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RESPONSE OF CROP GEOMETRY AND PHOSPHORUS LEVELS ON FIELD PEA (*Pisum sativum* L.) VARIETIES

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ABSTRACT

The field experiment was undertaken at Campus for Research and Advanced Studies, Dhablan, P.G. Department of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala during *rabi* season of 2019-20.The experiment was laid out in factorial randomized block design with three crop geometries (20 cm x 10 cm, 30 cm x 10 cm and 40 cm x 10 cm), three phosphorus levels (50 kg ha^{-1}, 60 kg ha^{-1} and 70 kg ha^{-1}), two varieties (Punjab-89 and GS-10) and replicated three times.The growth attributes i.e., plant height (cm), number of branches plant^{-1}, number of leaves plant^{-1} and dry weight plant^{-1} (g) and yield attributes i.e., number of pods plant^{-1}, number of seeds pod^{-1}, test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}) and biological yield (q ha^{-1}) of field pea were significantly influenced by crop geometry, phosphorus levels and varieties. Crop geometry (30 cm x 10 cm) and variety Punjab-89 was found to be more suitable for maximum unit^{-1} production and economic returns. Phosphorus level of 70 kg ha^{-1} resulted in higher growth and yield attributes, however 60 kg ha^{-1} P was observed to be more suitable in terms of economic returns (2.35).

(Key words: Field pea, crop geometry, phosphorus level, variety)

INTRODUCTION

Field Pea (*Pisum sativum* L.) is one among the foremost important pulse crop and grown everywhere in the world. It is an herbaceous annual plant belonging to family Fabaceae and sub family Papilionaceae. Pea is grouped by end use into field and garden pea.

In India field pea is grown over an area of 11.50 lakh ha with a production about 10.36 lakh tones during XIIth plan period (2012-15). In India, pea is cultivated on an area of 551 thousand hectares with the production of 5533 thousand metric tonnes during 2018-19 (Anonymous, 2019). The main field pea producing states in India are Uttar Pradesh, Rajasthan, Haryana, Punjab, Orissa, Bihar, Maharashtra and Madhya Pradesh. In Punjab, pea was cultivated on an area of 43.86 thousand hectares with average yield of 104.99 q ha^{-1} and production of 460.45 thousand tonnes during 2019-20 (Anonymous, 2020).

Crop geometry refers to the arrangement of plants in several rows and columns in an area for efficient utilization of the natural resources. This is often very essential to utilize the resources like light, water, nutrients and space.

It affects the crop yield through effect on light interception, rooting pattern and moisture extraction pattern. Phosphorus is one among the foremost important nutrient required by pea for growth and development.It is a constituent of adenosine di-phosphate (ADP), sugar phosphate, nucleic acid, proteins and a number of other co-enzymes which are of great importance in energy transformation and metabolic processes of plants. Phosphorus deficiency is the vitally important factor for poor nodulation and low yield of leguminous crops. Punse *et al.*(2018) inferred that application of 60 kg phosphorus ha^{-1} and 30 kg sulphur ha^{-1} yielded maximum for growth and growth attributes (plant height, number of branches and plant dry matter accumulation, leaf area),yield and yield attributes (number of pod plant^{-1}, test weight, seed and straw yield ha^{-1}) as well as economics of greengram also improved by the same treatment in green gram. Similarly, Marbaniang (2020)revealed that combined application of 30 kg phosphorus ha^{-1}and 20 kg sulphur ha^{-1} recorded highly significant growth parameters (plant height, number of leaves plant and nodulation), yield and yield parameters (number of pods, plant, number of seeds pod, seed and stover yield) in mungbean. Selection of suitable variety plays a beneficial role in crop production. The selection of right variety of pea helps in augmenting crop productivity. So, the worth of stable and high yield varieties has been universally recognized as a crucial input for enhancing the production.

MATERIALS AND METHODS

The field experiment was conducted at Campus for Research and Advanced Studies, Dhablan, P.G. Department

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of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala during *rabi* season of 2019-20.The soil of the experimental field was of clayey texture having slightly alkaline pH (7.4), medium in organic carbon (0.53%), medium in available nitrogen (262.42 kg ha^{-1}), medium in available phosphorus (21.2 kg ha^{-1}) and medium in available potassium (137 kg ha^{-1}).The experiment was carried out in factorial randomized block design and replicated three times.The experiment was comprised of three crop geometries (20 cm x 10 cm, 30 x 10 cm and 40 cm x 10 cm), three phosphorus levels (50 kg ha^{-1}, 60 kg ha^{-1} and 70 kg ha^{-1}) and two varieties (Punjab-89 and GS-10).For the soil analysis, representative soil sample was collected from 0-15 cm depth randomly from several spots of the experimental field before starting the experiment. A homogeneous mixture was then prepared for mechanical and chemical analysis.Biometric observations for plant height (cm), number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and dry weight $plant^{-1}$(g) were recorded at different periodic stages of crop i.e., 30, 60, 90 DAS and at harvest. For recording observations, five plants were randomly selected and tagged from each plot and the mean of observations taken from all the plants was calculated. However, for dry matter accumulation, five plants were randomly selected from border plot area and the mean was calculated.Yield attributes i.e., number of pods $plant^{-1}$, number of seeds pod^{-1} were also studied by taking mean observations. Yield was studied after harvesting of the crop in order to find out the response of different treatments. Filed pea cultivars 'Punjab 89' and GS-10 were sown in lines as per treatments during second week of November in each experimental unit. All the recommended package of practices was followed to raise the crop. The crop was harvested during first week of April, 2020.The observations recorded during the course of investigation were tabulated and analyzed statistically to draw a valid conclusion. The data analyzed as per the standard procedure for analysis of variance (ANOVA) as described by Gomez and Gomez (1984). The significance of the treatment was analyzed by F-test. The standard error of the treatment was calculated in all cases. The differences in the treatment mean were analyzed by using critical difference (CD) at 5% level of probability. The economics of different treatments was worked out by taking into consideration of all the expenses gained. The cost of input and price of produce predominant at Campus for Research and Advanced Studies, Dhablan were taken into consideration for calculating economics of different treatments and expressed as net return and benefit: cost ratio (B: C).

RESULTS AND DISCUSSION

Data in Table 1 clearly indicates significant variation of growth attributes i.e., plant height (cm), number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and dry weight $plant^{-1}$(g) under different treatments of crop geometry, phosphorus levels and varieties. The maximum plant height of field pea was observed under closer crop geometry of 20 cm x 10 cm at 30, 60, 90 DAS and at harvest. The maximum number of branches $plant^{-1}$ (19.41), number of leaves $plant^{-1}$ (108.36) and dry weight $plant^{-1}$ (55.65 g) were observed under wider crop geometry of 40 cm x 10 cm at 30, 60, 90 DAS and harvest. The similar results were also found by Shaukat *et al.* (2012). They observed that plant height (cm) and number of branches $plant^{-1}$, indicated highly significant differences for sowing dates and row spacing. Maximum plant height (cm) was recorded on 5thMay sowing with 30 cm spacing and 20th April sowing with 50 cm spacing. Maximum number of branches $plant^{-1}$ was counted in 20th April sowing with 50 cm spacing.In case of phosphorus levels, the highest plant height (cm), maximum number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and dry weight $plant^{-1}$ (g) were noticed with the application of 70 kg ha^{-1} at 30, 60, 90 DAS and at harvest, however the results were at par with 60 kg ha^{-1}at all growth stages. Similar response was observed by Sharma *et al.* (2020). They found that application of 60 kg phosphorus ha^{-1} recorded significantly higher growth characters *viz.,* plant height (cm), number of leaves, number of branches, fresh weight and dry weight as well as yield (grain and straw yield) than lower levels of 40 and 0 kg phosphorus ha^{-1}. Among the varieties, Punjab-89 resulted significantly tallest plant height (cm), more number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and dry weight $plant^{-1}$(g) at 30, 60, 90 DAS and at harvest.Corresponding research findings of varieties were also observed by Mandloi *et al.* (2020). They observed that growth parameters and yield attributes of pea were significantly increased with every increase in levels of phosphorus up to 90 kg P_2O_5 ha^{-1} which were statistically at par with 90 kg P_2O_5 ha^{-1} but significantly higher than other levels of phosphorus. Pusa Pragti recorded the highest grain yield (104.84 q ha^{-1}). Phosphorus use efficiency decreased with the increase in P level. Net returns (Rs.113150 ha^{-1}) and benefit cost (1:3.57) ratio were the highest with 90 kg P_2O_5 ha^{-1} level.

Data in Table 2 indicates response of crop geometry, phosphorus levels and varieties on number of pods $plant^{-1}$, number of seeds pod^{-1} and test weight (g) of field pea. Crop geometry 40 cm x 10 cm produced highest number of pods $plant^{-1}$, highest number of seeds pod^{-1} and maximum test weight. Similar observations were also recorded by Rahman *et al.* (2020).Considering the varieties, number of branches $plant^{-1}$ and seed yield were found highest in BARI Motorshuti-1 in pea crop. Number of branches $plant^{-1}$, number of nodes $plant^{-1}$, 100 pod weight, pod yield and seed yield of pea were found highest at the 40 cm ×15 cm spacing. Due to interaction effect of variety and spacing, the highest seed yield was found at BARI Motorshuti-1 with 30×15 cm spacing.Among the phosphorus levels, application of phosphorus at 70 kg ha^{-1} resulted in maximum number of pods $plant^{-1}$, maximum number of seeds pod^{-1} and maximum test weight however, application of phosphorus at 60 kg ha^{-1} showed at par results in terms of yield attributes. This may be due to the fact that phosphorus enhances vegetative and reproductive growth of plant and also helps in better translocation of nutrients. Above findings

are in accordance with Sharma *et al.* (2020).They observed highly significant difference among sowing dates, row spacing and interaction for number of pods plant^{-1}, pod length, numbers seeds pod^{-1} and seed yield ha^{-1}. Maximum numbers of pods plant^{-1}, pod length and number of seeds pod^{-1} were recorded in 20th April sowing with 50 cm spacing. Among the varieties, Punjab-89 resulted in significantly higher number of pods plant^{-1}, higher number of seeds pod^{-1}and higher test weight.

Data in Table 3 indicates significant response of crop geometry, phosphorus levels and varieties on yield of field pea. Crop geometry 30 cm x 10 cm resulted in maximum grain yield, straw yield and biological yield. Sibhatu *et al.* (2016) reported similar findings as plant spacing influenced plant height, grain yield and biomass yield. The greatest plant height (50.63 cm) was obtained at a spacing of 60 cm x 20 cm, while the maximum mean grain yield (544.58 kg ha^{-1}) and biomass yield (1562.65 kg ha^{-1}) was obtained at spacing of 40 cm x15 cm in cropping seasons. Among the phosphorus levels, application of phosphorus at 70 kg ha^{-1} resulted in maximum grain yield, 60 kg phosphorus ha^{-1} resulted in maximum straw yield and 70 kg ha^{-1} resulted in maximum biological yield, however 60 kg ha^{-1} phosphorus showed non-significant results with respect to grain yield and biological yield. Among both the varieties, Punjab-89 noticed significantly higher grain , straw and biological yield.

Table 1. Response of crop geometry, phosphorus levels and varieties on growth attributes of field pea

Treatments	Growth attributes															
	Plant height (cm)				Number of branches plant^{-1}				Number of leaves plant^{-1}				Dry weight plant^{-1} (g)			
	30 DAS	90 DAS	120 DAS	At harvest	30 DAS	90 DAS	120 DAS	At harvest	30 DAS	90 DAS	120 DAS	At harvest	30 DAS	90 DAS	120 DAS	At harvest
C_1 : 20 x 10 cm	**21.24**	**54.97**	**93.20**	**94.76**	3.67	7.28	11.82	14.44	21.07	46.29	91.16	88.71	2.14	10.12	18.72	26.17
C_2 : 30 x 10 cm	20.8	50.50	89.09	88.65	4.00	8.36	16.07	16.13	24.28	51.37	97.92	96.17	3.06	16.74	32.54	48.12
C_3 : 40 x 10 cm	19.10	48.44	81.39	83.95	**5.61**	**9.19**	**19.41**	**18.91**	**26.61**	**56.70**	**109.1**	**108.36**	**3.41**	**18.22**	**37.28**	**55.65**
SE(m)±	0.46	0.63	0.79	0.65	0.59	0.64	1.21	0.61	0.49	0.60	0.58	0.58	0.15	0.46	0.80	0.64
CD (5%)	1.20	1.61	1.52	1.76	0.66	0.54	2.53	1.12	1.15	1.57	1.08	1.49	0.42	1.30	2.24	1.51
P_1 : 50 kg ha^{-1}	19.87	49.72	86.86	88.32	3.49	6.03	14.16	14.90	21.79	45.48	89.48	87.73	2.57	12.55	25.09	36.14
P_2 : 60 kg ha^{-1}	20.70	51.04	88.27	89.83	4.29	9.20	16.68	16.79	25.79	53.82	103.78	102.03	2.99	15.89	31.11	45.77
P_3 : 70 kg ha^{-1}	**21.82**	**52.16**	**89.56**	**91.12**	**4.90**	**9.99**	**17.47**	**17.70**	**26.78**	**55.06**	**105.23**	**103.48**	**3.09**	**16.74**	**32.64**	**48.23**
SE(m)±	0.40	0.56	0.55	0.66	0.19	0.36	0.44	0.38	0.35	0.45	0.65	0.75	0.11	0.33	0.60	0.49
CD (5%)	1.17	1.35	1.59	1.65	0.54	1.06	1.29	1.12	1.03	1.32	1.90	2.19	0.33	0.97	1.75	1.43
V_1 : Punjab-89	**21.42**	**51.91**	**89.25**	**91.12**	**4.77**	**9.01**	**16.89**	**17.14**	**25.87**	**53.60**	**102.39**	**100.64**	**3.17**	**16.72**	**33.80**	**50.07**
V_2: GS-10	20.21	49.95	87.12	88.45	3.58	7.79	15.31	15.79	23.71	49.10	96.51	94.76	2.59	13.33	25.41	36.68
SE(m)±	0.34	0.28	0.60	0.56	0.19	0.36	0.41	0.39	0.44	0.47	0.52	0.71	0.14	0.34	0.53	0.49
CD (5%)	0.89	0.77	1.62	1.93	0.53	1.05	1.19	1.17	1.23	1.27	1.51	2.11	0.37	0.83	1.50	1.48

Table 2. Response of crop geometry, phosphorus levels and varieties on yield attributes of field pea

Treatments	Yield attributes		
	Number of pods plant^{-1}	Number of seeds pod^{-1}	Test weight (g)
Crop Geometry			
C_1 : 20 x 10 cm	17.34	7.53	129.68
C_2 : 30 x 10 cm	29.53	8.94	132.69
C_3 : 40 x 10 cm	33.09	9.00	133.21
SE(m)±	**0.43**	**0.31**	**0.45**
CD (5%)	**1.23**	**0.81**	**1.31**
Phosphorus levels			
P_1 : 50 kg ha^{-1}	24.40	7.81	130.47
P_2 : 60 kg ha^{-1}	27.71	8.71	133.04
P_3 : 70 kg ha^{-1}	28.89	9.06	134.06
SE(m)±	**0.42**	**0.23**	**0.35**
CD (5%)	**1.23**	**0.67**	**1.02**
Varieties			
V_1 : Punjab-89	30.23	8.98	132.30
V_2: GS-10	23.67	8.12	131.69
SE(m)±	**0.45**	**0.26**	**0.49**
CD (5%)	**1.33**	**0.68**	**1.46**

Table 3.Response of crop geometry, phosphorus levels and varieties on yield(q ha^{-1}) of field pea

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})
Crop Geometry			
C_1 : 20 x 10 cm	18.26	39.15	57.57
C_2 : 30 x 10 cm	23.16	43.22	66.33
C_3 : 40 x 10 cm	19.27	39.76	59.16
SE(m)±	**0.49**	**0.36**	**0.78**
CD (5%)	**1.41**	**1.01**	**2.31**
Phosphorus levels			
P_1 : 50 kg ha^{-1}	16.92	34.18	51.10
P_2 : 60 kg ha^{-1}	21.96	44.69	65.98
P_3 : 70 kg ha^{-1}	22.16	43.21	66.04
SE(m)±	**0.49**	**0.70**	**0.89**
CD (5%)	**1.42**	**2.04**	**2.61**
Varieties			
V_1 : Punjab-89	23.47	46.11	70.69
V_2: GS-10	17.02	35.39	53.39
SE(m)±	**0.48**	**0.28**	**0.38**
CD (5%)	**1.33**	**0.63**	**1.09**

Table 4. Response of crop geometry, phosphorus levels and varieties on gross returns (Rs. ha^{-1}), net returns (Rs. ha^{-1}) and benefit : cost ratio of field pea

Treatments	Gross returns(Rs.ha^{-1})	Net returns(Rs.ha^{-1})	Benefit : Cost ratio
Crop Geometry			
C_1:20x10cm	91822.22	58907.56	1.76
C_2:30x10cm	111894.44	80354.78	2.48
C_3:40x10cm	95373.89	65209.22	2.13
SE(m)±	**1599.35**	**1599.35**	**0.08**
CD(5%)	**4279.76**	**4279.76**	**0.20**
Phosphoruslevels			
P_1:50kgha^{-1}	83068.89	51981.89	1.63
P_2:60kgha^{-1}	107932.22	76392.22	2.35
P_3:70 kgha^{-1}	108089.44	76097.44	2.33
SE(m)±	**2008.01**	**2008.01**	**0.06**
CD(5%)	**5860.92**	**5860.92**	**0.17**
Varieties			
V_1:Punjab-89	115402.96	84238.30	2.63
V_2:GS-10	83990.74	52076.07	1.58
SE(m)±	**1683.39**	**1683.39**	**0.05**
CD(5%)	**5033.16**	**5033.16**	**0.12**

The perusal of data (Table 4) indicated that maximum gross return (111894.44 Rs. ha^{-1}) was earned under crop geometry 30 cm x 10 cm spacing and phosphorus level 70 kg ha^{-1} resulted in maximum gross return (108089.44 Rs. ha^{-1}) followed by 60 kg ha^{-1} resulting in gross return of (107932.22 Rs. ha^{-1}). Among varieties, Punjab-89 resulted in significantly higher gross return (115402.96 Rs.ha^{-1}). Crop geometry 30 cm x 10 cm spacing resulted in maximum net returns (80354.78 Rs.ha^{-1}). Application of phosphorus at 60 kg ha^{-1} resulted in maximum net returns (76392.22 Rs.ha^{-1}), while application of phosphorus 70 kg ha^{-1} resulted in net return of (76097.44 Rs.ha^{-1}) because of higher cost of cultivation under application with phosphorus70 kg ha^{-1}and variety Punjab-89 resulted in significantly greater net return (84238.30 Rs.ha^{-1}). Finally, it was observed that crop geometry 30 cm x 10 cm spacing resulted in maximum benefit: cost ratio of 2.48 and application of phosphorus 60 kg ha^{-1} resulted in maximum benefit: cost ratio of 2.35, while application of phosphorus 70 kg ha^{-1} resulted in Benifit : cost ratio of (2.33) because of higher cost of cultivation with the application of phosphorus 70 kg ha^{-1}. Among both the varieties, Punjab-89 resulted in significantly greater benefit: cost ratio of 2.63 however GS-10 resulted in comparatively less benefit: cost ratio (1.58).

On the basis of above research findings, it is inferred that crop geometry 20 cm x 10 cm resulted in significantly maximum plant height and spacing of 30 x 10 cm resulted in maximum growth attributes, yield attributes, yield (q ha^{-1}) and highest B : C ration (2.48).Phosphorus level @ 70 kg ha^{-1} resulted maximum growth and yield attributes, however phosphorus level @ 60 kg ha^{-1} is more suitable for maximum economic returns (2.35).The variety Punjab-89 resulted in maximum growth attributes, higher yield as well as B:C ratio (2.63).

REFERENCES

Anonymous, 2019.National Horticultural Board, Ministry of Agriculture and Farmers Welfare, Government of India.Department of Agricultural Cooperation and Farmers Welfare.*http://www.nhb.gov.in*.

Anonymous, 2020.Package and Practices of Vegetable Crops. pp. 76-81. Punjab Agricultural University, Ludhiana.

Gomez, K.A. and A.A. Gomez, 1984. Statistical procedures for Agricultural Research. John Wiley and Sons, New York.pp. 680.

Mandloi, R., S.K.J. Waskel, K.N. Tambi and D.R. Agashe, 2020.Varietal and phosphorus response on pod yield of pea (*Pisum sativum* L.). Int. J. Curr. Microbiol. App. Sci. **10**: 213-221.

Marbaniang, E.E., A.O. Engrala, G. Yabi and A.K. Singh, 2020.Effect of phosphorus and sulphur on growth, yield and quality of mungbean (*Vignaradiata* L. Wilczek). J. Soils and Crops,**30** (1): 56-62.

Punse, M., P. C. Pagar, P. Rangari and K.R. Siddagangamma, 2018. Effect of phosphorus and sulphur on growth, yield and economics of green gram. J. Soils and Crops, **28** (2): 402-406.

Rahman, M.M., Raziuddin, M.R. Islam, M.G. Azam, M. Zakaria, S. Hasna and S.D. Setu, 2020.Effect of Spacing on Seed Yield and Quality of Pea Varieties. Int. J. Agri. Inno. R. **9**(1): 13-21.

Sharma, K., K. Kumar, P. Kumar and R.S. Dhaliwal, 2020. Influence of plant hormones and level of phosphorus on growth and yield of field pea (*Pisum sativum* L.) under irrigated conditions of Punjab. Int. J. Chem. Studies. **8**(4): 2231-2234.

Shaukat, S.A., Z. Ahmad, Y.A. Choudry and S.K. Shaukat, 2012.Effect of different sowing dates and row spacing on the growth, seed yield and quality of off-season pea (*Pisum sativum* L. cv. Climax) under temperate conditions of Rawalakot Azad Jammu and Kashmir. Scientific J. Agri. Sci. **1**(5): 117-125.

Sibhatu, B., H. Berhe, G. Gebrekorkos and K. Abera, 2016. Determination of planting spacing for improved yield and yield components of Dekoko (*Pisum sativum* var. abyssinicum) at Raya Valley, Northern Ethiopia. African J. Plant Sci. **10**: 157-161.

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