weight and dry weight of plant

The fresh and dry weight $plant^{-1}$ was significantly influenced by the different levels of potassium treatments and varieties at flowering and maturity stage. The treatment K_4 (90 kg potash ha^{-1}) was registered the maximum fresh weight (21.55 g) and dry weight (6.32 g) of plant at flowering stage, whereas fresh weight (29.82 g) and dry weight (26.77 g) of plant at maturity stage which was produced significantly higher fresh weight than all over three levels of potassium like K_3, K_2 and K_1. Furthermore, variety V_3 (KWR-108) was accumulated the maximum fresh and dry weight and $plant^{-1}$ respectively at the flowering stage which was produced significantly higher than rest of the treatments. However, the minimum fresh and dry weight of plant was accumulated in variety V_1 (Udai). These primary and secondary branches per plant are different due to varieties wise nutrients uptake efficiency with different doses of potassium. Characteristics like nutrient efficiency variety. Similar results were also put forward by Deolenkar (2005) [4].

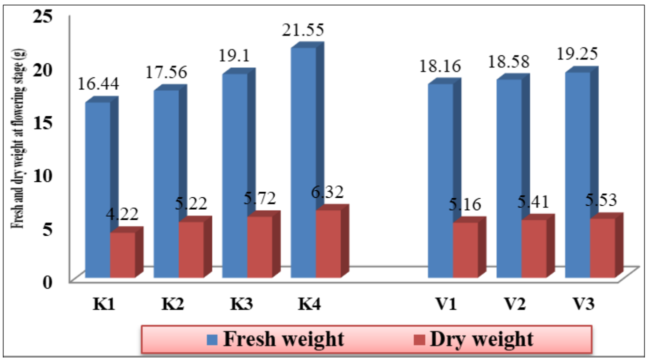

Fig 3: Influenced of potassium levels and varieties on fresh and dry weight at flowering stage

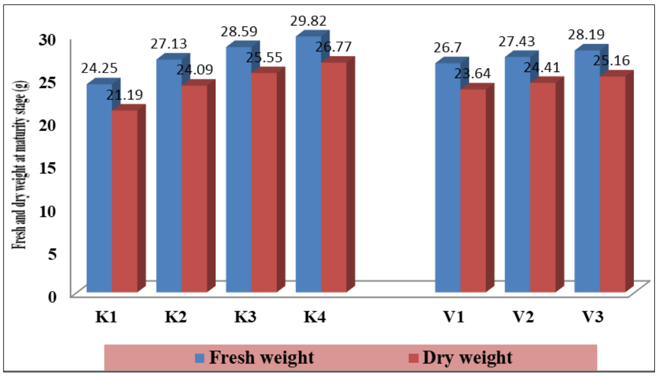

Fig 4: Influenced of potassium levels and varieties on fresh and dry weight at maturity stage (g)

Yields and harvest index

It is clear from the Table 1 significantly, maximum biological yield, seed yield straw yield were obtained in treatment K_4 (90 kg potash ha^{-1}) followed by with application of 60 kg potassium (K_3). 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 per plant, seed per plant, seed weight per plant and 100 seed weight which are maximized at 90 kg potassium ha^{-1}. Thus this dose performed better in the respect of growth, yield attributes and yield of chickpea. Similar finding have been reported by Kumar *et al.* (2005) [7] and Gill *et al.* (2005) [5]. Similar trends with significant effect were also noted under harvest index. Further, biological yield (31.46 q ha^{-1}), grain yield (15.32 q ha^{-1}), straw yield (16.13 q ha^{-1}), and harvest index (48.59 %) were significantly higher achieved in KWR-108 variety. However the minimum biological (28.81q ha^{-1}), grain (13.94 q ha^{-1}) and straw (14.89 q ha^{-1}) yield and harvest index (48.25 %) were achieved in Udai variety.

Table 1: Yields and Harvest Index as influenced by various treatments

Treatment	Biological yield (q ha^{-1})	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest Index (%)
Potassium levels				
K_1	24.80	11.60	13.19	46.74
K_2	27.85	13.58	14.30	48.77
K_3	29.99	14.99	15.33	48.87
K_4	37.90	18.66	19.22	49.25
SE(d) ±	0.030	0.262	0.015	0.038
CD at 5%	0.062	0.54	0.032	0.078
Varieties				
V1	28.81	13.94	14.89	48.25
V2	30.14	14.87	15.51	48.38
V3	31.46	15.32	16.13	48.59
SE(d) ±	0.026	0.227	0.013	0.033
CD at 5%	0.054	0.473	0.028	0.068

Production economics

Cost of cultivation of chickpea increased with increasing doses of potassium up to 90kg. It was due to additional cost of potassium fertilizer in different treatments. Kumar *et al.* (2005) [7] also found increased doses of potassium increased the cost of cultivation. It is cleared from the table 4.9 application of 90 kg potassium ha^{-1}. Earned significantly maximum grass income (Rs. 57856.00 ha^{-1}), net profit (Rs. 29032.00 ha^{-1}) and B: C (2.00). However, the minimum values were recorded in control plot. Alike trends were also noted with varieties in which KWR-108 had recorded maximum profit as against rest of the counterparts. These effect may be associated with grain and straw yields which are also maximized act same fertility levels. The cost of produced at increased fertility levels was much higher than the cost involved in fertilizer. The results are in agreement to those of Goud *et al.* (2014).

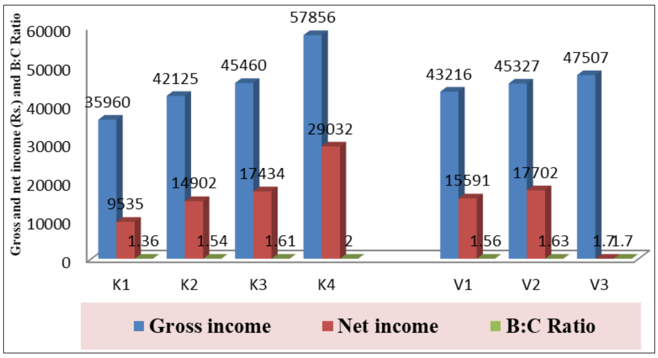

Fig 5: Influenced of potassium levels and varieties on gross, net income (Rs. per ha) and benefit cost ratio

Conclusion

On the basis of present experiment, it can be concluded that better growth, yield and production economics was achieved with application 90 kg potash per ha of potassium doses. Likewise, KWR-108 variety proved to be better in order to obtained maximum growth, yields and profits. Thus, chickpea variety KWR-108 should be fertilized with 90 kg potassium per ha for achieving maximum yields and profit.

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