Pak. J. Bot., 39(2): 523-527, 2007.

EFFECT OF DIFFERENT POTASH LEVELS ON THE GROWTH, YIELD AND PROTEIN CONTENTS OF CHICKPEA (*CICER ARIETINUM* L.)

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Abstract

A field experiment was carried out to study the effect of varying levels of potash (0, 25, 50, 75, 100, 125 and 150 kg K_2O ha^{-1}) on growth and yield of chickpea (*Cicer arietinum* L.) cultivar CM-2000 at the Agronomic Research Area, University of Agriculture, Faisalabad, during the winter season 2003-2004. The growth and yield components were significantly increased by different potash levels. However, the differences between control and 25 kg K_2O ha^{-1} were non-significant for the number of pods per plant and 1000-seed weight. The application of 25 kg K_2O ha^{-1} could not increase the seed and biological yield significantly thereafter, seed yield increased gradually with the increase in potash levels and the maximum seed yield (2341 kg ha^{-1}) was obtained with 150 kg K_2O ha^{-1}. The seed protein contents also increased gradually with an increase in potash level and maximum protein contents (23.87%) were recorded with application of 150 kg K_2O ha^{-1}. The highest potash level resulted in maximum net benefit as well.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the important pulse crops that plays a vital role in human diet. It is the main source of vegetable protein in human diet as it contains 21% protein and 38-59% carbohydrates (Gupta, 1989). It is cultivated over 0.96 million hectares with an annual production of 0.58 million tones and average yield of 605 kg ha^{-1} in Pakistan (Anon., 2003). The average seed yield of chickpea in Pakistan remains very low as compared to some other chickpea growing countries. The major reasons for its low yield` are disease and pest attack, cultivation on marginal land and inadequate or imbalance fertilizer application. Among these imbalanced use of fertilizer has supreme importance.

Potassium is the third major element taken up by the plant. Plants absorb it in larger amounts as compared to other minerals except nitrogen. It has utmost importance for imparting drought and disease resistance and has synergistic effect with nitrogen and phosphorus (Das, 1999). It is not a constituent of organic structures, but regulates enzymatic activities (over 60 enzymes require K for activation), translocation of photosynthates (Mengel & Kirkby, 1987) and considerably improves seed yield of chickpea if applied as a fertilizer (Samiullah & Khan, 2003, Singh *et al*., 1994, Verma, 1994). Keeping in view the importance of potash for plants this study was carried out to investigate the growth, yield and quality response of chickpea to different levels of potash.

Materials and Methods

A field experiment to study the effect of varying levels of potash (0, 25, 50, 75, 100, 125 and 150 kg ha^{-1}) on growth and yield of chickpea cultivar CM-2000 was carried out at the Agronomic Research Area, University of Agriculture, Faisalabad, during the winter season 2003-2004. The soil of experimental site located at 31°N and 73°E is sandy clay loam with pH 8.1, having 0.04 % nitrogen, 6.7 ppm phosphorus, 118 ppm potash and 0.84% organic contents. The experiment was laid out using a randomized complete block design having three replications with a net plot size of 1.8 x 7.0 m.

The crop was sown on 1st November, 2003 using a seed rate of 40 kg ha^{-1} with a single row hand drill at 40 cm spaced rows. A fertilizer dose of N @ 30 kg ha^{-1} and P_2O_5 @ 75 kg ha^{-1} and prescribed doses of K_2O were also side drilled after sowing. The sources of N, P_2O_5 and K_2O were urea (46% N), diammonium phosphate (46 % P_2O_5 and 18 % N) and sulphate of potash (50% K_2O), respectively.

Ten plants were selected at random from each plot for recording plant height, number of branches per plant, number of pods per plant and number of seeds per pod at maturity. Three samples of 1000 seeds were selected at random from the seed lot of each plot and were weighed using an electric balance. Seed and biological yield were recorded on per plot basis and were converted to kg ha^{-1}.

Total nitrogen contents of seed samples were determined by the micro-Kjeldahl methods (Tecator, 1991). Nitrogen and crude protein (CP) contents were worked out using the following formulae.

$$\text{Nitrogen (\%)} = \frac{\text{Volume of acid used x 0.0014 x 250 x 100}}{\text{Sample weight x 10 ml}}$$

$$\text{Crude protein (\%)} = \text{\% nitrogen x 6.25}$$

To calculate net field benefits, data obtained from experiment were subjected to economic analysis using the methodology described in CIMMYT (Anon., 1998). The data obtained were analyzed statistically by using Fisher's analysis of variance techniques. Least significant difference (LSD) test at 5% probability was applied to test the significance of treatments' means (Steel *et al*., 1997).

Results

Growth and yield components: The application of fertilizer significantly affected plant height of chickpea (Table. 1). The significantly minimum plant height (70.97 cm) was recorded in plots where the crop was grown without fertilizer application. Plant height increased significantly with gradual increase in potash levels up to 125 kg K_2O ha^{-1} but further increase in potash level could not enhance it significantly. Hence, the maximum plant height (88.23 cm) was recorded for 150 kg K_2O ha^{-1} which was statistically at par with the 125 kg K_2O ha^{-1}.

The number of branches per plant was significantly affected by various potash levels (Table 1). Application of K_2O @ 150 kg ha^{-1} produced significantly higher number of branches plant^{-1} (10.47) than control, followed by 125 kg K_2O ha^{-1} which was statistically at par with 100 kg K_2O ha^{-1}. All other fertilizer levels varied significantly among themselves for number of branches per plant. The significantly minimum number of branches per plant (6.37) was recorded in control plots.

Table 1. Effect of different potash levels on the growth, yield, yield attributes and protein contents of chickpea.

Potash levels (kg K_2O ha^{-1})	Plant height (cm)	No. of branches $plant^{-1}$	No. of pods $plant^{-1}$	No. of seed pod^{-1}	1000-seed weight (g)	Biological yield (kg ha^{-1})	Seed yield (kg ha^{-1})	Protein content (%)
0	70.97f	6.37f	44.10f	1.03 f	253.89 f	3968.25 f	1335.97 f	18.50 g
25	74.27e	7.57e	46.90f	1.17 e	262.93 f	4285.71 f	1428.57 f	19.92 f
50	77.73d	8.40d	49.90e	1.32 d	266.17 e	4682.53 e	1653.42 e	20.12 e
75	80.67c	9.10c	54.50d	1.46 c	267.77 d	5211.64 d	1857.14 d	21.44 d
100	83.90b	9.70b	57.90c	1.53 b	269.77 c	5476.19 c	2031.74 c	22.88 c
125	87.70a	9.83b	59.90b	1.59 b	274.72 b	5714.28 b	2182.53 b	23.31 b
150	88.23a	10.47a	61.90a	1.77 a	279.23 a	5942.38 a	2341.25 a	23.87 a
LSD at 5%	0.879	0.160	0.795	0.064	0.533	134.31	84.373	0.001

NS= Non-significant

Any two means not sharing a letter in common differ statistically at 5% probability level.

Potash levels showed significant effect on the number of pods per plant (Table 1). Application of 25 kg K_2O ha^{-1} showed non-significant increase in number of pods per plant over control. However, further increase in potash levels significantly increased the number of pods per plant. The application of 150 kg K_2O ha^{-1} produced significantly maximum number of pods $plant^{-1}$ (61.9) and was followed by 125 kg K_2O ha^{-1}. On the other hand minimum number of pods $plant^{-1}$ (44.1) was obtained in control treatment.

There was significant increase in number of seeds per pod due to application of potash (Table 1). The differences among all the fertilizer levels were significant except that between 100 and 125 kg K_2O ha^{-1}. The significantly highest number of seeds per pod (1.77) varying significant with control was produced by 150 kg K_2O ha^{-1} application. The significantly lowest number of seeds per pod (1.03) was obtained without fertilizer application.

The effect of different fertilizer levels on 1000-seed weight of chickpea was significant (Table 1). Application of potash @ 150 kg K_2O ha^{-1} exhibited the highest 1000-seed weight (279.33g) and was followed by 125 kg K_2O ha^{-1}. The significantly lowest 1000-seed weight (253.89) was recorded in control treatment which was statistically at par with 25 kg K_2O ha^{-1}.

Seed and biological yield: The potash levels differed significantly for seed and biological yield (Table 1). The difference between control and 25 kg K_2O ha^{-1} was non-significant, however, further increase in potash levels significantly increased both seed and biological yields. The significantly maximum seed and biological yields (2341.25 and 5942.38 kg ha^{-1}, respectively) of chickpea were recorded with the application of 150 kg K_2O ha^{-1} and was followed by 125 kg K_2O ha^{-1}. Both yields gradually increased with increase in potash level beyond 25 kg K_2O ha^{-1}.

Seed protein contents (%): The protein content of chickpea seed was affected significantly by various potash levels (Table 1). The significantly lowest protein content (18.5%) was obtained without fertilizer application. It increased significantly with each increase in potash level and maximum was recorded for150 kg K_2O ha^{-1}.

Economic analysis: Economic analysis of treating chickpea with different potash levels (Table 2) revealed that application of 150 kg K_20 ha^{-1} gave the maximum net benefit of Rs. 49431.25 ha^{-1} (76.23 % increase in net benefits compared to control) while application of 125 kg K_2O ha^{-1} was the next better treatment with net benefits of Rs. 46088.25 ha^{-1} (64.31% increase over control).

Table 2. Net benefits (Rs. ha^{-1}) of chickpea as affected by different Potash levels.

Potash level (kg K_2O ha^{-1})	Seed yield (kg ha^1)	Value of seed Yield (Rs ha^1)	Expenditure	Net field benefits (Rs ha^1)
0	1335.97	33399.25	5350	28049.25
25	1428.57	35714.25	5975	29739.25 (6.25%)
50	1653.42	41335.50	6600	34735.50 (23.84%)
75	1857.14	46428.50	7225	39203.50 (39.76%)
100	2031.74	50793.50	7850	42943.50 (53.10%)
125	2182.53	54563.25	8475	46088.25 (64.31%)
150	2341.25	58531.25	9100	49431.25 (76.23%)

Remark:

Seed yield value	@	Rs 1000/40 kg
Nitrogen	@	Rs 25 kg^{-1}
Phosphorous	@	Rs 40 kg^{-1}
Potash	@	Rs 25 kg^{-1}
Seed	@	Rs 40 kg^{-1}

Discussion

Significant increase in plant height with potash application can be attributed to the fact that potash enhances plant vigour and strengthens the stalk (Das, 1999). During this study we examined that these results also resemble the findings of Barik *et al*., (1994) who reported increase in plant height with potash application.

Application of K increased the availability of nitrogen and phosphorus (Sahai, 2004) which resulted in better plant growth and more number of branches per plant. Hanolo & Pulung (1994) have also reported that number of branches per plant in pea increased with increasing K rate. These results are however, contrary to those reported by Kar *et al*., (1989) and Barik *et al*., (1994) who reported non-significant effect of potash on number of branches per plant. These contradictory results might be due to difference in genetic makeup of crop plants and fertility status of soil.

The minimum number of pods in control might have been due to less availability of N and P and stunted growth. The results are almost same as were reported by Smiullah & Khan (2003) who noticed that addition of potassium @ 40 kg ha^{-1} doubled the number of pods per plant.

Application of K might have enhanced the photosynthetic activity which resulted in more number of seeds per pod. Similar results have been reported by Smiullah & Khan (2003) who examined significantly higher number of seeds per pod with the application of potash as compared to control.

Higher potash levels during this study resulted in higher seed weight probably due to role of potash in translocation of photosynthates and its ability to develop bold seeds as already reported by Das (1999). Similar findings have been reported by Samiullah & Khan (2003).

Differences in biological yield in various potash levels may be attributed to variation in the number of branches, plant height and seed yield. Significant differences among NPK levels for biological yield have been already reported by Verma (1994).

The higher seed yield in case of 150 kg K_2O ha^{-1} can be attributed to more number of pods $plant^{-1}$, number of seeds pod^{-1} and higher 1000-seed weight. Similar results have been reported by Singh *et al*., (1994) and Samiullah & Khan (2003).

As potash has synergistic effect on nitrogen uptake, facilitates protein synthesis and activate different enzymes (Das, 1999) therefore, protein contents increased significantly with each increase in potassium level. Similar results has also been reported by Mali *et al*., (2000).

Conclusion: On the basis of the present findings it is concluded that application of 150 kg K_2O ha^{-1} resulted in maximum seed yield of good quality and highest net field benefit.

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(Received for publication 7 June 2006)