



## Effect of phosphorus fertilisation on growth, yield and quality of pea (*Pisum sativum*)

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### ABSTRACT

In the present study, experiments were undertaken during 2016-2017 to examine the effect of phosphorus application on pea (*Pisum sativum* L.) cv. Arkel and Azad P-1. Four levels of phosphorus (0, 60, 90, 120 kg/ha) keeping the N at K dose constant at 25 and 50 kg ha<sup>-1</sup> respectively with 3 replications were used in two way factorial analysis. The effects of different doses of phosphorus were judged on growth, yield and quality attributes. Evaluation of comparative performance of pea varieties Arkel and Azad P-1 in the climatic condition of Western plain zones of Uttar Pradesh suggested better performance of Azad P-1 over Arkel. However, on studying the interaction between NPK levels and Variety, Azad P-1 with P @ 120 kg ha<sup>-1</sup> registered maximum pod yield (9.24 kg/plant) than Arkel (8.55 kg/plant). Results revealed that the performance of pea variety Azad P-1 was better than the variety Arkel. The higher number of pods per plant (17.94), weight of pods per plant (124.86 g), number of grains per pod (7.72) and pod yield per plot (7.79 kg) was recorded in the variety Arkel than Azad P-1. The study also revealed that ascorbic acid as well as total sugar content in harvested pods showed a declining trend with higher level of phosphorus irrespective of variety. Thus, pea variety Azad P-1 was found to be performing better with phosphorus application of 120 kg/ha in terms of growth, yield and quality attributes. This variety can hence be recommended for integration in horticulture based farming systems of Western Uttar Pradesh.

**Key words:** Arkel, Azad P-1, Phosphorus, Pea, Quality and Yield

Vegetable pea (*Pisum sativum* L.) is the most important vegetable belonging to family *Leguminosae*. Besides being rich in proteins, it is a good supplier of several minerals and vitamins. It is grown mainly for green pods and can be consumed raw as well as in cooked form. Peas are also canned, frozen or dehydrated. The environmental factors like temperature, humidity, light intensity and rainfall regulate number of morphological and physiological responses of the plant are considered to be important in determining the yield of pea. Besides, the adequate supply of macro and micro nutrients is also essential for getting optimum plant growth and yield. Phosphorus is one of the most important nutrient required by pea for proper growth and development. Phosphorus is a constituent of adenosine diphosphate (ADP), sugar phosphate, nucleic acid, proteins and several co-enzymes which are of great importance in energy transformation and metabolic process of plants.

Phosphorus deficiency is usually the most important

factor for poor nodulation and low yield of leguminous crops. An adequate supply of phosphorus has been reported beneficial for better growth, yield, quality and enormous nodule formation in legume. The production of pea on more than 30% of the world arable land is limited by P availability (Tsfaye *et al.* 2007). Phosphorus may be a critical constraint for legumes under low nutrient environment because there is a substantial need of phosphorus in the nitrogen fixation process (Tsvetkova and Georgiev 2007).

Phosphorus has an enhancing impact on plant growth and biological yield through its importance as energy storage and transfers energy necessary for metabolic processes-. Sharma and Chandra (2004) reported that one of the advantages of feeding the plants with phosphorus is to create deeper and more abundant roots. Phosphorus causes early ripening in plants, decreases grain moisture and improves crop quality. It is the most sensitive nutrient to soil pH. It also raises the efficiency of plants for photosynthesis, enhances the activity of rhizobia and increases the number of branches and pod per plants, consequently producing a higher total yield of pea. Nitrogen fixation is accelerated when optimum quantity of phosphorus is available in the soil. Phosphorus is source of metabolic energy and helps in the formation of nodules, root development, better nitrogen

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and carbon fixation.

Cultivation of pea is highly profitable and attractive to the farmers for its short durability and high price. It takes about 55 to 75 days from sowing for its green pod harvest and 75 to 100 days for matured seed harvest. Garden pea fits well in the existing cropping systems as a nitrogen fixing crop with a high assimilating capacity of the roots. It utilizes the chemical compounds, which are low in solubility and rarely accessible to cereals from the cultivated soil or deeper layers. As a preceding crop, the garden pea facilitates increase in efficiency of utilization of organic matter by subsequent crops especially grain and cash crops. Garden pea in crop rotation helps in improvement of soil fertility and yield of the succeeding crops. To understand the role of phosphorus in table pea, in terms of growth, yield and quality attributes along with its optimal dose, present study entitled, "Effect of phosphorus fertilization on growth, yield and quality of table pea (*Pisum sativum* L.) has been conducted at ICAR-IIFSR, Modipuram, Meerut, India during 2016-17.

#### MATERIALS AND METHODS

The present investigations were undertaken on pea varieties Arkel (V1) and Azad P-1 (V2) with four levels of phosphorus and three replications using two-way factorial analysis at Siwaya farm of ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut during 2016-17. The experiment on the effect of phosphorus application on pea comprised of Control ( $T_0$ ),  $T_1$  (N:P:K-25:60:50 kg ha<sup>-1</sup>),  $T_2$  (N:P:K-25:90:50 kg ha<sup>-1</sup>) and  $T_3$  (N:P:K-25:120:50 kg ha<sup>-1</sup>). The doses of N and K were kept constant @25 kg ha<sup>-1</sup> and 50 kg ha<sup>-1</sup> respectively. The half dose of nitrogen, full dose of phosphorus and potash were applied in experimental plots and thoroughly mixed in soil at the time of bed preparation whereas, the remaining half dose of nitrogen was applied one month after sowing. The soil of the experimental plot was sandy loam with pH 7.57, organic carbon 0.52%, Available N content 97.01 kg/ha, available P content 13.80 kg/ha and Available K<sub>2</sub>O 154.61 kg/ha. The seeds were sown in a bed of 10 m<sup>2</sup> (5 × 2m) at a depth of 2.0 cm. The seeds were covered with pulverized soil just after sowing and gently pressed with hands. The sowing was done on 12 Dec, 2016 in rows and at a spacing of 30 (row to row) × 10 cm (plant to plant). All the crop management practices were adopted during cropping season. Observations on growth, yield and quality of table pea varieties Arkel and Azad P-1 were recorded as per the standard procedures.

The parameters studied for judging the growth included Days to germination, plant height (20 days), plant height (40 days), plant height (60 days), plant stand (15 days), plant stand (30 days), plant stand (60 days) and plant stand (90 days). The yield attributes studied were number of branches/plant, days to 50% flowering, number of pods/plant, length of pod (cm), weight of pods/plant (g), number of grains/pod and pod yield/plot (kg) and total sugars and ascorbic acid contents were estimated for judging the quality of pea pods (Ranganna 1986). The obtained results were subjected to statistical analysis using method of analysis of variance

(ANOVA) using SPSS software (ver. 16.0). Means of different treatments and their interactions were compared using Duncan multiple range test (DMRT) at 5% probability level (Steel & Torrie 1980). Mention the parameters used for data recordings to decide performance of the plants.

#### RESULTS AND DISCUSSION

Different growth characteristics and yield attributes of Arkel and Azad P-1 were compared and results presented in Table 1 clearly depicts that the application of higher levels of phosphorus had a significant effect on the germination of seeds. Treatment  $T_3$  (N:P:K-25:120:50 kg ha<sup>-1</sup>) promoted early germination for both the varieties. Among both the varieties Azad P-1 germinated slightly earlier than Arkel but when the interaction between variety and treatments were recorded, there was no significant interaction effect of variety and phosphorus level on days to germination (Table 1). Significantly higher values of plant height were recorded in Azad P-1 as compared to Arkel as observed in the present study. Azad P-1 registered a growth in plant height by 10.77 cm at 20 DAS and 34.53 cm at 60 DAS. Combined effect of different NPK levels and variety on plant height at 20 and 60 DAS presented in Table 1 shows the interaction between NPK level and variety to be significant for achieving higher plant height where Azad P-1 with the application of  $T_3@25:120:50$  recorded the maximum plant height (14.45 cm) at 20 DAS and  $T_2@25:90:50$  recorded maximum plant height of 34.36 cm at 60 DAS. This might be due to the higher availability of nutrients which promoted more vegetative growth in the plants receiving higher doses of P. Similar findings have been recorded by Kumar *et al.* (2000) in chickpea who have reported that with the use of different levels of phosphorus (0, 20, 40 and 60 kg P<sub>2</sub>O<sub>5</sub>/ha in chickpea, the application of 40 kg P<sub>2</sub>O<sub>5</sub>/ha significantly increased the plant height, number of branches per plant, number of leaves per plant and leaf area index per plant over preceding levels of phosphorus. Muhammad *et al.* (2011) reported higher values of growth parameters, i.e. main stem length, leaf area, length of pod with 120 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> in pea and Sharma *et al.* (2017) found that NPK

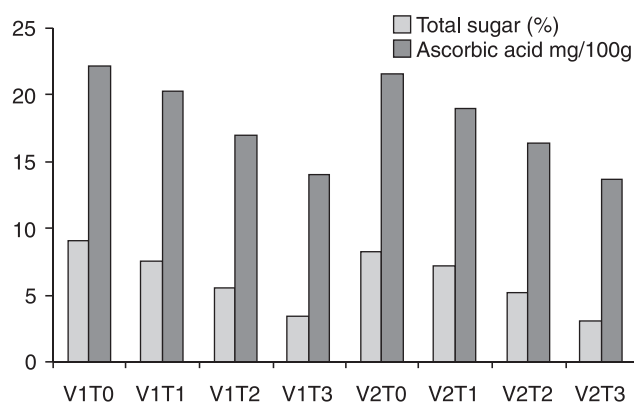


Fig 1 Interaction of NPK levels and variety on quality attributes of table pea.

Table 1 Interaction of NPK levels and variety on growth attributes of table pea

| Treatment                  | Days to germination | Plant height 20 days | Plant height 40 days | Plant height 60 days | Plant stand 15 days | Plant stand 30 days | Plant stand 60 days | Plant stand 90 days |
|----------------------------|---------------------|----------------------|----------------------|----------------------|---------------------|---------------------|---------------------|---------------------|
| <i>NPK level</i>           |                     |                      |                      |                      |                     |                     |                     |                     |
| T <sub>0</sub> (control)   | 9.39 <sup>c</sup>   | 8.04 <sup>a</sup>    | 22.31                | 31.27 <sup>a</sup>   | 73.81 <sup>a</sup>  | 76.93 <sup>a</sup>  | 77.38 <sup>a</sup>  | 71.09 <sup>a</sup>  |
| T <sub>1</sub>             | 8.49 <sup>b</sup>   | 8.40 <sup>a</sup>    | 22.65                | 32.39 <sup>b</sup>   | 77.85 <sup>b</sup>  | 79.80 <sup>b</sup>  | 81.23 <sup>b</sup>  | 75.03 <sup>b</sup>  |
| T <sub>2</sub>             | 8.16 <sup>b</sup>   | 9.21 <sup>b</sup>    | 23.08                | 34.38 <sup>c</sup>   | 82.86 <sup>c</sup>  | 84.24 <sup>c</sup>  | 85.31 <sup>c</sup>  | 77.63 <sup>b</sup>  |
| T <sub>3</sub>             | 7.44 <sup>c</sup>   | 11.38 <sup>c</sup>   | 23.78                | 36.92 <sup>d</sup>   | 89.07 <sup>d</sup>  | 90.53 <sup>d</sup>  | 91.34 <sup>c</sup>  | 81.33 <sup>c</sup>  |
| SEM±                       | 0.18                | 0.24                 | 0.19                 | 0.18                 | 0.53                | 0.46                | 0.44                | 0.94                |
| <i>Variety</i>             |                     |                      |                      |                      |                     |                     |                     |                     |
| V1 (Arkel)                 | 8.41                | 7.74 <sup>a</sup>    | 22.88 <sup>a</sup>   | 32.96 <sup>a</sup>   | 79.75 <sup>a</sup>  | 82.13 <sup>a</sup>  | 83.47               | 72.70 <sup>a</sup>  |
| V2 (Azad P-1)              | 8.32                | 10.77 <sup>b</sup>   | 23.03 <sup>b</sup>   | 34.53 <sup>b</sup>   | 82.04 <sup>b</sup>  | 83.62 <sup>b</sup>  | 84.16               | 79.84 <sup>b</sup>  |
|                            | 0.12                | 0.17                 | 0.14                 | 0.13                 | 0.38                | 0.32                | 0.31                | 0.67                |
| <i>NPK level × Variety</i> |                     |                      |                      |                      |                     |                     |                     |                     |
| V1T0                       | 9.44                | 7.42 <sup>a</sup>    | 22.00                | 29.91 <sup>a</sup>   | 70.51 <sup>a</sup>  | 74.70 <sup>a</sup>  | 75.25 <sup>a</sup>  | 66.84               |
| V1T1                       | 8.22                | 7.54 <sup>a</sup>    | 22.55                | 31.77 <sup>b</sup>   | 75.33 <sup>b</sup>  | 78.07 <sup>b</sup>  | 80.14 <sup>b</sup>  | 70.14               |
| V1T2                       | 8.33                | 7.72 <sup>ab</sup>   | 23.13                | 34.16 <sup>d</sup>   | 81.66 <sup>c</sup>  | 83.11 <sup>c</sup>  | 84.62 <sup>d</sup>  | 73.85               |
| V1T3                       | 7.66                | 8.31 <sup>abc</sup>  | 23.85                | 36.01 <sup>e</sup>   | 91.10 <sup>f</sup>  | 92.66 <sup>f</sup>  | 93.88 <sup>f</sup>  | 79.96               |
| V2T0                       | 9.33                | 8.67 <sup>bc</sup>   | 22.61                | 32.64 <sup>c</sup>   | 77.10 <sup>b</sup>  | 79.17 <sup>b</sup>  | 79.51 <sup>b</sup>  | 75.33               |
| V2T1                       | 8.77                | 9.26 <sup>c</sup>    | 22.76                | 33.01 <sup>c</sup>   | 79.96 <sup>c</sup>  | 81.55 <sup>c</sup>  | 82.33 <sup>c</sup>  | 79.92               |
| V2T2                       | 7.99                | 10.71 <sup>d</sup>   | 23.05                | 34.63 <sup>d</sup>   | 84.07 <sup>d</sup>  | 85.36 <sup>d</sup>  | 85.99 <sup>d</sup>  | 81.40               |
| V2T3                       | 7.21                | 14.45 <sup>e</sup>   | 23.70                | 37.83 <sup>f</sup>   | 87.05 <sup>e</sup>  | 88.40 <sup>e</sup>  | 88.80 <sup>e</sup>  | 82.70               |
|                            | 0.25                | 0.34                 | 0.27                 | 0.26                 | 0.75                | 0.65                | 0.62                | 1.32                |
| <i>ANOVA, P &gt; F</i>     |                     |                      |                      |                      |                     |                     |                     |                     |
| <i>Main effect</i>         |                     |                      |                      |                      |                     |                     |                     |                     |
| NPK Level                  | **                  | **                   | NS                   | **                   | **                  | **                  | **                  | **                  |
| Variety                    | NS                  | **                   | **                   | **                   | *                   | *                   | NS                  | **                  |
| NPK level × variety        | NS                  | **                   | NS                   | *                    | **                  | **                  | **                  | NS                  |

Mean values (\* P<0.05, \*\* P<0.01, NS = Non-Significant). Data expressed as Mean of Triplicate measurements (n = 3); T<sub>0</sub> = (Control), T<sub>1</sub> = 25:60:50, T<sub>2</sub> = 25:90:50, T<sub>3</sub> = 25:120:5.

application of 120:60:80 kg/ha was found to be performing better for yield contributing characters of cauliflower var. Pusa Snowball K-1 with maximum plant weight (1.50 kg/plant), net curd weight (659 g/plant), curd diameter (13.33 cm), curd height (10.12 cm), stalk length (3.25 cm) and curd yield per plot (14.29 kg/plot).

The results revealed the significant effect of NPK level on percent plant stand of pea varieties under study. The maximum percent plant stand of 89.07% at 15 DAS, 90.53% at 30 DAS and 91.34% at 60 DAS, 81.33% at 90 DAS has been recorded for T<sub>3</sub>. The variety Azad P-1 had higher increase in plant stand% (82.04% at 15 DAS, 83.62% at 30 DAS and 79.84% at 90 DAS respectively) followed by Arkel (87.05% at 15 DAS, 88.40% at 30 DAS and 88.60% at 60 DAS) which was found to be significant. The results revealed the significant effect of NPK level on number of branches per plant and days to 50% flowering as presented in Table 1. The highest number of branches per plant (4.62), the minimum days to 50% flowering (49.05) has been recorded for treatment T<sub>3</sub> whereas, the

lowest numbers of branches per plant and highest days to 50% flowering were recorded under control (T<sub>0</sub>). There was significant difference Arkel and Azad P-1 variety on number of branches and days to 50% flowering. Azad P-1 recorded higher values for number of branches per plant (3.42), minimum days to 50% flowering (50.11) as compared to Arkel. Significant interaction effect of variety and NPK level was observed in number of branches per plant where higher number of branches per plant (4.67) was recorded for treatment T<sub>3</sub> as compared to Arkel. This could be attributed to enhanced plant growth coupled with adequate recorded food material which fascinated the adequate vegetative growth and subsequent higher yield. The maximum number of branches per plant under high dose of fertilizers might be due to the its application in large quality that affected the plant height and production of number of branches. The results are in line with the findings of Singh and Singh (2003) in pea, Aga *et al.* (2004), Sharma *et al.* (2017) who have also recorded higher number of leaves with higher doses of nutrients in different crops.

Table 2 Interaction of NPK levels and variety on growth and yield attributes of pea varieties under study

| Treatment                  | No. of branches/plant | Days to 50% flowering | No. of pods/plant  | Length of pod (cm) | Weight of pods/plant (g) | No. of grains/pod | Pod yield/ plot (kg) |
|----------------------------|-----------------------|-----------------------|--------------------|--------------------|--------------------------|-------------------|----------------------|
| <i>NPK level</i>           |                       |                       |                    |                    |                          |                   |                      |
| T <sub>0</sub> (control)   | 2.74 <sup>a</sup>     | 52.83 <sup>b</sup>    | 14.77 <sup>a</sup> | 7.01 <sup>a</sup>  | 104.81 <sup>a</sup>      | 6.22 <sup>a</sup> | 6.41 <sup>a</sup>    |
| T <sub>1</sub>             | 3.00 <sup>b</sup>     | 52.11 <sup>b</sup>    | 15.95 <sup>b</sup> | 7.47 <sup>b</sup>  | 108.10 <sup>b</sup>      | 6.70 <sup>b</sup> | 6.78 <sup>a</sup>    |
| T <sub>2</sub>             | 3.58 <sup>c</sup>     | 49.28 <sup>a</sup>    | 17.30 <sup>c</sup> | 7.99 <sup>c</sup>  | 115.50 <sup>c</sup>      | 7.77 <sup>c</sup> | 7.91 <sup>b</sup>    |
| T <sub>3</sub>             | 4.62 <sup>d</sup>     | 49.05 <sup>a</sup>    | 19.89 <sup>d</sup> | 9.04 <sup>d</sup>  | 124.86 <sup>d</sup>      | 9.50 <sup>d</sup> | 8.90 <sup>c</sup>    |
| SEM±                       | 0.04                  | 0.62                  | 0.19               | 0.06               | 0.47                     | 0.11              | 0.13                 |
| <i>Variety</i>             |                       |                       |                    |                    |                          |                   |                      |
| V1 (Arkel)                 | 3.55 <sup>b</sup>     | 51.52 <sup>b</sup>    | 17.94 <sup>b</sup> | 7.82               | 108.84 <sup>a</sup>      | 7.38 <sup>a</sup> | 7.21 <sup>a</sup>    |
| V2 (Azad P-1)              | 3.42 <sup>a</sup>     | 50.11 <sup>a</sup>    | 16.01 <sup>a</sup> | 7.93               | 117.81 <sup>b</sup>      | 7.72 <sup>b</sup> | 7.79 <sup>b</sup>    |
|                            | 0.03                  | 0.44                  | 0.13               | 0.04               | 0.33                     | 0.08              | 0.09                 |
| <i>NPK level × Variety</i> |                       |                       |                    |                    |                          |                   |                      |
| V1T0                       | 2.76 <sup>a</sup>     | 53.44                 | 15.48              | 7.08               | 0.98.60 <sup>a</sup>     | 5.93              | 6.30                 |
| V1T1                       | 3.17 <sup>b</sup>     | 52.99                 | 17.21              | 7.32               | 1.04 <sup>b</sup>        | 6.53              | 6.42                 |
| V1T2                       | 3.70 <sup>d</sup>     | 49.55                 | 18.18              | 7.91               | 1.12 <sup>c</sup>        | 7.83              | 7.57                 |
| V1T3                       | 4.57 <sup>c</sup>     | 50.11                 | 20.90              | 8.10               | 1.21 <sup>d</sup>        | 9.20              | 8.55                 |
| V2T0                       | 2.72 <sup>a</sup>     | 52.22                 | 14.06              | 6.94               | 1.11 <sup>c</sup>        | 6.50              | 6.52                 |
| V2T1                       | 2.83 <sup>a</sup>     | 51.22                 | 14.70              | 7.62               | 1.12 <sup>c</sup>        | 6.87              | 7.14                 |
| V2T2                       | 3.46 <sup>c</sup>     | 49.00                 | 16.42              | 8.07               | 1.19 <sup>d</sup>        | 7.70              | 8.25                 |
| V2T3                       | 4.67 <sup>c</sup>     | 47.10                 | 18.88              | 9.08               | 1.29 <sup>e</sup>        | 9.80              | 9.24                 |
|                            | 0.05                  | 0.87                  | 0.26               | 0.08               | 0.67                     | 0.15              | 0.18                 |
| <i>ANOVA, P &gt; F</i>     |                       |                       |                    |                    |                          |                   |                      |
| <i>Main effect</i>         |                       |                       |                    |                    |                          |                   |                      |
| NPK Level                  | **                    | *                     | **                 | **                 | **                       | **                | **                   |
| Variety                    | *                     | *                     | **                 | NS                 | **                       | *                 | **                   |
| NPK level × Variety        | *                     | NS                    | NS                 | NS                 | *                        | NS                | NS                   |

Mean values (\* P<0.05, \*\* P<0.01, NS = Non-Significant). Data expressed as mean of triplicate measurements (n = 3).

Main and interaction effect of variety as well as different levels of NPK on yield performance of table pea was studied and results are presented in Table 2. There was significant effect of NPK level on number of pods per plant, length of pod (cm), weight of pods per plant (g), number of grains per pod and pod yield per plot (kg) in the present study (Table 2). T<sub>3</sub> recorded maximum number of pods per plant (19.89), length of pod (9.04 cm), weight of pods per plant (124.86 g), number of grains per pod (9.50) and pod yield per plot (8.90 kg). Among the two varieties performance of Azad P-1 was better than Arkel but higher number of pods per plant (17.94) was recorded from variety Arkel and weight of pods per plant (124.86 g), number of grains per pod (7.72) and pod yield per plot (7.79 kg). The interaction of NPK and variety was found significant. Maximum weight of pods per plant (1.29 g) was recorded for Azad P-1 with T<sub>3</sub>. The results revealed that with increasing supplementation of P levels yield attributes of both varieties of table pea increased up to P supplementation at 25:120:50. However, further increase in P levels did not contribute to additional increase in yield attributes suggesting the negative impact of high dose of P. This might be due to the fact P fertilisers when applied

in optimum quantity could have promoted the metabolic activities in plant resulting in increased pod weight and pod yield. These results are also in close conformity with the findings of Kumar *et al.* (2000), Gupta *et al.* (2000) in pea and El-Shaikh *et al.* (2010), Muhammad *et al.* (2011) and Puniya (2011).

The result indicated that the treatment receiving high dose of phosphorus along with N and K resulted in higher vegetative growth while optimum doses of phosphorus resulted in reproductive growth in terms of higher pod yield, pod weight, pod length, number of grains and number of pod.

Perusal of data given in Table 3 reveals that the total sugars (Ranganna (1986) and ascorbic acid content (Ranganna 1986) were significantly influenced by NPK levels as well as varietal difference. The total sugar as well as ascorbic acid content showed a decreasing trend with increasing level of phosphorus input irrespective of variety. T<sub>0</sub> (Control) had the highest total sugar (8.68%) and ascorbic acid (21.90 mg/100 g) whereas, the application of P fertilisers resulted in the lowering of total sugar (3.27%) and ascorbic acid (13.85 mg/100 g) However, there was no significant interaction effect was observed in the present

study. The results of present investigation revealed that P and total sugar content were inversely related to each other. The higher doses of P fertilisers resulted in lowering of total sugar and ascorbic acid content. This might be due to the higher doses of P fertilizers which reduced the dry matter content resulting in less total sugar and Ascorbic acid content. These results are in conformity with the findings of Yemane (16) who have also recorded reduction in total sugar content with higher doses of P in pea. Similar results have also been reported by Das *et al.* (2013) in broccoli. Thus pea variety Azad P-1 with phosphorus application of 120 kg ha<sup>-1</sup> was found to be appropriate for western plain zones of Uttar Pradesh in terms of growth, yield and quality attributes and hence suggested its suitability for inclusion as main crop/intercrop in developing horticulture based cropping system and bringing diversification in the existing systems through vegetables.

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