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EFFECT OF PHOSPHORUS AND ZINC NUTRITION ON YIELD, NUTRIENT UPTAKE AND QUALITY OF CHICKPEA

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ABSTRACT

*A field experiment was conducted to study the individual and interactive effect of P and Zn on yield, nutrient content and nutrient uptake of chickpea (*Cicer arietinum *L.) The grain and straw yields increased significantly with increasing doses of P and Zn.The interaction between P and Zn also had significantly beneficial effect on the yield of chickpea. An increase in P uptake by grain and straw with applied P was recorded but it was decreased at higher level of applied Zn. The content and uptake of Zn in grain and straw increased significantly with increasing levels of Zn. Phosphorus and zinc applied to chickpea significantly increased the protein content in grain and straw.*
Key words: Phosphorus, zinc, nutrition, protein, chickpea, economics

INTRODUCTION

Chickpea (*Cicer arietinum L.)* is a multipurpose pulse crop consumed by the people in different forms viz. dal leaves, germinated seed etc. Phosphorus, key nutrient for increasing productivity of pulses, is required for plant growth and root development. Phosphorus deficiency in soils is widespread and crops grown under deficient situation show significant responses to fertilizer P. Zinc is essential for promoting certain metabolic reactions. It is necessary for the production of chlorophyll and carbohydrates. Zinc is directly or indirectly required by several enzyme systems, auxin and protein synthesis. Zinc is believed to promote RNA synthesis, which in turn is needed for protein production. At several places normal yield of crops could not be achieved despite judicious use of NPK fertilizers due to deficiency of micronutrients in soil, in general, that of Zn in particular. A favourable balance between phosphorus and zinc should be maintained for optimum growth of plant. Most of the soils of Uttar Pradesh have been rated as deficient in available zinc. Sharma et al. (2000) reported antagonistic effect of P levels on Zn nutrition by the crops. The information on Zn and P relationship in an important crop like chickpea is not adequate, especially in situations where both the interacting nutrients (P and Zn) are deficient in soil. Therefore, the present investigation was carried out to study the effect of P and Zn application on yield, nutrient uptake and quality in chickpea grown in alluvial soils of Uttar Pradesh.

MATERIALS AND METHODS

A field experiment was conducted during the winter (*rabi*) seasons of 2008 - 09 and 2009 - 10 at Amar Singh College , Lakhaoti , Bulandshahr (U.P.). The experimental soil had pH 7.8, EC (1:2) 0.19 dS m^{-1}, organic carbon 3.9 g kg^{-1}, available N 178 kg ha^{-1}, available P 9.8 kg ha^{-1}, available K 195 kg ha^{-1} and DTPA – extractable Zn 0.50 mg kg^{-1}. Four levels of each of P_2O_5 (0, 30, 60 and 90 kg ha^{-1} as DAP) and Zn (0, 2.5, 5 and 10 kg ha^{-1} as Zn) were applied in 16 treatment combinations replicated thrice in randomized block design. A common basal dose of 20 kg N ha^{-1} through Urea and 40 kg K_2O ha^{-1} through muriate of Potash was applied to all the plots. The N present in DAP was adjusted while calculating the amount of N given as basal dressing by Urea. The plot size was 4.5 m x 3.6 m with row spacing of 30 cm x 10 cm. Chickpea var. KPG 59 was shown on 28 and 26 October in 2008 and 2009 and harvested on 21 and 18 March in 2009 and 2010, respectively .Grain and straw samples collected at maturity were analyzed for P content in di acid (HNO_3: $HClO_4$) extract by Vanadomolybdo phosphoric yellow

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extract was determined by atomic absorption spectrophotometer. Protein in grain and straw was computed by multiplying per cent N content by 6.25.

RESULTS AND DISCUSSION

Yield, protein content and economics: Successive and significant increase in P levels up to 60 kg P_2O_5 ha^{-1} resulted in enhanced grain and straw yields of chickpea (Table 1). Application of 60 kg P_2O_5 ha^{-1} increased the grain and straw yields significantly by 27.4 and 24.7 per cent, respectively over the control .The higher level of P (90 kg $P_2O_5ha^{-1}$) was statistically at par with 60 kg P_2O_5 ha^{-1} in increasing the yield. The increase in yield of chickpea grain and straw with P application may be due to fact that soil under study was deficient in available P (9.8 kg ha^{-1}). Kumar at al. (2009) also observed an increase in yield of chickpea with increasing levels of P on phosphorus deficient soils. The yield of chickpea grain and straw (Table 1) increased significantly by 9.8 and 11.4 per cent, respectively with the application of 5 kg Zn ha^{-1}. This might be due to its function as catalyst or stimulant in most of the physiological and metabolic processes. However, the response was better at lower rate (2.5 kg Zn ha^{-1}) application rather than at higher rate. Increase in yield due to application of Zn is quite obvious, as the soil under study was deficient in available zinc (0.5 mg kg^{-1}). Sharma et al. (2000) and Singh and Ram (2001) also noted a significant response of legumes to Zn applied to deficient soils.

Table 1: Effects of phosphorus and zinc levels on yield, protein content and economics of chickpea (Pooled data)

Treatments	Yield (qha^{-1})		Protein (%)		Net profit (Rs ha^{-1})	Benefit : cost ratio
	Grain	Straw	Grain	Straw		
P_2O_5 (kg ha^{-1})						
0	15.40	18.50	20.09	8.99	18572.6	1.18
30	17.23	20.72	20.37	9.34	22035.3	1.34
60	19.63	23.07	20.59	9.55	26748.0	1.57
90	20.22	23.81	20.90	9.71	27457.7	1.56
CD(P=0.05)	0.90	1.40	0.16	0.17	-	-
Zn (kg ha^{-1})						
0	17.02	20.23	20.21	9.18	21372.6	1.28
2.5	18.24	21.74	20.49	9.31	24015.5	1.43
5.0	18.69	22.54	20.55	9.52	25565.8	1.52
10.0	18.26	21.60	20.65	9.62	23859.7	1.41
CD (P=0.05)	0.90	1.40	0.16	0.17	-	-

Protein content in chickpea grain and straw increased significantly with application of phosphorus and zinc individually as well as in combination as compared to control (Table 1).The maximum percentage of protein (20.90% in grain and 9.71% in straw) was recorded at 90 kg P_2O_5 ha^{-1}. The response of applied phosphorus with respect to protein contents in chickpea is attributed to more nitrogen fixation in soil. Similar results were reported by Meena et al. (2001) in chickpea. Application of increasing doses of zinc resulted in a significant increase in protein content of chickpea over control. The protein content in grain and straw increased from 20.21 to 20.65 and 9.18 to 9.62 with 10 kg Zn ha^{-1}. The increase in protein content due to Zn addition might be attributed to its involvement in N metabolism of plants. The data on monetary advantage (Table 1) based on 2 years of experimentation indicated that maximum net return and benefit: cost ratios were obtained with higher dose of P and Zn. This could be ascribed to higher grain yield obtained owing of higher levels of P and Zn.

Table 2: Effect of phosphorus and zinc levels on their content and uptake in chickpea (pooled data)

Treatment	P content (%)		Zn content (mg kg^{-1})		P uptake (kg ha^{-1})		Zn uptake (g ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
P_2O_5 (kg ha^{-1})								
0	0.46	0.21	23.76	20.73	7.1	3.8	36.6	37.6
30	0.50	0.23	23.02	19.91	8.6	4.7	39.7	40.5
60	0.58	0.26	22.99	19.81	11.4	6.0	45.1	44.7
90	0.60	0.27	22.52	19.41	12.1	6.5	45.6	45.1
CD (P=0.05)	0.012	0.007	0.73	0.50	0.65	0.43	3.10	2.50
Zn (kg ha^{-1})								
0	0.51	0.23	19.93	16.91	8.7	4.6	34.0	34.2
2.5	0.55	0.25	21.52	20.31	10.1	5.5	39.3	44.0
5.0	0.51	0.25	24.23	21.42	9.6	5.5	46.0	48.3
10.0	0.49	0.23	26.60	23.15	9.0	5.0	48.6	49.5
CD (P=0.05)	0.012	0.007	0.73	0.50	0.65	0.43	3.10	2.50

Content and uptake of nutrients: Phosphorus content of grain and straw of chickpea increased significantly with increasing doses of P (Table 2) which may be attributes to deeper root growth by phosphorus, resulting in higher content of P in the crop. Application of lower levels of zinc increased the P content in grain and straw over control. The maximum Values of P content in

grain and straw were recorded with 2.5kg Zn ha^{-1}. Application of 10 kg Zn ha^{-1} tended to decrease the P content in grain and straw and this reduction in P content was significant over 5 kg Zn ha^{-1} . This reduction in P content may be due to hindrance caused by increased concentration of zinc in the absorption and translocation of P from the roots to the above ground parts. Singh and Manohar (1982) also reported similar results. The highest uptake of P was recorded at 90 kg P_2O_5 ha^{-1} and lowest in the control. Among various levels of P, the higher level could probably maintain the available P status in soil to facilitate its uptake at an optimum level. This increase in P uptake may be attributed to higher P content as well as grain and straw yields with higher dose of P. The results are in conformity with the findings of Kanwar and Paliyal (2002). Application of 2.5 kg Zn ha^{-1} tended to increase the P uptake by chickpea grain and straw significantly over the control. Phosphorus uptake by chickpea decreased at higher level of Zn (5 and 10 kg Zn ha^{-1}) over 2.5 kg Zn ha^{-1}. The results indicate an antagonistic relationship between P and Zn nutrition of chickpea.A significant increase in the Zn content of grain and straw of chickpea with a corresponding increase in the Zn dose was observed (Table 2). Application of 10 kg Zn ha^{-1} increased the zinc content by 6.6 mg kg^{-1} and that of straw by 6.2 mg kg^{-1} over control. Similar results were reported by Singh and Ram (2001). Zinc content of grain and straw of chickpea decreased significantly as the dose of P increased. This decrease in Zn content at an increased P level may be due to the depressive effect of P on Zn. The reduction in Zn content may be ascribed to antagonistic effect of P on Zn absorption by the plants. Similar observations with added phosphorus were reported by Singh and Ram (2001). The uptake of zinc by chickpea grain and straw increased significantly with increasing levels of zinc over the control due to increase in yield and zinc content as a result of zinc application. The uptake of zinc was also influenced significantly by P application. Uptake of zinc by chickpea crop increased significantly with phosphorus addition up to 90 kg P_2O_5 ha^{-1}.The higher levels(60 and 90 kg P_2O_5 ha^{-1}) of P were at par in respect of zinc uptake by chickpea. Similar results were also reported by Sharma et al. (2000). Maximum values of Zn uptake by grain and straw were obtained with 90 kg P_2O_5 ha^{-1}. On the other hand, lower values of Zn uptake by grain and straw were recorded under control.

Table 3: Interaction effect of phosphorus and zinc levels on grain and straw yield of chickpea (pooled data)

P_2O_5 (kg ha^{-1})	Zn levels (kg ha^{-1})			
	0	2.5	5.0	10
Grain yield (q ha^{-1})				
0	14.42	15.26	16.02	15.89
30	16.27	17.40	18.17	17.07
60	18.23	19.73	20.48	20.08
90	19.18	20.56	21.18	19.98
CD (P=0.05)	2.10			
Straw yield (q ha^{-1})				
0	17.17	18.64	19.43	18.76
30	19.81	20.94	21.69	20.48
60	21.43	23.28	24.05	23.52
90	22.51	24.11	25.00	23.65
CD (P=0.05)	2.55			

Interaction

The interaction effect of P and Zn was significant for grain and straw yield (Table 3). The maximum grain and straw yields were obtained under 90 kg P_2O_5 + 5 kg Zn ha^{-1} treatment. Application of 60 kg P_2O_5 + 5 kg Zn ha^{-1} proved at par to 90 kg P_2O_5 + 5 kg Zn ha^{-1} in respect of grain and straw production. Protein content also improved with P and Zn application. This favourable effect of P and Zn combination may be because addition of Zn with P might have maintained a favourable balance between P and Zn in the chickpea plant for optimum growth. Satyajit et al. (2003) also reported response of chickpea to P and Zn. In can be concluded that combination of 60 kg P_2O_5 + 5 kg Zn ha^{-1} would be sufficient to get higher yields of chickpea.

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