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Original Research Article

Varietal and Phosphorus Response on Pod Yield of Pea (*Pisum sativum L.*)

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Variety, Phosphorus, Pea

A B S T R A C T

The effect of phosphorus on growth and productivity of garden pea varieties was studied during rabi Season at Horticulture Research Farm, Department of Horticulture, R.A.K. College of Agriculture, Sehore, Madhya Pradesh. The experiment comprised of three levels of phosphorus (30, 60 and 90 kg $P_2O_5ha^{-1}$) and four pea varieties viz., Arkel, PusaPragati, Adarsh andVikash. Results showed that the maximum growth and yield attributes were obtained with higher PusaPragti variety. Most of the growth parameters and yield attributes were increased significantly 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. PusaPragti recorded the highest grain yield (104.84 q ha-1). Phosphorus use efficiency decreased with the increase in P level. Net returns (113150 ha^{-1}) and benefit cost (1:3.57) ratio were the highest with 90 kg P_2O_5 ha-1 level.

Introduction

Garden pea (*Pisum sativum L.*) is an important vegetable crop cultivated on a large scale for green pods and seeds. At global level, it ranks fifth in terms of area and production under legumes. It is grown with less care and low manorial requirement. The productivity of pea is low because of its cultivation generally in poor soils. Pulses have inherent capacity to fix atmospheric nitrogen in symbiotic association with Rhizobium. This characteristic of pulses has helped in maintaining the sustainable fertility levels of soils. Under the pulses the soil does not allow water to run very fast which enhance the soil productivity, especially in case of the dry farming zones. Because of their better ground coverage, the pulses reduce water losses through evaporation from the soil surface. Application of phosphorus increased the production of pulse crops (Sharma *et.al* 2014). The response of phosphorus depends upon many factors like climate, variety and soil type and availability of nutrients during the period of growth. The requirement of phosphorus in legumes like pea is higher than other crops for their root development and metabolic activities. Phosphorus is the vital component of DNA, RNA, ATP and photosynthetic system and catalyses a number of bio chemical reactions from the beginning of seedling growth through to the formation of grain at maturity.

Selection of suitable variety plays a vital role in crop production. The choice of right variety of pea helps in augmenting crop productivity. Thus, the value of stable and high yield varieties has been universally recognized as an important non case input for boosting the production any crop. There is a possibility of ranging the productivity per unit area by essential use of phosphorus. The present investigation was therefore carried out to the study the effect of phosphorus levels on yield and economics of pea varieties.

Materials and Methods

The present experiment was conducted at Horticulture Research Farm, Department of Horticulture, R.A.K. College of Agriculture, Sehore, Madhya Pradesh, India. The field is situated at 27012'N latitude, 77000'E longitude, experiencing subtropical climate with mean annual precipitation of 689.3 mm, minimum and maximum temperature of 6.8 ± 1 and 46 ± 2° C, respectively. An experiment was sown in factorial randomized block design with three replications. The experimental materials for the present study comprised of four elite genotypes viz., Arkel, PusaPragati, AdarshandVikashand three phosphorus levels viz., 30, 60 and 90 kg P2O5 per hectare were used in experiment. Entire quantities of Nitrogen, phosphorus and potassium were applied, as per the treatments through urea, single super phosphate and murate of potash respectively. The crop was sown on in third week of October 2012. All agronomic practices like weeding intercultural practices and irrigation were done according to need of the crop. Growth and yield attributes were recorded at maturity. The observations were recorded on five randomly selected plants from each plot for yield and its attributes (Table 1). Economics of various treatments was calculated on the basis of prevailing market prices of different input and final produce. The data were statistically analyzed according to the method suggested by Panse and Sukhatme (1985) and to test the significance of differences among the plant populations.

Results and Discussion

Effect of different varieties and levels of phosphorus on growth parameters of pea

The significantly maximum plant height, number of branches plant-1 was recorded in treatment V2 (PusaPragati), followed by V1 (Arkel) at maturity, respectively (Table 1). Similar results have been reported by Rakesh Kumar *et al.,* (2007), Thakur (2007), Bhupendra Kumar (2008) and Vijaylaxmi (2013). The significantly maximum plant height, number of branches plant-1 was recorded under treatment P3 (90 kg P_2O_5 ha^{-1}) followed by P2 (60 kg $P_2O_5ha^{-1}$) at t maturity, respectively, while minimum plant height was recorded in treatment P1 (30 kg P_2O_5 ha^{-1}) at maturity, respectively. The findings is also in agreement with the findings of Shafeek *et al.,* (2005), Jitender Kumar (2011), Khanday *et al.,* (2012) and Gulpadiya *et al.,* (2014).

The treatment combination T6 (PusaPragati + 90 kg P_2O_5ha-1) was recorded maximum plant height, number of branches $plant^{-1}$ followed by T3 (Arkel + 90 kg $P_2O_5ha^{-1}$) at maturity, respectively. While, the minimum plant height was recorded in the treatment combination of T7 (Adarsh + 30 kg P_2O_5 ha^{-1}) at maturity, respectively. Similar results have been reported by Jitender Kumar (2011), Dar *et al.,* (2011), Khanday *et al.,* (2012) and Singh *et al.,* (2012).

Variation in plant height and number of branches plant-1 was due to the inherent genetic makeup of the varieties, and

phosphorus application to pea certainly improved the growth of crop plants. It is an established fact that phosphorus is one of the major essential nutrients needed in adequate quantity in available form for proper growth and development of plants. It helps in securing good establishment and better root development of plants particularly at early growth stage. Phosphorus also increases the availability of nitrogen, which is most essential element for the growth of plants. Besides this in general leguminous crops respond more to phosphate fertilization than any other elements.

Effect of different varieties and levels of phosphorus on phenological parameters of pea

Among phenological parameters i.e. days to 50% flowering and days to first pod picking were studies in pea.

The earliest flowering were observed under the treatment V3 (Adarsh), V4 (Vikash) and V1 (Arkel), respectively. While, it was late in treatment V2 (PusaPragati). These findings are in agreement with the findings of Chetia *et al.,* (2006), Nawab *et al.,* (2008) and Bhupendra Kumar (2008). Among the phosphorus application, the minimum days was observed for early flowering under the treatment P1 (30 kg $P_2O_5ha^{-1}$) and late flowering was found in P3 (90 kg $P_2O_5ha^{-1}$) as compared to other treatment (Table 2). Similar results have been reported by Jitender Kumar (2011).

The treatment combination T7 (Adarsh + 30 kg $P_2O_5ha^{-1}$) was recorded earliest 50% flowering as compared to other treatment. While, the late days was recorded in the treatment combination of T6 (PusaPragati + 90 kg $P_2O_5ha^{-1}$). These findings are in agreement with the findings of Jitender Kumar (2011).

The treatment V3 (Adarsh) was recorded in early first pod picking and late first pod picking was found in treatment V2 (PusaPragati). These findings are in agreement with the findings of Ihsan Ali *et al.,* (2002). Application of phosphorus also prolong the first picking and it was recorded late maturity in treatment P3 (90 kg P_2O_5ha-1). However, the early was found in treatment P1 (30 kg P_2O_5ha-1). Significantly early picking was observed in treatment combination of T7 (Adarsh + 30 kg P_2O_5 ha^{-1}) as compared to other treatment combinations. While the late picking exhibited in treatment combination of T6 (PusaPragati + 90 kg P_2O_5ha-1).

Variation in days to 50% flowering and days to first pod picking was due to the inherent genetic makeup of the varieties. Phosphorus also increases the availability of nitrogen, and nitrogen increased cell division and cell differentiation in plants. Thus, plant remained in vegetative phase and resulted in imbalance between C: N ration thus delayed flowering at higher phosphorus level and lower level of phosphorus resulted in earlier flowering.

Effect of different varieties and levels of phosphorus on Yield parameters of pea

Among yield parameters i.e. number of pods plant-1, pod length, pod width, days to maturity, 100 seed weight, pod yield plant-1, pod yield plot-1 and pod yield $hectare^{-1}$ were studies in pea.

In case of varieties, the highest pods plant-1 were observed under the treatment V2 (PusaPragati) and V1 (Arkel), respectively as compared to other treatment. As regards to levels of phosphorus, the maximum pods plant-1 was recorded under the treatment P3 (90 kg P_2O_5ha-1), followed by P2 (60 kg $P_2O_5ha^{-1}$). The treatment combination T6 (PusaPragati + 90 kg $P_2O_5ha^{-1}$) was recorded

maximum pods plant-1 followed by T3 (Arkel + 90 kg P_2O_5ha^{-1}), T5 (PusaPragati + 60 kg P_2O_5ha^{-1}) and T12 (Vikash + 90 kg P_2O_5ha-1) as compared to other treatment. While, the minimum pods plant^{-1} was recorded in the treatment combination of T7 (Adarsh + 30 kg P_2O_5ha^{-1}) (Table 2). Similar results have been reported by Shafeek *et al.,* (2005), Faheema *et al.,* (2006) and Jitender Kumar (2011).

In case of varieties, the maximum pod length were observed under the treatment V2 (PusaPragati) and V1 (Arkel), respectively as compared to other treatment. While, it was minimum pod length in treatment V3 (Adarsh). These findings are in agreement with the findings of Nawab *et al.,* (2008), Kumar *et al.,* (2008) and Sharma and Sharma (2012).

As regards to levels of phosphorus, the maximum pod length was recorded under the treatment P3 (90 kg P_2O_5ha^{-1}), followed by P2 (60 kg P_2O_5ha^{-1}). While, it was minimum in treatment P1 (30 kg P_2O_5ha^{-1}). Similar results have been reported by Jitender Kumar (2011) and Khanday *et al.,* (2012).

The treatment combination T6 (PusaPragati + 90 kg P_2O_5ha-1) was recorded maximum pod length followed by T3 (Arkel + 90 kg P_2O_5ha^{-1}), T5 (PusaPragati + 60 kg P_2O_5ha^{-1}) and T12 (Vikash + 90 kg P_2O_5ha^{-1}) as compared to other treatment. In case of varieties, the maximum pod width were observed under the treatment V2 (PusaPragati) and V1 (Arkel) and which were at par with each other. While, it was minimum pod width in treatment V3 (Adarsh). Similar results have been reported by Pan *et al.,* (2001) and Kumar *et al.,* (2008).

As regards to levels of phosphorus, the maximum pod width was recorded under the treatment P3 (90 kg P_2O_5ha^{-1}) and P2 (60 kg P_2O_5ha-1) and which were at par with each other. While, it was minimum in treatment P1 (30 kg P_2O_5ha^{-1}).

The treatment combination T6 (PusaPragati + 90 kg P_2O_5ha^{-1}) and T3 (Arkel + 90 kg P_2O_5ha^{-1}) was recorded maximum pod width followed by T5 (PusaPragati + 60 kg P_2O_5ha-1) as compared to other treatment. While, the minimum pod width was recorded in the treatment combinations of T7 (Adarsh + 30 kg P_2O_5ha^{-1}).

Significantly maximum seeds pods-1 were obtained under the treatment V2 (PusaPragati) followed by V1 (Arkel) as compared to other treatment. These findings are in agreement with the findings of Pan *et al.,* (2001), Bhupendra Kumar (2008) and Ngeno *et al.,* (2012).

As regards to levels of phosphorus, the maximum seeds pods-1 was recorded under the treatment P3 (90 kg P_2O_5ha^{-1}), followed by P2 (60 kg P_2O_5ha^{-1}). Similar results have been reported by Jitender Kumar (2011) and Khanday *et al.,* (2012).

The treatment combination T6 (PusaPragati + 90 kg P_2O_5ha^{-1}) was recorded maximum seeds pods-1 followed by T5 (PusaPragati + 60 kg P_2O_5ha^{-1}) and T3 (Arkel + 90 kg P_2O_5ha^{-1}) as compared to other treatment. While, the minimum seeds pods-1 was recorded in the treatment combination of T7 (Adarsh + 30 kg P_2O_5ha^{-1}). These findings are in agreement with the findings of Jitender Kumar (2011) and Khanday *et al.,* (2012).

Application of phosphorus, it was recorded late maturity in treatment P3 (90 kg P_2O_5 ha^{-1}). However, the early was found in treatment P1 (30 kg P_2O_5ha^{-1}). Similar results have been reported by Jitender Kumar (2011).

Significantly early maturity was observed in treatment combination of T7 (Adarsh + 30 kg P2O5ha^{-1}) followed by T8 (Adarsh + 60 kg $P_2O_5ha^{-1}$) and T10 (Vikash + 30 kg $P_2O_5ha^{-1}$) as compared to other treatment combinations. The variety V2 (PusaPragati) was recorded maximum weight of 100 seed, followed by V1 (Arkel), while variety V3 (Adarsh) was noted minimum weight of 100 seed. Treatment P3 (90 kg $P_2O_5ha^{-1}$) was recorded maximum weight of 100 seed followed by P2 (60 kg $P_2O_5ha^{-1}$). Therefore minimum weight of 100 seed was observed in P1 (30 kg $P_2O_5ha^{-1}$). These findings are in agreement with the findings of Singh and Singh (2002) and Shafeek *et al.*, (2005).

Interaction of both treatments, the treatment combination of T6 (PusaPragati + 90 kg $P_2O_5ha^{-1}$) was exhibited maximum weight of 100 seed followed by T3 (Arkel + 90 kg $P_2O_5ha^{-1}$) as compared to other treatment combinations. Therefore lowest weight of 100 seed was found in treatment combination of T7 (Adarsh + 30 kg $P_2O_5ha^{-1}$). Similar results have been reported by Singh and Singh (2002), Chaubey and Singh (2004), Aga *et al.*, (2004) and Shafeek *et al.*, (2005). Significantly maximum pod yield plant-1 was obtained under the variety V2 (PusaPragati) followed by V1 (Arkel) as compared to other treatment. These findings are in agreement with the findings of Nawab *et al.*, (2008), Bhupendra Kumar (2008) and Sharma and Sharma (2012).

Treatment P3 (90 kg $P_2O_5ha^{-1}$) was recorded maximum pod yield plant-1 followed by P2 (60 kg $P_2O_5ha^{-1}$). Therefore minimum pod yield plant-1 was observed in P1 (30 kg $P_2O_5ha^{-1}$). Similar results have been reported by Singh *et al.*, (2007) and Khanday *et al.*, (2012).

Table.1 Individual effect of different varieties and levels of phosphorus

Treatment Sym.	Treatments Name		Days to maturity	Days to 50% flowering	Days to 1st pod picking	No. of pods plant^{-1}	Pod length (cm)	Pod width (cm)	Pod yield plant^{-1} (g)	Pod yield hectare^{-1} (q)	100 seed weight
V_1	Arkel		105.22	54.44	77.78	29.64	8.54	1.15	150.22	78.35	27.72
V_2	PusaPragati		113.00	58.00	78.44	33.29	9.75	1.16	190.22	88.55	30.23
V_3	Adarsh		83.00	50.67	71.89	24.40	8.23	1.07	123.22	46.50	22.87
V_4	Vikash		86.00	53.22	74.89	27.49	8.34	1.08	131.56	55.21	24.70
SEm±			0.29	0.34	0.29	0.38	0.08	0.02	2.28	1.09	0.25
C.D. at 5% level			0.86	1.02	0.86	1.12	0.24	0.07	6.74	3.24	0.76
P_1	30 kg $P_2O_5ha^{-1}$		94.41	50.25	71.83	21.80	7.55	1.05	108.50	51.43	21.96
P_2	60 kg $P_2O_5ha^{-1}$		96.50	54.17	76.50	29.48	8.79	1.13	138.67	68.16	27.33
P_3	90 kg $P_2O_5ha^{-1}$		99.50	57.83	78.92	34.83	9.81	1.15	199.25	81.87	29.85
SEm±			0.25	0.30	0.25	0.32	0.07	0.02	1.97	0.95	0.22
C.D. at 5% level			0.75	0.88	0.74	0.97	0.21	0.06	5.84	2.80	0.66

Table.2 Interaction effect of different varieties and levels of phosphorus

Treatment	Plant Height At maturity	Days to maturity	Days to 50% flowering	Days to 1st pod picking	No. of pods plant^{-1}	Pod length (cm)	Pod width (cm)	Pod yield plant^{-1}	Pod yield hectare^{-1} (q)	100 seed weight
T_1	65.76	102.67	51.00	74.00	22.47	7.27	1.07	116.67	65.24	22.33
T_2	68.32	105.00	53.00	77.67	31.00	8.66	1.17	123.33	75.46	29.50
T_3	74.33	108.00	59.33	71.67	35.47	9.69	1.19	210.67	94.36	31.33
T_4	69.20	111.33	53.00	74.33	26.60	8.62	1.10	155.67	70.94	24.03
T_5	71.45	112.67	60.33	79.00	35.27	9.32	1.18	193.33	89.87	30.67
T_6	77.44	115.00	60.67	82.00	38.00	11.31	1.19	221.67	104.84	36.00
T_7	63.53	80.00	46.00	66.33	17.00	7.16	1.02	78.33	27.92	20.43
T_8	66.41	82.67	51.67	74.33	25.47	8.55	1.08	113.33	51.36	23.10
T_9	69.77	86.33	54.33	75.00	30.73	8.99	1.10	178.00	60.22	25.07
T_{10}	64.66	83.67	51.00	72.67	21.13	7.16	1.02	83.33	41.61	21.03
T_{11}	67.33	85.67	51.67	75.00	26.20	8.62	1.10	124.67	55.94	26.07
T_{12}	70.37	88.67	57.00	77.00	35.13	9.25	1.13	186.67	68.08	27.00
SEm±	0.54	0.50	0.60	0.50	0.65	0.14	0.04	3.95	1.90	0.44
C.D. at 5%	1.62	N.S.	1.77	1.49	1.94	0.42	N.S.	11.68	5.61	1.32

Table.3 Economics of different varieties and levels of phosphorus of pea

Treatment	Bulb yield (q/ha)	Gross income (Rs/ha)*	Expenditure (Rs/ha)	Net income (Rs/ha)	C:B ratio
T_1	65.24	97860	37735	60125	1: 2.59
T_2	75.46	113190	40914	72276	1: 2.77
T_3	94.36	141540	44110	97430	1: 3.21
T_4	70.94	106410	37735	68675	1: 2.82
T_5	89.87	134805	40914	93891	1: 3.29
T_6	104.84	157260	44110	113150	1: 3.57
T_7	27.92	41880	37735	4145	1: 1.11
T_8	51.36	77040	40914	36126	1: 1.88
T_9	60.22	90330	44110	46220	1: 2.05
T_{10}	41.61	62415	37735	24680	1: 1.65
T_{11}	55.94	83910	40914	42996	1: 2.05
T_{12}	68.08	102120	44110	58010	1: 2.32

*Sale rate of produce was Rs 1500/q

Interaction of both treatments, the treatment combinations of T6 (PusaPragati + 90 kg $P_2O_5ha^{-1}$) and T3 (Arkel + 90 kg $P_2O_5ha^{-1}$) were exhibited maximum pod yield plant-1, and which were at par with each other. Similar results have been reported by Singh *et al.*, (2007) and Khanday *et al.*, (2012).

The differential behavior of the variety might have been caused due to its more growth i.e. number of leaves, number of branches plant-1 and number of nodules plant-1 which increased the photosynthetic efficiency of the crop plants resulting in higher yield and its contributing characters like number of pods per plant, pod length, pod width, days to maturity, 100 seed weight, pod yield per plant and pod yield per hectare. The superiority of these genetic characters under PusaPragati favored it in performing better with the highest level of phosphorus application.

Effect of different varieties and levels of phosphorus on economics

Higher money value and less cost of cultivation are desirable traits for getting higher returns. Hence economics of the treatments was work out.

It is revealed from the data obtained that the significantly maximum pod yield of 104.84 q ha-1 was obtained in pea variety PusaPragati (Table 3). Under the treatment combination T6 (PusaPragati + 90 kg $P_2O_5ha^{-1}$) was obtain maximum net return of Rs 1,13,150 ha and cost benefit ratio 1: 3.57 followed by T3 (Arkel + 90 kg $P_2O_5ha^{-1}$) gave the pod yield 94.36 q/ha along with net return of Rs 97430 ha and cost benefit ratio 1: 3.21. However, the lowest pod yield of 27.92 q ha, net return of Rs 4145 ha and cost benefit ratio 1: 1.11. But treatment combination T5 (PusaPragati + 60 kg $P_2O_5ha^{-1}$) was obtain the maximum cost benefit ratio 1: 3.29 and ranked second, due to lower cost of cultivation then T3. Similar results have been reported by Faheema*et al.,* (2006), Bhat *et al.,* (2013) and Singh *et al.,* (2014).

On the basis of present investigation, it is concluded that the pea variety PusaPragati responded well in terms of growth, phenological and yield parameters and suitable for commercial production in Malwa agro climatic condition. Growth and yield of pea increased significantly with increasing levels of phosphorus. Application of 90 kg $P_2O_5ha^{-1}$ was observed best for growth and yield of pea. Interaction of both treatments, the treatment combination of T6 (PusaPragati + 90 kg $P_2O_5ha^{-1}$) was exhibited maximum growth and yield of pea.

It is revealed from the data obtained that the significantly maximum pod yield of 104.84 q ha^{-1} was obtained in pea variety PusaPragati. Under the treatment combination T6 (PusaPragati + 90 kg $P_2O_5ha^{-1}$) was obtain maximum net return of Rs 1,13,150 ha and cost benefit ratio 1: 3.57.

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