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EFFECT OF PHOSPHORUS AND ZINC ON THE YIELD ATTRIBUTES AND YIELD OF PIGEONPEA VARIETIES GROWN DURING WINTER SEASON

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ABSTRACT

A field experiment was conducted in the Viswavidyalaya Farm at Kalyani during the winter season of 1981-82 and 1982-83 to study the response of 20 (105) and HY3C varieties of pigeonpea to P_2O_5/ha and zinc (0, 10 and 20 kg $ZnSO_4$/ha). Yield attributed and seed yield of pigeonpea varieties were significantly influenced by phosphorus and zinc. Application of 20 kg $ZnSO_4$ produced significantly more height of the plant, number of pods per plant, length of the pod and yield of pigeonpea. But the number of branches per plant, number of seeds per pod and 1,000 seed weight did not reach the level of significance. The response due to the application of phosphorus was quadratic in nature and optimum dose was 88.8 and 76.4 kg/ha for 20 (105) and HY3C respectively. Maximum benefit-cost ratio of 3.15 and 4.12 were obtained at 35 kg P_2O_5/ha level for 20 (105) and HY3C varieties respectively. Variety 20 (105) yielded significantly higher over HY3C due to its higher seed number per pod and 1000 seed weight.

KEY WORDS : Phosphorus, Zinc, Effect, Pigeonpea, Winter

Pigeonpea is one of the most promising legumes at the present time but the yield potentialities of this crop is very low in India (7-8 q/ha) as well as in West Bengal (2 q/ha). The main reasons for low level of production of this crop in the country are non-utilisation of high yielding and disease resistant varieties and non-adoption of proper agro-techniques by the cultivators. Soils differ in their capacity to provide plant nutrients to the growing crops. Different crops need different quantities of nutrients. The nutrient application should be specific to meet the demand of crops to achieve optimum yields and to ensure most economic and efficient use of fertilizers. Determination of optimum dose of phosphorus for this crop during winter season is, therefore, essential for higher production because pigeonpea, being a legume crop responds well to the application of phosphorus.

Zinc has an important role in the growth of this crop, but no such type of experimental findings have been reported. So it was considered necessary to include this micronutrient in the present investigation to show the effect of this nutrient on yield attributes and yield.

MATERIALS AND METHODS

The experiment was conducted during winter season of 1981-82 and 1982-83 in the District Seed Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India (23.5°N latitude, 89°E longitude, 9.75 m altitude) i sandyloam soil with 0.07 per cent total N, 36 l available P_2O_5, 112 kg available K_2O/ha, and 8 ppm of available zinc. The experiment was laido in a factorial randomised block design with pigeonpea varieties 20 (105) and HY3C, 4 level of phosphorus (0,35,70 and 105 kg P_2O5/ha) and levels of zinc (0,10 and 20 kg $ZnSO_4$/ha) Altogether, there were 24 treatment combination which were distributed in the plots of 5 m x 4 m size in three replications.

Seeds were sown in rows with 20 cm and in plants with 15 cm apart. Seed rate of pigeonpea was 75 kg/ha. The crop was sown on October 23rd and 6th in the two years respectively. All the plots of pigeonpea received 20 kgN/ha and 30 kg K_2O/ha as basal. Urea, single super phosphate and muriate of potash were applied as source of N P_2O_5 and K_2O respectively. The maximum and minimum temperature during this period (October to April) varied from 26.19 to 36.43°C and 11.31 to 25.53°C during 1981-82 and 26.2 to 35.93°C and 11.04 and 25.26°C during 1982-83 respectively The maximum and minimum relative humidity were from 77.58 to 90.13 and 40.42 to 61.33 per cent respectively during the periods of crop growth.For recording the characters like height of the plant, branch number per plant, pod length number of pods per plant and seed per pod observations were recorded from randomly selected ten plants from each plot.

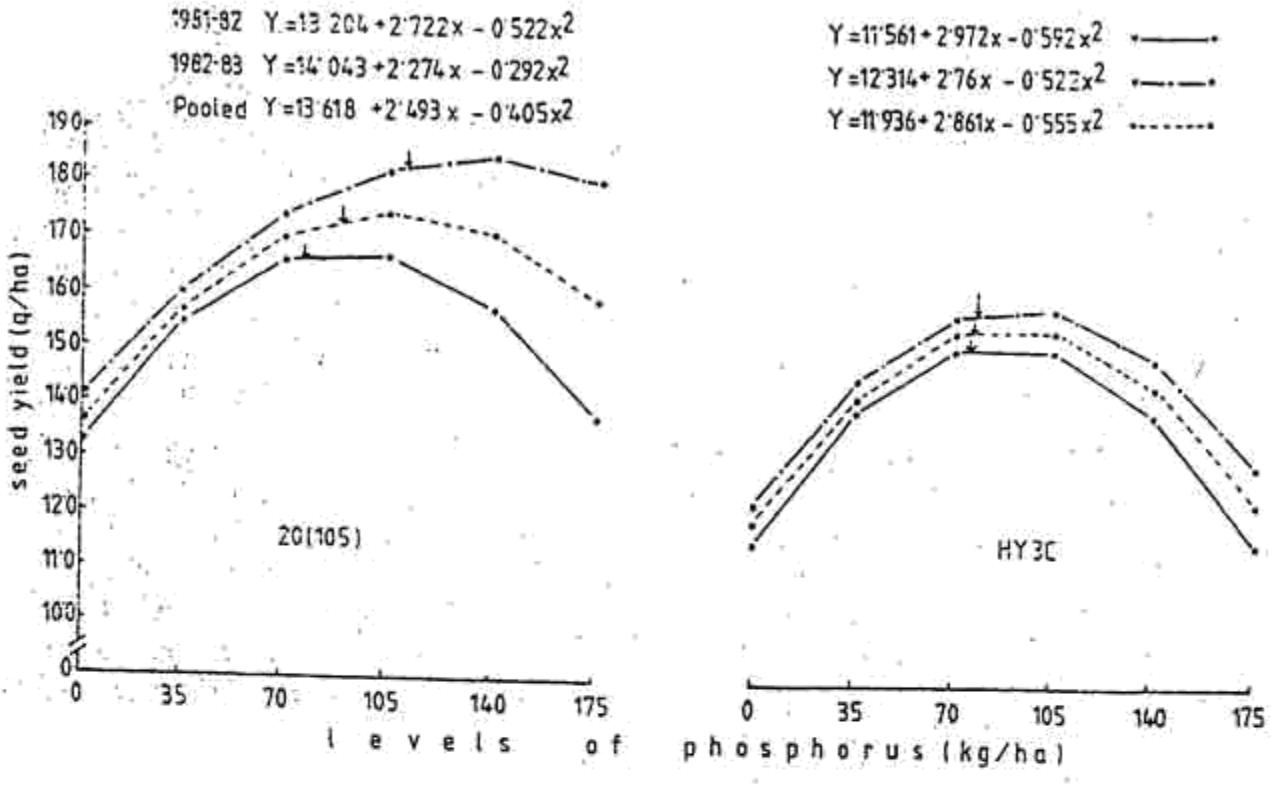

FIG.1 Response curve for phosphorus

RESULTS AND DISCUSSION

Yield attributes and yield

Plants of HY3C were taller than that of 20 (105) in both the years (Table 1). This variety also produced more number of branches per plant than 20 (105), because it being taller than 20 (105), offered more opportunity for bearing more number of branches. Variety HY3C had more number of pods per plants than 20 (105) because greater number of branches per plant of HY3C gave of HY3C gave more points for pod setting. To the contrary, 20 (105) produced longer pods and hence contained higher number of seeds per pod as compared to HY3C. This was due to varietal character. It had bold seeds, as a result its 1000 - seed weight was significantly higher than HY3C. So it outyielded HY3C by 10.8 and 12.3 per cent during first and second years, respectively, mainly due to its greater seed number and 1000-seed weight.

Application of phosphorus increased number of branches per plant, number of pods per plant and number of seeds per pod significantly in both the years of experimentation, but influenced plant height, pod length and 1000 - seed weight in 1981 - 82 only (Table 2). Plant height was maximum at 70 kg P_2O_5 5/ha which was at par with 105 P_2O_5/ha. This is in conformity with the findings reported by Kaul and Sekhon (1975). Number of branches per plant increased significantly upto 70 kg P_2O_5/ha, beyond which there was significant reduction at 105 kg P_2O_5/ha during 1982-83. Ram and Giri (1973) also observed the beneficial effect of P_2O on the number of branches per plant. Maximum

Table 1. Yield attributes and seed yield as affected by pigeonpea varieties

Variety	Height of the plant (cm)		Number of branches/plant		Number of pods/plant		Length of the pod (cm)		Number of seed/pod		1000 seed weight (gm)		Seed yield (q/ha)	
	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83
20(105	62.05	77.30	66.01	84.57	49.96	52.26	5.46	5.52	3.43	3.68	110.21	117.20	15.46	16.43
HY3C	98.72	100.65	95.55	92.36	92.57	80.82	5.05	5.18	3.25	3.24	105.52	108.05	13.95	14.63
S.Em ±	2.44	2.09	3.49	2.71	2.43	2.43	0.05	0.03	0.054	0.051	1.58	1.55	0.42	0.37
C.D. at 5%	6.95	5.95	9.94	7.73	6.92	6.92	0.14	0.08	0.153	0.150	4.51	4.43	1.19	1.06

Table 2. Effect of level of phosphorus on yield attributes and seed yield of pigeonpea varieties

Phosphorus level (Kg/ha)	Height of the plant (cm)		Number of branches/plant		Number of pods/plant		Length of the pod (cm)		Number of seed/pod		1000 seed weight (gm)		Seed yield (q/ha)	
	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83
0	75.36	73.13	68.78	72.33	59.55	56.30	5.13	5.15	3.10	3.05	103.72	104.83	12.26	13.18
35	83.55	89.47	93.47	93.93	70.17	65.28	5.30	5.35	3.44	3.59	107.05	112.22	15.04	15.28
70	79.00	98.05	76.55	103.19	70.69	72.36	5.27	5.46	3.27	3.62	111.87	117.48	15.48	16.60
105	83.61	95.25	84.33	84.80	84.64	71.72	5.31	5.45	3.53	3.57	108.80	115.98	16.03	17.07
S.Em ±	3.45	2.95	4.93	3.84	3.43	4.12	0.07	0.041	0.076	0.072	2.24	2.20	0.592	0.53
C.D. at 5%	NS	8.41	14.06	10.94	9.78	11.75	NS	0.12	0.22	0.21	NS	6.26	1.69	1.50

number of pods per plant was observed at 105 kg P_2O_5/ha in first year and at 70 kg P_2O_5/ha in second year. But there was no significant difference in pod number between 70 and 105 Kg P_2O_5/ha in second year. Beneficial effect of phosphorus on pod number of pigebnpea was also reported by Ram and Giri (1973), Kaul and Sekhon (1975) and Bhowmik *et al.* (1983). Application of phosphorus increased pod length significantly over control but there was no significant difference in pod length among the applied phosphorus levels. Like pod length, phosphorus enhanced seed number per plant over control. Similar observation was made by Ram and Giri (1973) and Bhowmik *et al* (1983). Application of 70 kg P_2O_5/ha recorded maximum weight of 1000-seeds; however, it did not differ from 35 and 105 kg P_2O_5/ha in both years. This confirms the findings reported earlier by Ram and Giri (1973) and Bhowmik *et al.* (1983) on red gram. Phosphorus is known to develop more extensive root system and thus enabling the plants to extract water and nutrients from deeper soil layers. This might be the reason for increased growth of plants with more number of branches which helped the plants to produce more pods and greater yield attributes. As a result, phosphorus enhanced seed yield. Maximum seed yield was recorded at 105 kg P_2O_5 which was at par with 70 kg P_2O_5/ha during 1982-83 and with 35 and 70 kg P_2O_5/ha during 1981-82. Increase in seed yield over control was 15.9 to 22.68 per cent, 25.9 to 26.2 per cent and 29.5 to 30.7% at 35, 70 and 105 kg P_2O_5/ha, respectively. Earlier workers (Ram and Giri, 1973; Rathi *et al.*, 1974; Singh *et al.*, 1983) also reported an increase in the seed yield due to phosphorus application.

Zinc application increased the yield attributes of pigeonpea in both the years of experimentation (Table 3). Plant height, pod number per plant and 1000-seed weight remained unaffected due to application of 10 kg $ZnSO_4$, but increased significantly over control when 20 kg $ZnSO_4$ was added. In case of branch number and seed number, the response to zinc application was observed upto 10 kg/ha, further increase to 20 kg/ha did not increase these characters over 10 kg/ha $ZnSO_4$. The response of pod length to zinc application was variable in different years. Ten and 20 kg $ZnSO_4$ being at par was superior to control in 1981-82, whereas progressive increase in pod length was observed with successive increment of $ZnSO_4$ upto 20 kg/ha in 1982-83. Zinc takes part in the metabolism of plant as an activator of several enzymes which in turn can directly or indirectly affect the synthesis of carbohydrate and proteins.

Table 3. Effect of level of zinc on yield attributes and seed yield of pigeonpea varieties

Zinc level (Kg/ha)	Height of the plant (cm)		Number of branches/plant		Number of pods/plant		Length of the pod (cm)		Number of seed/pod		1000 seed weight (gm)		Seed yield (q/ha)	
	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83	1981-82	1982-83
0	74.92	81.75	68.00	76.27	62.89	60.56	5.12	5.18	3.05	3.25	104.05	107.94	12.74	13.90
10	78.34	88.82	81.73	91.08	66.21	64.92	5.25	5.38	3.40	3.50	107.37	112.32	14.73	15.73
20	88.09	96.35	92.62	98.04	84.69	74.14	5.39	5.50	3.55	3.63	111.57	117.62	16.64	16.96
S.Em ±	2.99	2.56	4.27	3.32	4.21	3.57	0.06	0.03	0.066	0.062	1.94	1.90	0.512	0.457
C.D. at 5%	8.52	7.28	12.18	9.47	11.98	10.18	0.17	0.10	0.19	0.18	5.52	1.46	1.46	1.303

Table 4. Response of pigeonpea to fetiliser in kg seed per kg of applied nutrient (phosphorus)

Variety	kg seed/kg of phosphorus / Dose of phosphorus (kg/ha)			Optimum dose
	35	70	105	
20(105)				
1981-82	7.37	4.53	3.48	4.62 (76.58)*
1982-83	5.11	4.97	3.90	3.82 (110.07)*
Pooled	6.23	4.74	3.69	4.21 (88.83)*
HY3C				
1981-82	8.51	4.68	3.70	5.09 (74.9)*
1982-83	6.88	4.78	3.49	4.62 (77.87)*
Pooled	7.68	4.73	3.60	4.84 (76.44)*

* Figures in parenthesis indicates optimum dose of phosphorus

This might have contributed to the increase in the yield attributes of pigeonpea. Favourable influence on the yield attributes due to Zn application contributed to significant increase in seed yield. Application of 10 and 20 kg $ZnSO_4$ increased seed yield significantly over control in both years. However, seed yield did not differ between 10 and 20 kg $ZnSO_4$ in 1982-83. Maximum seed yield was recorded at 20 kg $ZnSO_4$ which gave an additional yield of 3.90 and 3.06 q/ha or 30.6 and 22.0 per cent over control respectively, during two years. Beneficial effect of the application of zinc on the yield of legumes was observed by Kapur *et al.* (1977) in soybean, Sakal *et al.* (1980) in lentil and Devarajan *et al.* (1980) in green gram.Interaction between P x Zn on yield attributes and seed yield of pigeonpea was not significant in any of the year.

Response

Relationship between level of P_2O_5 (kg/ha) and seed yield of pigeonpea varieties (q/ha) was studied and it was found quadratic in nature during both years as well as in pooled data (Fig.1). The optimum dose of phosphorus in kilogramme per hectare ranged from 76.58 to 110.07 and 74.90 to 77.87 for 20 (105) and HY3C during both years with average values of 88.83 and 76.44 kg P_2O_5 per hectare for these varicties respectively.

Response to phosphorus application over control was maximum at 35 kg in both varieties (Table 4) and it decreased with increase in the level of phosphorus. At almost all levels of phosphorus, 20(105) proved slightly superior to HY3C except at 35 kg level.

Table 5. Economics of phosphorus application (average of two years)

	Fertilizer applied P_2O_5 (kg/ha)	Benefit cost ratio
20(105)		
	35	3.15
	70	2.16
	105	1.46
HY3C		
	35	4.12
	70	2.15
	105	1.40

Price of pigeonpea = Rs. 5.00/kg and price of single super phosphate = Rs. 1.00/kg

Economics of fertiliser application

Benefit-cost ratio was maximum at 35 kg phosphorus application to both varieties compared to other levels of P_2O_5 (Table 5). It was 3.15 and 4.12 per rupee invested on fertiliser at 35 kg P_2O_5 from 20 (105) and HY3C respectively. With the increase in the dose of P_2O_5 decreasing trend of the ratio was observed.

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