International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 1850-1856

Received: 16-11-2019
Accepted: 18-12-2019

Jitendra Kumar
Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India

Rahul Kumar
Department of Agronomy, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Uma
Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India

SB Singh
Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India

Corresponding Author:
Jitendra Kumar
Department of Agronomy, Raja Balwant Singh College, Bichpuri, Agra, Uttar Pradesh, India

Effect of different phosphorus levels on growth and productivity of field pea (*Pisum sativum* var. Arvense) cultivars in Agra region

Jitendra Kumar, Rahul Kumar, Uma and SB Singh

DOI: https://doi.org/10.22271/chemi.2020.v8.i1aa.8533

Abstract
A field experiment was conducted to study the effect of phosphorus levels on growth and yield of field Pea (*Pisum sativum* var. Arvense) varieties at the research farm of Raja Balwant Singh College, Bichpuri, Agra. The soil of experimental field was alluvial with calcareous layer at the depth of about 1.5-2 m, well drained and deficient in available nitrogen, low in organic carbon, medium in available phosphorus and fairly rich in potash content and was slightly alkaline in reaction. The experiment was laid out in randomized block design (RBD) with four replication of three pea cultivars *i.e.* KPMR-400 (V_1), Rachna (V_2) and KPMR-522 (V_3) and four levels of phosphorus *viz.* 0, 30, 60 and 90 kg P_2O_5 ha^{-1}. Thus there were twelve treatment combinations in the study. The crop stand per running meter, plant height, number of primary branches per plant was obtained significantly higher with the variety KPMR-522 (V_3) as compared to other varieties at most of stages of crop growth. Variety 'Rachna' (V_2) gave higher dry matter accumulation. 'Rachna' (V_2) variety produced significantly higher length of primary roots and number of nodules as compared to all other varieties. Variety 'KPMR-522' (V_3) resulted in highest biological and grain yield and prove its superiority over all other varieties except (V_1) Variety. Variety affected harvest index significantly and higher harvest index was obtained with 'KPMR-400' (V_1) as compared to all other varieties. Application of 60 kg P_2O_5 ha^{-1} Produced maximum number of branches per plant and dry matter accumulation. Primary root length was found significantly superior with the application of phosphorus @ 60 kg P_2O_5 ha^{-1}. Effective nodules per plant was recorded superior with the application of phosphorus @ 90 kg P_2O_5 ha^{-1} and most similar result with 60 kg P_2O_5 ha^{-1}. Exactly same order of significance *i.e.* P_3 (90 kg), P_2 (60 kg), P_1 (30 kg) and P_0 (no phosphorus) P_2O_5 was noticed for grain yield (q ha^{-1}), Stover yield (q ha^{-1}), Biological yield (q ha^{-1}), shelling percent and harvest index. Maximum grain yield (18.69 q ha^{-1}) application of P 90 kg P_2O_5 ha^{-1}, biological yield (68.02 q ha^{-1}) recorded with the application of P_2 (60 kg P_2O_5 ha^{-1}) and Stover yield (52.05 q ha^{-1}) with P_1 (30kg P_2O_5 ha^{-1}), non-significant shelling percent (74.14%) and significant harvest index (28.97%) was associated with the application of P_3 (90 kg P_2O_5 ha^{-1}).

Keywords: Field pea, phosphorus

Introduction
Pulse crops are wonderful gift of the nature. They provide nutrition's food, and fodder and thrive well in fragile ecosystem where other crops often fail. Pulses have the ability to trap atmospheric nitrogen in their root nodules in association with Rhizobium bringing qualitative improvement in physical, chemical and biological properties of soil. Pulses are next to cereals in term of their economic importance as human food. The ability of pulses to fix atmospheric nitrogen in the soil crop system is their unique and beneficial characteristic among all the plant species. Thus pulses can contribute significantly to achieve the twin objective of increasing productivity and improving the sustain ability of rice and wheat based cropping systems. India has undergone a series of ups and down in agricultural production with the climatic condition playing have in the years of abnormality. We faced many drought in 18th and 19th centuries without much know how to counterfeit late middle years of 20th century. India has improved its position in food grain production with technological interventions. Currently, agro-eco systems are facing the problems of overexploitation of natural resources, decline in soil fertility, ground water level and agricultural productivity. Hence, ensuring sustainable food security is the need of the hour.

Pulses play an important role in providing a nutritionally balanced diet. These are the principal source of protein for vegetarians. India is the world's largest producer with 25% share in the global production.

Field pea is one of the most popular food crops in the world as it is very nutritious and its cultivation is also easy. Field pea usually grows in the cold areas of the world unlike the other major pulses of the world. But they have universal appeal, as they are required in all over the world for consumption. Field pea pulse is generally comes in two colors *i.e.* green and yellow. According to FAO statistics, India is one of the largest producer of field pea in the world and stands at the 5^{th} place in the list of major field pea production next to France. The India production contributes to around 7% in the world's total produce with the production figures of 7.8 laces tonnes. Uttar Pradesh is a major field pea producing state in India producing about 60% of the country's produce. The other major pea producing state in India is Madhya Pradesh. In Uttar Pradesh, Jalaun district contributes highest in terms of area and production by 21% and 29% respectively to the state total area and production of field pea. Again Lalitpur stands at the second position in the area (18%) and production (19%) share to the state total, followed by Jhansi area 14% and production 14%, Mahoba (area 8% production 5%), Hamirpur (area 3% and production 3%) and Azamgarh (area 2% and Production 2%) Rest 33% and 28% of acreage and output respectively are come from other state. In India, field pea is used as Dal, Chholla, many attractive dishes and snacks, green pods are also used as vegetable, Nutritionally, it is very rich as it contains 22.9-25% crude protein (dry weight basis), 0.9% Threonine, 0.2% Methionine, 1.8% lysine, 60-65% carbohydrate and 2.0% fat and minerals (Ali and Howthorne, 1993) [3].

Phosphorus is one of the essential nutrients for plant growth and development. Phosphorus regulates protein synthesis in plants, because it is a component of the complex nucleic acid structure phosphorus is important in cell division and development of new tissue, also phosphorus play a vital role in plant energy reactions, photo synthesis, respiration, genetic transfer, seed and fruit production, and nutrient transfer in plants (Raghothama and karthikeyan, 2005) [17]. Phosphorus is also component of phytin, a major storage from of p in seeds, phospholipids, and ATP. Moreover, phosphorus promotes root growth and stimulants tillering and often fertilizer are mainly determined by the soil P available but are not related to soil organic matter, total N, total P, soil $CaCo_3$ contents, and soil N available (Li *et al*., 2011) [13]. Despite the potential for pea crops in agriculture, they still face challenges due to competition from weeds, insects and due to lack of successful nodulation (Date, 2000 Lemerle *et al.*, 2006; Martin – Sanz *et al.*, 2011) [5, 12, 14]. The growth and final yield of pea plants are dependent on the formation of nodules and nitrogen fixation by Rhizobium leguminosarum bv. Viciae (Evans *et al*, 1996) [8]. Poor nodulation can lead to unsuccessful establishment of pea plants, or ineffective Rhizobium bacteria relationship, and consequently poor atmospheric N fixation. Nodulation failure can be explained by unfavorable fields conditions such as low or high pH, high salinity, high soil nitrate content, low soil moisture and lack of essential elements (Evans *et al.,* 1989; Begum *et al.*, 2001) [8, 4] and the absence of effective strains of Rhizobium in the soil (Date, 2000) [5]. Therefore, inoculation of legumes with desired efficient strains of Rhizobium in the form of commercial inoculate products is a common practice to improve nitrogen fixation and final crop yield (This *et al.*, 1991) [20]. The information on phosphorus requirement of pluses especially on peas is quite meager. Therefore, to understand the phosphorus requirement in relation to pea cultivars for maximization of yield, the present experiment was conducted.

Methods and Materials

The present field experiment was carried out at the research farm of Raja Balwant Singh College, Bichpuri, Agra, which is situated at the distance of about 11 km away from Agra city on Agra-Bharatpur road at an elevation 163.4 m above mean sea level with 27.2^0 N latitude and 77.9^0 E longitude. The region has a semi arid and sub tropical climate with hot and dry summers and severe cold winters. The soil of experimental field was alluvial with calcareous layer at the depth of about 1.5 m to 2 m and was well drained to know the exact nature and physico-chemical properties of experimental soil, a composite soil sample from the surface of soil (0-30 cm depth) was taken before application of fertilizers and sowing of the experimental plots with the help of an auger and subjected to mechanical and chemical analysis. The soil of the experimental field was deficient in available total nitrogen, low in organic carbon, medium in available phosphorus and fairly rich in potash content and soil was slightly alkaline in reaction. The experiment was laid out in randomized block design (RBD) with four replication of three pea cultivars *i.e.* KPMR-400 (V_1), Rachna (V_2) and KPMR-522 (V_3) and four levels of phosphorus *viz.* 0, 30, 60 and 90 kg P_2O_5 ha^{-1}. Thus there were twelve treatment combinations in the study. Fertilizer application was done as basal during sowing of the experimental crop, full dose of nitrogen (20 kg/ha) and potash (20 kg/ha) was supplied as basal and phosphorus was applied as per treatment. Total crop duration was 131 days, prior to harvest border rows were harvested and removed then experimental plots were harvested manually and allowed to sun drying for 7 days. The total weight of harvested produce was recorded plot wise to get total biomass just before threshing and straw and grain yield per plot were recorded after threshing. The observation regarding root study and effective nodules were taken at 50-75% flowering stage.

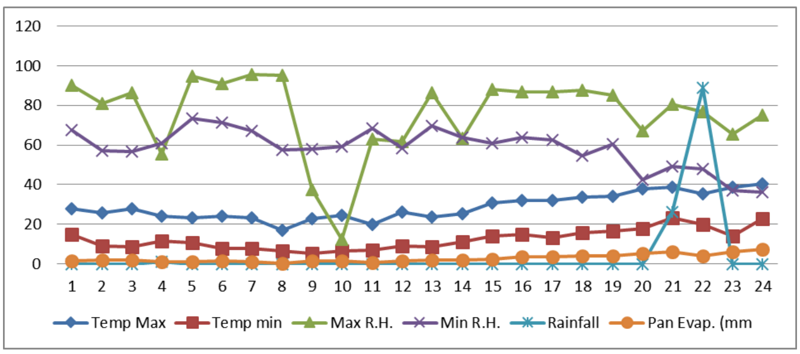

Fig 1: Mean weekly meteorological, observation recorder during crop season (Nov. 12, 2017 to April 23, 2018)

Results

Growth

The crop stands remained practically unaffected due to different varieties and phosphorus levels. However, variety 'Rachna (V_2)' Produced maximum crop stand. At all the Stages of crop growth but at harvest maximum crop stand variety is KPMR-400 (v_1) but the crop stands per running meter tended to increase by increasing the P_2O_5 rates thus, highest number of crop stands per running were noted with P_2.

The effect of variety on the shoot height was found to be significant at varieties tested, maximum shoot height was noted with variety 'Rachna' (v_2). Application of phosphorus improved the plant height continuously significant only two stages (30 DAS and 60 DAS) and non – significant at three stages (90 DAS, 120 DAS and at harvest). The P_2O_5 rates, the highest plant height P_3 at 30 DAS, P_2 to 60 DAS, P_1 at 90 DAS & 120 DAS, and P_2 at harvest. In general, number of branches per plant increase from the very beginning up to at harvest. The maximum number of branches per plant were recorded with variety 'KPMR-522 (V_3)' Which was found Significantly superior as compared to all other varieties at all the recorded stages of crop growth. The increasing levels of phosphorus up to 60 kg P_2O_5 ha^{-1} significantly increased the number of branches per plant at all the stages of crop growth, Maximum number of branches per plant *i.e* 14.93 was recorded with application of 60 kg P_2O_5 ha^{-1} (P_2).

Variations in dry matter accumulation due to different varieties were found to be significant at all the stages of crop growth and only one stage non- significant (60 DAS). The higher values of dry matter accumulation was recorded with the 'Rachna (V_2) and also was found significantly superior as compared to all other varieties at all the stages of crop growth. The effect of the levels of phosphorus application on dry matter accumulation in plant was statistically significant at various stages and non-significant at (120 DAS) of crop growth except 90 and 120 DAS. Table also be indicated that the dry matter accumulation in plants increased significantly with level of phosphorus up to maximum 60 kg P_2O_5 ha^{-1} at 30, & 60, & 120 DAS, 90 Kg P_2O_5 ha^{-1} 90 DAS & at harvest.

The maximum primary root length was found with variety 'Rachna' (V_2). It is also revealed that the differences brought about by the application of phosphorus in the primary root length were affected significantly during the investigation. P_2 level of phosphorus application brought up significant increase in the primary root length over other levels of phosphorus application while P_2 produced primary roots with maximum length (4.39 cm) which was found significantly superior over all the tested levels of phosphorus application. Variation in effective root nodules per plant due to varieties were found nominal and level of Significance. However, the maximum root nodules were produced by the variety 'Rachna (V_2). It is also clear from the table that variation in nodules due to application of phosphorus levels also maximum root nodules P_3 & P_2.

Table 1: Crop growth parameters of pea as affected by different varieties and phosphorus levels.

Treatments	Crop Stands (per running meter)	Plant Height (cm)	Branches per plants	Dry Matter accumulation (g/plant)
Varieties				
KPMR-400 (V_1)	22.31	45.30	14.19	5.36
Rachna (V_2)	21.84	104.81	13.59	6.23
KPMR-522 (V_3)	21.84	54.87	14.40	5.78
S.Em ±	0.450	3.75	0.163	0.183
C.D at 5%	NS	10.8	0.480	0.528
Phosphorus levels				
0 (Control: P_0)	20.50	66.13	13.27	5.90
30 (P_1)	23.17	66.73	13.88	6.40
60 (P_2)	23.42	74.18	14.93	5.92
90 (P_3)	21.92	66.27	14.14	6.34
S.Em ±	0.520	4.33	0.188	0.211
C.D at 5%	1.50	NS	0.55	0.610

Table 2: Root studies per plant at development 75 percent flowering stage as influenced by different varieties and phosphorus levels.

Treatments	Primary root length plant (cm)	Effective nodules plant^{-1}
Varieties		
KPMR-400 (V_1)	3.52	12.50
Rachna (V_2)	4.27	18.81
KPMR-522 (V_3)	4.26	10.87
S.Em ±	0.117	0.313
C.D at 5%	0.34	0.910
Phosphorus levels		
0 (Control: P_0)	3.13	11.25
30 (P_1)	4.22	11.91
60 (P_2)	4.39	14.50
90 (P_3)	4.33	14.58
S.Em ±	0.135	0.361
C.D at 5%	0.39	1.05

Yield attributes

The data presented, reveal that the number of pods per plant was found significantly higher with the variety 'Rachna' (V_2). It is obvious from the data on number of pods per plant given in table 3 under reference that there was significant difference among rate phosphorus application @ 90 kg P_2O_5 ha^{-1} produced the maximum number of pods per plant. The weight of pods per plant exhibited significant variation due to different varieties. The maximum weight of pods per plant was obtained with 'KPMR-400' (V_1) and this was found significantly superior overall other varieties under test. The application of the phosphorus up to 60 kg P_2O_5 ha^{-1} resulted in significantly higher weight of pods per plant and this level was found at par with the phosphorus application @ 90 kg P_2O_5 ha^{-1}. The variations in pod length due to different varieties could not reach the level of significant, However, The maximum pod length (6.18 cm) was obtained under 'Rachna' (V_2) followed by 'KPMR-400 (V_1) (5.56 cm) and KPMR-522 (V_3) (5.87 cm). The effect of different levels of phosphorus was recorded non-significant in pod length. Also However, the highest pod length was found with the phosphorus application @ 90 and 60 kg P_2O_5 ha^{-1}. The pea cultivars significantly differ in respect of number of seeds per pod. The higher number of seeds per pod was found with variety 'Rachna' (V_2) but this was found statistically at par' KPMR-522' (V_3). Phosphorus levels significantly affect the number of seeds per pod phosphorus application @60 kg P_2O_5 ha^{-1} produced maximum number of seeds per pod this was found statistically at par with the phosphorus application@ 30 kg P_2O_5 ha^{-1}**.** The varieties did not bring about any difference in weight of seeds per pod. Almost very similar weight of seeds per pod was found under each variety. Application of phosphorus also failed to affect the weight of seeds per pod. However, the highest weight of seeds per pod was found with the phosphorus application @ 60 kg P_2O_5 ha^{-1}.

With regard of weight of test weight the variation was noted non-significant order. Variety 'KPMR-400' (V_1) gave significantly higher weight of 1000 grains and this was found significantly superior over all other varieties in this regard during the investigation. Whereas the lowest test weight was obtained with 'Rachna' (V_2). Application of phosphorus significantly affected the test weight, however, the maximum test weight was recorded with the phosphorus application @ 90 kg P_2O_5 ha^{-1} and this was found statistically at par with phosphorus application @ 60 kg P_2O_5 ha^{-1} in this respect.

Table 3: Yield attributes as influenced by different varieties and phosphorus levels.

Treatments	Dry weight plant^{-1} (g)	Number of Pod plant^{-1}	Weight of Pod plant^{-1}	Pod length (cm)	Number of seeds pod^{-1}	Weight of seeds pod^{-1} (g)	Test weight (g)
Varieties							
KPMR-400 (V_1)	5.561	7.81	11.44	5.56	5.75	10.06	212.81
Rachna (V_2)	7.23	10.68	9.87	6.18	6.50	1.06	198.24
KPMR-522 (V_3)	5.74	8.37	10.81	5.87	6.06	1.08	210.60
S.Em ±	0.226	0.25.	0.278	0.241	0.140	0.38	0.432
C.D at 5%	0.653	0.730	0.804	NS	0.405	NS	NS
Phosphorus levels							
0 (Control: P_0)	6.26	9.00	10.09	4.91	5.50	0.97	180.9
30 (P_1)	6.40	9.00	10.48	5.91	6.16	1.04	210.56
60 (P_2)	5.98	8.50	11.30	6.33	6.33	1.16	217.09
90 (P_3)	6.15	9.33	11.09	6.33	4.81	1.10	220.33
S.Em ±	0.261	0.288	0.321	0.278	0.162	0.44	0.499
C.D at 5%	NS	NS	0.928	0.83	0.467	0.127	1.44

Yield

Biological yield (q ha^{-1})

The result of experiment showed that the variation in biological yield (q ha^{-1}) due to different varieties was of significant order. However, the highest biological yield was obtained with the variety 'KPMR-522' (V_3). Data revealed that the biological yield (q ha-^{1}) increased significantly with the phosphorus application @ 30 kg P_2O_5 ha^{-1} as compared to 0 and 90 kg P_2O_5 ha^{-1}. However, the highest biological yield was obtained with the phosphorus application @ 60 kg P_2 O_5 ha^{-1}(P_2) but this was found statistically at par with 30 kg P_2O_5 ha^{-1} (P_1).

Grain yield (q ha^{-1})

Data pertaining to the grain yield revealed that the grain yield (q ha^{-1}) increased significant due to different varieties, among the varieties tested, maximum 'KPMR-522' (V_3), and this was found statistically at par with variety 'KPMR-400' (V_1). The phosphorus application significant improved the grain production. Every increase in the phosphorus level increased the grain yield significantly up to 90 kg P_2O_5 ha^{-1} during the experimentation.

Stover yield (q ha^{-1})

The data pertaining to stover yield, revealed that the highest Stover yield (51.74 q ha^{-1}) was recorded with the variety 'Rachna' (V_2) which produced significant more stover yield than 'KPMR-400' and except 'KPMR-522'. Application of phosphorus @ 30 and 60 kg P_2O_5 ha^{-1} being at par resulted in significant higher Stover yield than that obtained from no phosphorus and phosphorus application@ 90 kg P_2O_5 ha^{-1}.

Shelling percentage

A critical examination of data revealed that the variation in shelling percentage due to different varieties was found significant, Variety 'KPMR-522' (V_3) showed higher shelling percentage (84.56) as compared to all other varieties. Increasing doses of phosphorus up to 90 kg P_2O_5 ha^{-1} increased the shelling percentage. The non-significantly highest shelling percentage was noted with no phosphorus dose (P_3) as compared to all other levels of phosphorus application except 30 kg P_2O_5 ha^{-1} (P_1).

Harvest index (%)

The harvest index significantly affected due to different varieties. Table further revealed that maximum harvest index was obtained with variety 'KPMR-400' (V_1) and this was found significantly superior to all other varieties. Although, among tested different varieties, the lowest harvest index was observed with V_2. Application of phosphorus has appreciable effect on harvest index. Maximum harvest index was recorded with the phosphorus application @ 90 kg P_2O_5 ha^{-1} and this was found significantly superior over all other levels of phosphorus application in this respect.

Table 4: Yield of pea (q/ha) as influenced by different cultivars and phosphorus levels.

Treatments	Biological Yield (q ha^{-1})	Grain Yield (q ha^{-1})	Stover Yield (q ha^{-1})	Shelling (%)	Harvest Index (%)
Varieties					
KPMR-400 (V_1)	58.50	17.01	41.44	71.68	28.97
Rachna (V_2)	66.91	15.17	51.74	65.97	22.54
KPMR-522 (V_3)	67.72	17.15	50.57	84.56	25.37
S.Em ±	0.501	0.247	1.50	0.155	0.47
C.D at 5%	1.45	0.72	1.444	0.45	1.36
Phosphorus levels					
0 (Control: P_0)	57.04	13.42	43.63	55.71	23.45
30 (P_1)	67.96	15.84	52.05	74.04	23.99
60 (P_2)	68.02	17.83	50.19	73.83	26.10
90 (P_3)	64.48	18.69	45.80	74.14	28.97
S.Em ±	0.579	0.285	0.577	0.179	0.54
C.D at 5%	1.67	0.83	0.666	NS	1.57

Discussion

Influence of cultivars

Improved plant type plays an important role in rising yield potential a crop. The new plant types process substantially different growth pattern and also differ in yield potential. Different pea varieties influenced the crop stand at all growth stage. This was mainly due to the fact that once the initial plant stand maintained at 15 DAS remained almost same at each crop growth stage. Plant height was significantly influenced by varieties. However the maximum plant height was attained by 'Rachna' followed by 'KPMR- 522'. Significant differences among varieties were due to their genetic characteristics. Achakzai (2012) [2] have also reported likewise. Number of branches per plant was significantly higher with 'KPMR-522' than 'KPMR – 400' at all the stages of crop growth. The more number of branches under 'KPMR-522' might be attributed to its better growth under prevailing weather conditions.

Dry matter accumulation showed an increasing trend with the age of the crop, Growth is a function of a complex process of plant system interesting with the varying environmental conditions The dry matter accumulation in the plant, by and large, is understood as an index of growth, Dry matter accumulation was slow during initial growth stages due to Poor production of photo synthetic surface and canopy structure. With the advancement in growth, the leaves are capable of synthesizing more photo-synthates and offer roots to proliferate and to absorb more nutrients from the soil hence the dry matter accumulation grained momentum at later stages. Varieties influenced the dry matter accumulation significantly at all the stages but only one stage non-significant (60 DAS) of crop growth (Table 4). Variety 'Rachna' was capable to utilize more input and accumulate large dry matter as compared to other varieties. This differential behavior might be due to its responsiveness to inputs like fertilizer and irrigation and edaphic factors which led to non- significantly higher dry matter accumulation. These results are in constituents with the findings of Nandpuri and Dhillon (1984) [15].

Variety significantly affect the primary root length 'Rachna' higher root length than other varieties. The differences in length of root may be attributed to genetic characteristics of the varieties which caused significant differences. Number of nodules per plant was significantly influenced by varieties (Table 4). However, the maximum number of nodules per plant was produced by 'Rachna' followed by 'KPMR-400' and 'KPMR- 522'. This may be attributed to the varieties which may be attributed to the varieties which differed in growth characteristics.

Yield attributes are the function of vegetative development yield attribute viz; dry weight per plant (g), number of pods per plant, weight of pods per plant(g), pod length (cm), number of seeds per pod, weight of seed per pod (g) and test weight (g) were influenced significantly and non-significant with different varieties. The highest values of these characters were recorded with the 'Rachna' (V_2) similar results have also have been observed by Gupta *et al.* (1982) [10].

The biological grain and Stover yield increased significantly with 'KPMR-522' (V_3) and highest harvest index are 'KPMR-400 (V_2). Yield is function of complex inter relationship of its components which are determined from the growth rhythm in vegetative phase and from its subsequent reflection in reproductive phase. Better vegetative growth associated with higher yield attributes *viz*. dry weight per plant, number of seeds per pod and test weight resulted in higher seed, Stover and biological yields. Variety 'KPMR-522' (V_3) showed the highest shelling percentage and 'KPMR-400 (V_1) highest harvest index.

Influence of phosphorus levels

Crop stand was significantly affected by phosphorus levels at all growth stage because properly applied phosphatic fertilizer influenced the germination of seed which resulted in a uniform plant stand. Remained affected at later stage due to the uniform growth of the plants. Phosphorus application affect the plant height significantly at (30 DAS & 60 DAS) and non-significant at (90, 120 DAS & at harvest) crop stage (Table 4). Differential response of phosphorus to be attributed to its uptake efficiency and its utilization, *et al* which in turn is greatly influenced by environmental factor (Abbos *et al.*, 1994) [1]. Increasing levels of phosphorus from 0, 30 and 90 kg P_2O_5 ha^{-1} resulted in significant increase in branches per plant at all the stage (Table 4) However, phosphorus level P_2 (60 kg P_2O_5 ha^{-1}) was found to have maximum number of branches. Phosphorus is important in root development and translocation of photosynthates and, being the constituent of nucleic acid, phyton and phospholipids, its application increase different growth parameters. The findings are in accordance with Shaukat *et al.* (2014) [19]. Phosphorus application significantly increased and Non-significant (120 DAS) the dry matter up to 90 kg P_2O_5 ha^{-1} at 30, 60 and 120 DAS 90 kg P_2O_5 ha^{-1} at harvest time increase in dry matter accumulation to be attributed to increased branches per plant with increased phosphorus levels. The results are in close accordance with Krishna and Ahlawat (2000) [11]. Phosphorus application up to 60 kg P_2O_5 ha^{-1} significantly increased the length of root. This was mainly attributed to the favorable effect of phosphorus on root growth as phosphorus is essential for extensive root development phosphorus promotes root growth and cell formation (Diener, 1950) [6]. A dignified effect of phosphorus application was found on number of nodules. A does of 60 kg P_2O_5 ha^{-1} showed faster rate in increased the nodules $plant^{-1}$ and then slow rate was observed but maximum number of nodules $plant^{-1}$ was recorded with 90 kg P_2O_5 ha^{-1}. This might be due to the phosphorus application which increased the root growth. The roots are the seat of nodules therefore, better development of root with phosphorus also increase the number of nodules per plant. The results are in agreement with these of Shaukat *et al.* (2014) [19] and Erman *et al.* (2009) [7] also indicated improvement in nodulation due to P application.

The yield components viz. dry weight per plant (g), number of pods per plant, weight of pod per plant (g), pod length (cm), number of seeds per pod, Weight of seed per pod (g) and test weight (g) increased non-significantly 30 kg P_2O_5 ha^{-1} dry weight $plant^{-1}$ 60 kg P_2O_5 ha^{-1} weight of pod $plant^{-1}$, number of seed pod^{-1}, weight of seed pod^{-1} and significantly 90 kg P_2O_5 ha^{-1} number of pod $plant^{-1}$ & pod length (cm) and test weight. The improvement in plant growth by phosphorus application due to higher photosynthetic activity and translocation of photosynthates to sink, which consequently resulted in better development of yield attributes. These finding one in agreement with those Sharma *et al.* (1992). Biological yield improved up to 60 kg P_2O_5 ha^{-1}. Grain yield improved up to 90 kg P_2O_5 ha^{-1}. Stover yield improved up to 30 kg P_2O_5 ha^{-1}. The enhancement in seed, Stover and biological yield was due to augmenting effect of phosphorus application on all growth and yield attributes, This increase was further attributed better translocation of photosynthates from source to sink due to higher uptake of phosphorus which are responsible for quick and easy translocation of photosynthates. The favorable response of grain yield to P fertilization might be attributed to the potent role of this element in mobilization of nutrients and protein synthesis (Prihar and Tripathi, 1989) [16]. The findings are in accordance with Salehi and Aminpanah (2015).

Increasing doses of phosphorus in 90 kg P_2O_5 ha^{-1} increased shelling percentage and harvest index increased up to 90 kg P_2O_5 ha^{-1}, This may be attributed to increased number of seeds per pod. This might be due to the vigorous growth of plant with higher P level which increased grain as well as straw yield, significant improvement in seed index due to P application was also reported by Srivastava and Ahalawat (1993) [3].

Conclusion

Though the result are based on single season data, however taking into consideration the promising result of this experiment following main inferences are drawn. Among the three varieties tested, KPMR-400 (V_1) and KPMR-522 (V_3) gave better result in respect of grain yield. And Rachna (V_2) gave better results in respect of Stover yield. Maximum potential of field pea yield of the best quality crop must be fertilized with 90 kg P_2O_5 ha^{-1}.

References

1. Abbas M, Singh MP, Nigam KB, Kandalkar VS. Effect of phosphorus, plant densities and plant types on different growth and physiological parameters of soybean (*Glycine max*). Indian J Agron. 1994; 39(2):246-248.
2. Achakzai AKK. Effect of various levels of nitrogen fertilizer on some vegetative growth attributes of pea (*Pisum sativum* L.) cultivars. PaK. J Bot. 2012; 44(2):655-659.
3. Ali, Hawthorne. *Pisum sativum* L. (Field Pea) glenroy. Australian Journal of Experimental Agriculture. 1993; 33(5):672-673.
4. Begum AA, Leibovitch S, Migner P, zhang F. Inoculation of pea (*Pisum sativum* L.) by Rhizobium leguminosarum bv. Viceaepreincubated with naringenin and hesperetin or application of naringenin and hersperetin directly into soil increased pea nodulation undershort season conditions. Plant and soil. 2001; 237:71-80.
5. Date RA. Inculated legumes in cropping system of the tropics. Field crops Research. 2000; 65:123-136.
6. Diener T. Nutrition of legumes. Butterworths Scientific publication, London, 148. Effect of phosphorus, plant densities and plant types on different growth and physiological parameters of soybean (*Glycine max*). Indian J Agron. 1950; 39(2):246-248.
7. Erman M, Yieldirim B, Togay N, Cig F. () Effect of phosphorus application and Rhizobium inoculation on the yield, nodulation and nutrient uptake in field pea (*Pisum sativum* sp. Arvense L.). Jouarnal of Animal and veterinary Advances. 2009; 8(2):301-304.
8. Evans J, 'O' connor GE, Turner GL, Coventry DR, Fettell N, Mahoney J *et al*. N_2 Fixation and its value its value to soil N increase in lupin, field pea and other legumes in south-eastern Australia. Australian Journal of Agricultural Research. 1989; 40:791-805.
9. Food and Agricultural organization (2012) FAOSTAT Statistics database (online). Available at http://faostat.fao.org.
10. Gupta KR, Dahiya BS, Singh VP, Lal S. HFP-4, a high yielding promising strain of of field pea. Pulse crops News letter. 1982; 2:38-39.
11. Krishna KS, Ahlawat IPS. Effect of moisture stress and phosphorus. Sulphur and Zinc fertilizers on growth and development of pea (Pisum Sativum), 2000.
12. Lemerle D, Verbeek B, Diffey S. Influences of field pea (*Pisum sativum*) density on grain yield and competitiveness with annual rye grass (Laliumrigidum) in south – eastern Australia. Australian Journal of Experimental Agriculture. 2006; 46:1465-1472.
13. Li SX, Wang ZH, stewart BA. Differences of some Leguminous and Non-leguminous crops in utilization of soil Phosphorus and responses to phosphate fertilizers. Advances in Agronomy. 2011; 110:126-249.
14. Martin-Sanz A, Luis Palomo J, Perez de la Vega M, caminero C. Identification of path ovarsand races of pseudomonas syringae, the main causal agent of bacterial disease in pea in North- Central spain, and the search for disease resistance. European journal of plant pathology. 2011; 129:57-69.
15. Nandpuri KS, Dhillon GS. Punjab-87 two new mid-season pea varieties, prog. 1984; 15:15-16.
16. Prihar SS, Tripathi RS. Dry matter nodulation and nutrient uptake in chick pea (*Cicer arietinum* L.) as influenced by irrigation and phosphorus. Expt. Agric. 1989; 25:349-355.
17. Raghothama KG, Karthikeyan AS. Phosphate acquition. Plant and soil, 2005; 274-:37-49.
18. Sharma DK, Yadav A, Sharma R, Yadav A, Sharma R. Effect of dates of sowing and phosphorus fertilization on growth, pod yield and disease in pea (*Pisum Sativum* L.) Annals of Agricultural Research. 1997; 18(4): 564-566.

19. Shaukat SA, Atif MJ, Ali SSZ, Chaudhry YA, Shaukat SK. Effect of Different levels of phosphorus on growth and productivity of pea (*Pisum Sativum* L.) cultivars Grown as off – Season under Rawalakat Azad Janmu and Kashmir condition. J Recent. Adv. Agr. 2014; 2(6):252-257.
20. Thies JE, Singleton PW, Benbohlool B. Influence of the size of indigenous rhizobial populations on establishment and symbiotic performance of introduced rhizaobia on field grown legumes. Applied and Environmental Microbiology. 1991; 57:19-28.