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RESEARCH PAPER

Effect of sources and levels of phosphorus on yield, quality and phosphorus uptake in pigeonpea

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Abstract : A field trail on effect of sources and level of phosphorus on yield and quality of pigeonpea was conducted at Experimental Farm, Department of Agronomy, College of Agriculture, Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) during *Kharif* season of 2011-12. The present experiment was laid out in Split Plot Design with twelve treatment combinations of four phosphorus levels (25, 50, 75 and 100 kg P_2O_5 ha^{-1}) and three sources of phosphorus (single superphosphate diammonium phosphate and 20:20:00) replicated thrice. Yield attributes like number of pods per plant, weight of pods and weight of seeds per plant were increased due to application of 100 kg P_2O_5 ha^{-1} than 25 kg P_2O_5 ha^{-1}. However, it was at par with 50 and 75 kg P_2O_5 ha^{-1}. Among sources single superphosphate influenced the yield attributes. The combination effect of levels and sources of phosphorus application was non-significant for different yield attributes. The yield of pigeonpea was significantly influenced by levels and sources of phosphorus. The maximum seed yield (19.66 q ha^{-1}) was recorded under 100 kg P_2O_5 ha^{-1} than 25 kg P_2O_5 ha^{-1} (13.80 q ha^{-1}). However, it was at par with 50 and 75 kg P_2O_5 ha^{-1}. Among sources, single superphosphate was beneficial for improving pigeonpea seed yield (19.56 q ha^{-1}). Similar results were obtained in case of biological yield and harvest index.In case of protein content, an application of 100 kg P_2O_5 ha^{-1} gave higher protein content (20.52 %) than 25 kg P_2O_5 ha^{-1} (18.87%) and at par with 50 and 75 kg P_2O_5 ha^{-1}. While, single superphosphate gave higher values of protein content (20.00%) than the other sources of phosphorus.

Key Words : Levels of phosphorus, Sources of phosphorus, Single super phosphate, Yield, Quality

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INTRODUCTION

Among pulses, pigeonpea [*Cajanus cajan* (L.) Millsp.] is cultivated in the semi-arid areas of tropics and subtropics. It is native of Africa and the early traders have introduced the crop in India. Pigeonpea seeds contain 23.3 per cent protein, 35 per cent minerals, 57.6 per cent carbohydrates and provides 335 KCW energy/100 g. However, recent findings of national institute of nutrition conducted that pulses not supply 17 to 27 per cent of protein but also supply 20 per cent calories of the dietary requirement. Thus, pulses were valued both for proteins as well as calories requirement (Anonymous, 1981 and 2004). Since, the primary objectives of pigeonpea cultivation has been to meet surplus of grains as such there was not much increase in production and productivity of pigeonpea. During the year 2011-2012 area under pigeonpea in India has the worlds largest hectare 3.44 million ha, of pigeonpea and attribute about 85 per cent of global production of about 2.46 million tonnes. The major pigeonpea growing states in India are Maharashtra, Madhya Pradesh, Karnataka, Gujarat and Andhra Pradesh. Phosphorus is the most important nutrient-limiting pigeonpea productivity followed by Zn and

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N. The low P status of soil (< 5 ppm) results in delayed flowering and maturity. S and P have systematic and antagonistic effect with each other on their varying levels of application as well as level of availability in the soil (Marok and Dev, 1980; Mariswamy Gowda *et al.*, 2001). The evolution of short duration varieties of pigeonpea have provide the opportunity for multiple cropping in irrigated as well as rainfed areas. Even its short duration variety responds highly to phosphorus (Sarkar *et al*., 1997). Phosphorus is the major essential element required by the crop. In legumes nitrogen requirement is less as compared to phosphorus because major protein is supplied through nitrogen fixation. Therefore, phosphorus is a key nutrient for increasing productivity of pulses in general and pigeonpea in particular. The present investigation was undertaken to assess the effect of various agronomical practices in increasing and stabilizing the yield of BDN-711, newly released disease resistant varieties of Marathwada Krishi Vidyapeeth for large scale cultivation in the state. The knowledge of sources and levels of phosphorus of pigeonpea varieties will help to enhance the productivity and stabilize the yield of these varieties.

MATERIAL AND METHODS

The field experiment was conducted at the Experimental Farm, Department of Agronomy, College of Agriculture, Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) during *Kharif* season of 2011-12. The soil of experimental plot was clayey in texture. It was low in nitrogen, medium in phosphorus and high in potash, while medium in organic carbon and slightly alkaline in nature. The present experiment was laid out in Split Plot Design with twelve treatment combinations of four phosphorus levels and three sources of phosphorus replicated thrice.

Sr. No.	Treatments	Symbol
	Main plot (levels of phosphorus)	
1.	25 kg P_2O_5/ha	L_1
2.	50 kg P_2O_5/ha	L_2
3.	75 kg P_2O_5/ha	L_3
4.	100 kg P_2O_5/ha	L_4
	Sub plot (sources of phosphorus)	
1.	Single super phosphate (SSP)	S_1
2.	Diammonium phosphate (DAP)	S_2
3.	20:20:00	S_3

Treatment details :

The gross and net plot sizes of each experimental plot were 5.4×5m and 4.5×4 m, respectively. Pigeonpea was sown on 14th July, 2011. The sowing was done by dibbling method with 2 seeds per hill at a distance of 90×20 cm at about 5 cm depth and harvested at 1st Jan., 2012. Pure seed of pigeonpea (var. BDN-711) was used for sowing. Total precipitation during crop growth season was 633 mm that spread over 45 days mostly during June to September. Five plants were selected randomly from each net plot and labeled with tags. Periodical biometric observations were recorded on these plants.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield attributes :

Weight of pod per plant (g) and weight of seed per plant (g) :

The data on yield attributes (Table 1) *viz.,* weight of pods (g) and weight of seeds per plant (g) indicated that the differences in levels of phosphorus and sources in all these characters were significant. Highest weight of pods per plant (101.82 g) and weight of seed per plant (50.29 g) were recorded significantly by the application of higher level of phosphorus (100 kg P_2O_5 ha^{-1}) than 25 kg P_2O_5 ha^{-1}. However, it was at par with 50 and 75 kg P_2O_5 ha^{-1} indicating phosphorus play an important role in formation of seeds in pigeonpea. As regards the sources of phosphorus, an application of single superphosphate fond to be superior than diammonium phosphate and 20:20:00. Similar favouarble effect of increasing level of phosphorus application on weight of pods and weight of seeds per plant have been reported by Sarkar *et al*. (1997) and Shivran *et al*. (2000).

Test weight (g) :

The test weight was not significantly influenced by levels and sources of phosphorus. Kumar and Kushwaha (2006) reported non- significant influences of levels and sources of phosphorus on test weight.

Harvest index :

The increasing level of phosphorus application 100 kg P_2O_5 ha^{-1} proved to be optimum recording higher yield 19.66 kg ha^{-1} and harvest index 29.72 per cent of pigeonpea over 25 kg P_2O_5 ha^{-1}. However, it was at par with 50 and 75 kg P_2O_5 ha^{-1}. The beneficial effect of application of phosphorus on seed yield in pigeonpea was also reported by Chauvan and Singh (1981), Sarkar *et al*. (1997) and Mourya (2000).

Benificial effects of phosphorus :

The beneficial effect of phosphorus application on seed yield attributes resulting ultimately yield ha^{-1} as phosphorus play a specific role in increase the ratio of grain to bhusa. It is essential to reproductive functions; stimulates early root growth, enhances the activity of rhizobia and root nodules, synthesis of protein and amino acid of pulse crop. Thus, phosphorus has been identified as a essential primary nutrient. As regards the sources of phosphorus an application of single superphosphate significant by superior over diammonium

phosphate and 20:20:00 as far as the yield per hectare of pigeonpea is concerned. The superiority of single superphosphate as phosphorus fertilizer may be attributed to increased availability of phosphorus and increased availability of other nutrients particularly calcium (20%) in presence of sulphur (12%). Similar beneficial effect of single superphosphate as source of phosphorus fertilizer in pigeonpea was also reported by Sarkar *et al*. (1997); Singh *et*

Table 1 : Yield and yield attributes as influenced by different treatments

Treatments	Weight of pods per plant (g)	Seed weight per plant (g)	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Test weight per plant (g)	Harvest index (%)
Levels of phosphorus (L)							
L_1-25 kg P_2O_5 ha^{-1}	75.50	37.12	13.80	42.31	56.11	102.30	24.51
L_1-50 kg P_2O_5 ha^{-1}	95.02	47.06	19.36	46.72	65.08	103.54	28.56
L_1-75 kg P_2O_5 ha^{-1}	97.78	50.10	19.40	47.40	66.81	104.27	29.06
L_1-100 kg P_2O_5 ha^{-1}	101.82	50.29	19.66	49.13	68.79	104.36	29.72
S.E. ±	2.56	1.58	0.59	0.89	1.28	2.17	0.65
C.D. (P=0.05)	7.66	4.74	1.78	2.67	3.84	NS	1.95
Sources of phosphorus (S)							
S_1-SSP	97.74	49.56	19.56	47.90	67.46	103.76	28.92
S_2-DAP	90.18	45.01	17.89	45.50	64.23	103.60	27.49
S_3-20:20:00	85.92	42.83	16.72	44.02	60.90	103.49	27.48
S.E. ±	2.19	1.18	0.30	0.69	0.81	2.83	0.39
C.D. (P=0.05)	6.56	3.54	0.90	2.06	2.44	NS	1.16
Interaction (L×S)							
S.E. ±	4.38	2.37	0.60	1.37	1.63	5.66	0.77
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS
General mean	91.78	46.14	18.06	46.14	64.20	103.62	27.96

NS= Non-significant

Table 2 : Mean protein content (%), phosphorus uptake by seeds (kg ha^{-1}) and phosphorus uptake by straw (kg ha^{-1}) as influenced by different treatments

Treatments	Protein content (%)	Phosphorus uptake by seeds (kgha^{-1})	Phosphorus uptake by straw (kgha^{-1})
Levels of phosphorus (L)			
L_1-25 kg P_2O_5 ha^{-1}	18.87	6.65	5.33
L_1-50 kg P_2O_5 ha^{-1}	19.83	8.33	6.37
L_1-75 kg P_2O_5 ha^{-1}	20.39	8.71	6.50
L_1-100 kg P_2O_5 ha^{-1}	20.52	8.89	6.68
S.E. ±	0.30	0.27	0.11
C.D. (P=0.05)	0.90	0.80	0.34
Sources of phosphorus (S)			
S_1-SSP	20.00	8.32	6.16
S_2-DAP	19.93	8.22	6.08
S_3-20:20:00	19.78	8.13	6.01
S.E. ±	0.53	0.16	0.13
C.D. (P=0.05)	NS	NS	NS
Interaction (L × S)			
S.E. ±	1.07	0.33	0.25
C.D. (P=0.05)	NS	NS	NS
General mean	19.90	8.19	6.08

NS= Non-significant

al. (2005) and Kumar and Kushwaha (2006).

Quality and phosphorus uptake :

Protein content (%) :

Quality protein content (20.52 %) depicted in (Table 2) was improved significantly by the application of higher levels of phosphorus @ 100 kg P_2O_5 ha^{-1} than 25 kg P_2O_5 ha^{-1}. However, it was at par with 50 and 75 kg P_2O_5 ha^{-1} phosphorus application as it play important role in synthesis of protein and amino acids of pulse crop. Pawar *et al.* (1998) also reported similar increase results regarding in protein content due to increase in phosphorus level in pigeonpea (Deshbhratar *et al.*, 2010).

Phosphorus uptake by grain and straw of pigeonpea :

The phosphorus uptake by grain and straw of pigeonpea observed to be increased due to higher level of phosphorus 100 kg P_2O_5 ha^{-1} than 25 kg P_2O_5 ha^{-1}. However, it was at par with 50 and 75 kg P_2O_5 ha^{-1}. The uptake of phosphorus by seed, straw and protein contents were not significantly influenced by sources of phosphorus in pigeonpea.

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