RESEARCH ARTICLE

EFFECT OF PHOSPHORUS AND MOLYBDENUM ON YIELD AND NUTRIENT UPTAKE BY CHICKPEA UNDER RAINFED CONDITIONS OF MADHYA PRADESH

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Abstract: A field experiment was carried out to assess the growth, yield and chemical traits of chickpea cv. JG-11. The experiment was laid out in Randomized Block Design with three replications for chickpea crop consisted of 16 treatments i.e. four levels of phosphorus (0, 40, 60 and 80 kg ha^{-1}) and four levels of molybdenum (0, 0.5 1.0 and 1.5 kg ha^{-1}). The results revealed that application of phosphorus and molybdenum had a significant influence on plant growth, yield and nutrient uptake by chickpea. Grain and straw yield increased significantly up to 60 kg P_2O_5 ha^{-1} and giving 61.2 & 17.2 % and 42.5 & 7.3% higher over control and 40 kg P_2O_5 $ha^{-1,}$ respectively. Under different doses of molybdenum, maximum grain (1633.2 kg ha^{-1}) and straw (1956.5 kg ha^{-1}) yield was observed with 1.5 kg molybdenum which was significantly higher over control and 0.5 kg Mo ha^{-1} and was at par with 1.0 kg Mo ha^{-1} treatment. Significant increase in nitrogen, phosphorus and molybdenum uptake in grain and straw was observed with the application of phosphorus and molybdenum over the control.

Keywords: Chickpea, Growth, Molybdenum, Nutrient uptake, Phosphorus, Yield

INTRODUCTION

Pulses are gaining worldwide importance as they are the cheap source of protein in human diet. Hence, there is a need to enhance the total pulse production to provide sufficient amount of protein to the increasing population. Several factors contribute towards low productivity of pulses. Pulses have been traditionally grown under rainfed condition in marginal lands and in soils of low fertility in contrast to cereal crops which have been grown in more fertile lands with assured water supply. Chickpea *(Cicer arietinum* L.) is an annual legume grown throughout the world for grain pulse. Fertilizers are the most important inputs in crop production. An adequate supply of chemical fertilizers is closely associated with growth and development of plant and among the various factors of low productivity lack of application of phosphorus seems to be important.(Kumar *et al*, 2014). Molybdenum (Mo) plays an important role in increasing yield of pulses and oilseed legumes through their effects on the plant itself and on the nitrogen fixing symbiotic process. It's required for the formation of the nitrate reductase enzyme and in the legume it plays an additional role in symbiotic nitrogen fixation. A significant improvement in yield and biological nitrogen fixation due to phosphorus and molybdenum has been reported in soybean by Laltlanmawia *et al;* (2004). Keeping in all above views, the present experiment was conducted with varying doses of phosphorus with different combinations of molybdenum on chickpea under rainfed conditions.

MATERIALS AND METHODS

A field experiment was conducted to evaluate the effect of phosphorus and molybdenum on growth, yield and uptake of nutrients by Chickpea at the Rajola Research Farm, Faculty of Agricultural Sciences, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya, Chitrakoot – Satna (Madhya Pradesh). The experiment was laid out in factorial randomized block design and replicated thrice with four levels of phosphorus (0,40, 60 and 80 kg ha^{-1}) and four levels of molybdenum (0, 0.5 1.0 and 1.5 kg ha^{-1}). The soil of experimental site was sandy loam in texture and normal in reaction (pH 7.25) with EC 0.28 dSm^{-1}, organic carbon 3.7 g kg^{-1}, available N, P and K were 223.2, 14.56 and 219.5 kg ha^{-1}, respectively. JG-11 chickpea was used as a test cultivar. The experiment was conducted for two years 2013-14 and 2014-15 with four levels of phosphorus (0,40, 60 and 80 kg ha^{-1}) and four levels of molybdenum (0, 0.5 1.0 and 1.5 kg ha^{-1}) following a factorial randomized block design with three replications on October 21, 213 and October 24, 2014. Sowing of seeds was made with 30 cm row space with a seed rate of 100 kg ha^{-1}. Recommended doses of N (30 kg) and K (20 kg K_2O/ha) were applied through urea and muriate of potash at the time of sowing. Phosphorus and molybdenum was applied as per treatments through single super phosphate and ammonium molybdenum as basal. The ground seed and stover samples were digested with nitric-perchloric (9:4) di-acid mixture for the analysis of all other elements except N. Nitrogen was determined by KEL PLUS nitrogen estimation system and phosphorus by vanadomolybdate yellow

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colour method and potassium was estimated with flame photometer (Jackson, 1973). The uptake of nutrients was calculated with their content and yields of respective parts of chickpea.

RESULTS AND DISCUSSION

Growth and yield attributes parameters:

Growth and yield attributes: Chickpea significantly responded to phosphorus and molybdenum. It was found that growth and yield attributing parameters significantly influenced due to phosphorus and molybdenum fertilization (Table- 1). Maximum values were obtained with 80 kg P_2O_5 ha^{-1} which was significantly higher to control and 40 kg levels but was at par with 60 kg P_2O_5 ha^{-1} treatment. The higher value of different growth parameters with 60 kg P_2O_5/ha might was due to increased rate of energy metabolism and also might was attributed to beneficial effect of phosphorus on root proliferation, nodulation and accelerating effect of P on the synthesis of protoplasm there by the plants grew tall higher pace of dry matter production and higher number of branches/plant. Higher dose of P lead to increased photosynthesis, energy transfer reaction and symbiotic biological N_2 fixation, which ultimately result in better growth (Sarawagi *et al.*,1995).

Under molybdenum doses, pods $plant^{-1}$ and test weight increased significantly up to the levels of 1.0 kg Mo ha^{-1}. Combined application of phosphorus with molybdenum showed synergistic effect and resulted in improvement of morphological traits of chickpea in the form of longer vine length, more number of nodules $plant^{-1}$, nodule dry weight and root dry weight that triggered more flowering, better pod setting and higher number of pods and test weight (Subasinghe *et al.*, 2003).

Grain and straw yield: Data on grain and straw yield (Table- 1) indicate that the maximum grain yield was noted with 80 kg P_2O_5 ha^{-1} which was 62.3 and 18.0 percent significantly higher over control and 40 kg P_2O_5 ha^{-1} treatments but was statistically at par with 60 kg P_2O_5 ha^{-1}. However, grain and straw yield increased significantly up to 60 kg P_2O_5 ha^{-1} and giving 61.2 & 17.2 % and 42.5 & 7.3% higher over control and 40 kg P_2O_5 $ha^{-1,}$ respectively. This trend might be due to stunted growth of plants thereby having positive effect on yield attributes and giving higher yield. These results are in accordance with those reported by Meena *et al.* (2001). Higher values of yield and yield attributes may be described to the effect of P on root development, energy transformation and metabolic processes of the plant, which in term resulted in greater translocation of photosynthates towards the sink development. Similar results have been reported by Sudhir *et al.* (2012) and Kumar and Singh (2014).

Application of molybdenum improved the grain and straw yield of chickpea significantly during both the years. On the basis of pooled data, grain yield was recorded in the range of 1115.4 to 1633.2 kg ha^{-1}. Maximum grain (1633.2 kg ha^{-1}) and straw (1956.5 kg ha^{-1}) yield of chickpea was observed with 1.5 kg molybdenum which was significantly higher over control and 0.5 kg Mo ha^{-1} but was at par with 1.0 kg Mo ha^{-1} treatment. This increase of grain and straw yield with Mo application might be due to beneficial effect of Mo on growth and yield attributing characters, the increase in yield with Mo application was reported by Singh *et al.* (2002) and Lalitlanmawia *et al.* (2004).

Nutrients Uptake

N-uptake: The significant increase of N uptake by chickpea grain and straw was observed with increasing level of P over control. This increase of N uptake with increasing levels of P might be due to the beneficial effect of P on increase of N content and yield of grain and straw. Results endorse the finding of Dwivedi and Bapat (1998) and Sarawagi *et al.* (1999). The significant increase of N uptake by grain and straw might be due to beneficial effect of Mo application on increase of N content in grain and straw and their yields. The increase of N content in grain and straw and their uptake with Mo application was reported by Singh *et al.* (2002).

P–uptake: The data presented in table-2 revealed that the increasing levels of P significantly increased P uptake by grain and straw by chickpea. The increase of uptake by grain and straw total uptake by chickpea with P application was also reported by Deo and Khandelwal (2009).The application of Mo successively and significantly increased the P uptake by grain and straw by chickpea This might be due to synergistic effect of Mo application on P availability in soil resulted increase P uptake by grain and straw (Khan *et al*., 2007).

K–uptake: Uptake of potassium by grain and straw were significantly increased with phosphorus levels as compared to control. Maximum total - K uptake was noted with 80 kg P_2O_5 ha^{-1}which was significantly higher to control 40 and 60 kg P_2O_5 ha^{-1} treatments.

Applications of molybdenum also significantly increased K uptake by grain and straw as compared to control. Maximum K- uptake noted with 1.5 kg Mo ha^{-1} which was significantly higher to control, 0.5 and 1.0 kg Mo ha^{-1} treatments . The increase of K content in grain and straw and their uptake with Mo application was reported by Samui and Bhattacharya (1982).

Mo-uptake: The application of P significantly increased the Mo uptake by grain, and straw over control and maximum uptake was noted with 80 kg P_2O_5 ha^{-1} which was significantly higher to control and 40 kg P_2O_5 ha^{-1} treatments but was at par with 60 kg P_2O_5 ha^{-1}. Application of molybdenum increased the uptake by grain and straw and maximum value was observed with 1.5 kg Mo ha^{-1} which was significantly higher to rest of the doses. This might

be due to increased Mo availability in soil. Present findings are in agreement with those of Khan *et al.* (2007).

Table 1. Growth and yield parameters of chickpea as influenced by different levels of phosphorus and molybdenum

Treatments	Plant height (cm)	Number of branches	Number of pod plant^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Phosphorus levels (P)						
P_0: Control	37.64	15.79	25.04	17.68	1003.2	1312.3
P_1: 40 kg P_2O_5 ha^{-1}	43.31	17.75	35.13	19.19	1380.1	1741.7
P_2: 60 kg P_2O_5 ha^{-1}	45.10	19.63	41.50	20.67	1617.3	1869.7
P_3: 80 kg P_2O_5 ha^{-1}	45.12	19.83	41.75	20.79	1628.4	1972.0
S.E m.±	**0.32**	**0.37**	**0.50**	**0.20**	**22.0**	**18.1**
C.D. (P=0.05)	**0.92**	**1.07**	**1.43**	**0.56**	**63.1**	**51.7**
Molybdenum doses (Mo)						
Mo_0 : Control	40.77	15.75	28.79	18.13	1115.4	1476.3
Mo_1: 0.5 kg Mo ha^{-1}	42.25	17.67	36.00	19.72	1299.8	1630.3
Mo_2 : 1.0 kg Mo ha^{-1}	44.49	19.92	39.13	20.03	1580.7	1832.6
Mo_3 : 1.5 kg Mo ha^{-1}	43.76	19.67	38.00	20.06	1633.2	1956.5
S.E m.±	**0.32**	**0.37**	**0.50**	**0.20**	**22.0**	**18.1**
C.D. (P=0.05)	**0.92**	**1.07**	**1.43**	**0.56**	**63.1**	**51.7**

Table 2. Effect of phosphorus and molybdenum levels on nutrient uptake by chickpea (Pooled data of two years)

Treatments	N-Uptake (kg ha^{-1})		P-Uptake (kg ha^{-1})		K-Uptake (kg ha^{-1})		Mo-Uptake (g ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Phosphorus levels (P)								
P_0: Control	30.75	6.08	4.77	1.89	5.91	15.51	3.81	0.96
P_1: 40 kg P_2O_5 ha^{-1}	44.05	8.38	7.00	2.72	8.27	20.67	5.54	1.35
P_2: 60 kg P_2O_5 ha^{-1}	53.02	9.26	8.51	3.01	9.72	22.28	6.69	1.47
P_3: 80 kg P_2O_5 ha^{-1}	53.65	9.74	8.59	3.21	9.71	23.55	6.83	1.58
S.E m.±	**0.73**	**0.09**	**0.12**	**0.03**	**0.13**	**0.21**	**0.12**	**0.02**
C.D. (P=0.05)	**2.08**	**0.26**	**0.34**	**0.09**	**0.38**	**0.61**	**0.34**	**0.05**
Molybdenum doses (Mo)								
Mo_0 : Control	35.10	6.89	5.46	2.18	6.58	17.39	4.06	0.99
Mo_1: 0.5 kg Mo ha^{-1}	42.03	7.95	6.68	2.57	7.75	19.46	5.15	1.22
Mo_2 : 1.0 kg Mo ha^{-1}	51.58	9.02	8.26	2.95	9.49	21.93	6.53	1.47
Mo_3 : 1.5 kg Mo ha^{-1}	52.76	9.61	8.46	3.13	9.80	23.24	7.12	1.67
S.E m.±	**0.73**	**0.09**	**0.12**	**0.03**	**0.13**	**0.21**	**0.12**	**0.02**
C.D. (P=0.05)	**2.08**	**0.26**	**0.34**	**0.09**	**0.38**	**0.61**	**0.34**	**0.05**

CONCLUSION

It can be concluded from the above findings that the treatment combinations of 60 kg P_2O_5 & 1.0 kg Mo ha^{-1} along with a blanket dose of N_{30} K_{20} kg ha^{-1} were found suitable for higher uptake of nutrients by chickpea and maximizing yield of chickpea under rainfed condition of Chitrakoot (Satna) region of Madhya Pradesh.

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