Original Research Article

Influence of Date of Sowing and Different Levels of Phosphorus on Growth and Yield of Garden Pea (*Pisum sativum* L.)

ABSTRACT

The experiment was carried out at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during October 2017 to February 2018 to find out the growth, yield and economic benefit of garden pea as influenced by date of sowing and different levels of phosphorus. The research comprises of two factors: Factor A: Sowing time (three levels) as S_1=15 November, S_2=25 November, S_3=5 December and Factor B: Phosphorus fertilizer (four levels) as P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha. The experiment was set up in randomized complete block design (RCBD) with three replications. Sowing time and phosphorus influenced significantly on most of the parameters. Sowing time, S_2 (25 November) performed best in number of pods per plant (12.10), number of seeds per pod (4.62) and green pod yield (8.48 ton) per hectare and minimum in S_3 (5 December) treatment. Application of phosphorus, P_2 (75 kg P_2O_5) performed best in number of pods per plant (12.70), number of seeds per pod (4.90) and green pod yield (9.23 ton) per hectare and minimum in P_0 (control) treatment. Among the treatment combination S_2P_2 treatment gave the highest green pod yield (10.50 t/ha) and the lowest (4.48 t/ha) was obtained from S_3P_0 treatment. Combination of 25 November sowing with 75 kg P_2O_5 was ~~performed~~ the best for growth, pod formation and seed formation of garden pea. From the economic point of view, the highest Benefit Cost Ratio (BCR) was (2.35) noted from S_2P_2 and the lowest (1.02) from S_3P_0. ~~It is evident that the S_2P_2 gave the best performance for the growth, yield and economic benefit of garden pea.~~ So, it may be concluded that, the combination of 25 November sowing with 75 kg P_2O_5 can be used for commercial garden pea production.

Keywords: *Benefit Cost Ratio (BCR), Fertilizer, Garden pea, Sowing time.*

1. INTRODUCTION

Garden pea (*Pisum sativum*) belongings to the family Fabaceae (formerly Leguminosae) and subfamily Papilionoideae is one of the most important legume vegetables in Bangladesh and mostly grown for green pods and seeds. It is a cool season crop now grown in many parts of the world. The green pods and immature seeds are rich in vitamin and have a balanced amino acid composition. Moreover, some important mineral such as calcium, phosphorus and~~,~~ iron are present in abundant quantities in peas. The crop becomes popular for its high nutritive value and good taste. It contains 15-35% protein, 20-50% starch, 4-10% sugar, 0.6-1.5% fat and 2-4% minerals [1]. The importance of garden pea as a vegetables crop has sharply increases in many countries of the world. In Bangladesh people consumes 23 g vegetables per head per day but the minimum requirement is 200 g per head per day [2]. As

the nation with an acute shortage of vegetables its production should be increased to meet the shortage. At present pea is being cultivated in an area of 14620 ha with a production of 1189 tons [3]. The average yield is only 0.82 ton per hectare which is much lower as compared to other pea growing countries such as USA 3.94 ton/ha and France 2.23 ton/ha [1]. The yield is mainly due to lack of modern cultural practices. The production of a crop depends on many factors such as quality of seed, management practices including sowing time, plant spacing soil fertility management, intercultural operations etc. Sowing time is an important factor for the yield of any crop. Optimum sowing time ensures proper plant growth through efficient utilization of moisture, temperature, light etc. and also increases production. Sowing time determines the nutrient contents in seeds of pea. Ekeberg [4] reported that protein concentration increased with delay in sowing. Ali *et al.* [5] reported that late sowing also increases starch content of green seed of pea. Sowing time also affects the shelf life of garden pea. Early sowing crops which gave early harvest have a longer shelf life and lower weight loss. In Bangladesh garden pea is grown during cool period in the winter season with short durability. Thus sowing time is a very important factor which influences yield quality. Garden pea cultivation requires cool weather with abundant moisture during early growth stage and minimum rain fall at later stage [6]. Sowing of peas beyond or before its optimum period causes reduction in pod yield [7]. Late sowing and high temperature resulted in 38% lower yield than normal [8]. When crop was sown after 4 December yield was adversely affected [9]. Time of sowing determines the flowering time and also has great influence on pod formation seed setting and seed yield [10]. If the temperature is higher than 25°C during the flowering and pod filling stage, seeds yields must be reduced [11].

Fertilizer management is another important factor that contributes the production and yield of any crop. Adequate supply of nutrients increased yield. Since, the land is limited in Bangladesh, it is important to increase per hectare yield of any crop through all possible means. Plants required ~~food~~ nutritional needs to~~for~~ growth and development in the form of doses of N, P, K, S and other~~ nutrients~~. Soil is the main source ~~of~~ to plant nutrients. It supplies almost all of the essential nutrients to crop plants. Fertilizer exerts significant influence on yield, vigorous growth and yield attributes of legumes. Significant yield response to the addition of 36 to 90 kg P_2O_5 /ha were reported [12]. Phosphorus is an essential component of deoxyribonucleic acid (DNA), the set of genetic inheritance in plant and various forms of ribonucleic acid (RNA) are needed for protein synthesis. It is also a component of two compounds involved in the most significant energy transformations in plants, adenosine diphosphate (ADP) and adenosine triphosphate (ATP), that are associated with the uptake of some nutrients and their transport within the plants and as well as the synthesis of different molecules. Phosphorus plays a vital role in cell division in plants, flowering and fruiting, including seed formation, crop maturation, root development, improvement of crop quality and so on. Therefore, it is imperative to study the ~~that an~~ optimum sowing time should be determined for the cultivation of pea and the optimum dose of phosphorus in the form of fertilizer ~~for~~ to the better production of pea.

2. MATERIAL AND METHODS

2.1 Experimental Site

The experiment was conducted at the Horticulture Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during October 2017 to March 2018. Experimental site situated an elevation of 8 meters above the sea level in Agro-ecological zone of "Madhupur Tract" (AEZ-28). The soil was silty loam and medium high land in texture, having pH with a pH 6.7.

2.2 Planting materials

The variety BARI Motorshuti-3 was used as the test crop. The seeds were collected from the Horticulture Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. BARI Motorshuti-3 was the released variety of garden pea, which was recommended by the national seed board.

2.3 Experiment Frame Work

The experiment consisted of two factors. Factor A: Sowing time (three levels) as- S_1=15 November, S_2=25 November, S_3=5 December; and Factor B: Phosphorus fertilizer (four levels) as- P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha. The two factors experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The experiment was divided into three equal blocks where each block was divided into 12 plots. Then 12 treatment combinations were allotted at randomly in each block. Each unit of plot was 1m × 0.6 m in size. All together there were 36 plots in experiment. Distance between replication was 1 m and plot to plot was 0.5 m. The treatments were assigned randomly to each block as per design of the experiment.

2.4 Application of manure and fertilizer

Well decompose cow dung was used as manure applied before final land preparation at the rate of 15 ton per hectare. Required amounts of phosphorus fertilizers were applied as per treatments and all other fertilizers were applied in final plots preparation for each sowing time as basal dose, according to the Fertilizer Recommendation Guide [13]. Half of nitrogen and whole of phosphorus according to treatment and basal dose of potassium, zinc and sulphur were applied during final land preparation in the form of Urea, Triple super phosphate (TSP), Muriate of potash (MP), Zinc Sulphate (ZnSO4) and Gypsum ($CaSO_4$. $2H_2O$), respectively. The fertilizers were mixed thoroughly with the soil and rest nitrogen was applied in two equal splits on 05 December and 25 December, 2017 for first time sowing; for second time sowing it was done at 15 December, 2017 and 05 January, 2018 and for third sowing it was done at 25 December, 2018 and 15 January, 2018.

Table 1. Dose and application of fertilizer for garden pea cultivation

Nutrient	Dose/ha	Dose/plot
Nitrogen (N)	130 kg N/ha	10 g
Phosphorus (P)	0, 50, 75 and 100 kg P_2O_5/ha (as per treatment)	0 g, 6.5g, 9.5 g and 12.5 g (as per treatment)
Potassium (K)	100 kg K_2O/ha	8 g
Sulphur (S)	10 kg S/ha	1 g
Zinc (Zn)	2 kg Zn/ha	250 mg

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2.5 Sowing of seeds

Seeds were sown in each row at a depth of 3.0 cm. The seeds were covered with pulverized soil just after sowing and gently pressed with hands .The sowing was done on 15 November, 25 November and 5 December 2017 in rows and spacing of 25cm ×15cm. The seeds were covered with loose soil. ~~For each time sowing s~~Seeds were treated with vitavex-200 for preventing soil borne disease.

2.6 Harvesting

Harvesting was done according to its maturity. Green pods were harvested at tender stage on 25 January, 2018 for first time sowing;, it was done on 15 February for second time sowing; and for third time sowing it was done on 20 February. After harvest pods were separated from plants. Then plants and pods were weighed.

2.7 Cost analysis of Garden pea Production

The cost of production was analyzed in order to find out the most economic treatment in respect of NPK nutrients as chemical fertilizers and labour requirement for leaf plucking. All input cost, cost of land and running capital were considered for computing cost of production. The cost and return analysis was done in details according to the procedure of [14]. The benefit cost ratio (BCR) was calculated as follows:
BCR = Gross return per hectare (Tk.) ÷ Cost of production per hectare (Tk.)

2.8 Statistical Analysis

The data obtained for different parameters were statistically analyzed by MSTAT-C computer package. The significance of the difference among the treatment combinations means was compared by LSD test at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Plant height

Considerable variation was found among the different sowing time in respect of plant height of garden pea (Table 2). At 30 DAS and 45 DAS, the tallest plant (27.87cm and 39.05cm, respectively) was recorded ~~from~~ in S_2, while the shortest plant (23.57cm and 34.55cm, respectively) ~~from~~ in S_3. At harvest, the tallest plant (46.72cm) was observed in S_2 while the shortest plant (41.37cm) was in S_3. This height was due to the temperature variation. Similar results had been reported by [15].

Plant height of garden pea was influenced significantly by the application of different levels of phosphorus (Table 3). At 30 DAS and 45 DAS, the tallest plant (29.43cm and 40.46cm, respectively) was recorded ~~from~~ in P_2, while the shortest plant (21.60cm and 32.43cm, respectively) in~~from~~ P_0. At harvest, the tallest plant (48.56cm) was observed in P_2 while the shortest plant (39.46cm) was in P_0. Kanauija *et. al.* [16] also found that growth increased significantly with increasing levels of potassium (0, 30, 60 kg/ ha). The plant height was significantly influenced by the combined effect of different sowing time and different levels of phosphorus (Table 4). At 30 DAS, the tallest plant (32.20cm) was obtained from S_2P_2 while the shortest plant (20.40cm) was in S_3P_0. At 45 DAS, the tallest plant (43.20cm) was observed in S_2P_2 while the shortest plant (31.30cm) was in S_3P_0. At harvest, the tallest plant (53.40cm) was obtained from S_2P_2 whereas the shortest plant (38.30cm) was in S_3P_0.

Table 2. Effect of different sowing time on plant height of garden pea

Treatments	Plant height at 30 DAS	Plant height at 45 DAS	Plant height at harvest
S_1	26.85 b	37.70 b	44.80 b
S_2	27.87 a	39.05 a	46.72 a
S_3	23.57 c	34.55 c	41.37 c
CV%	7.68	8.82	11.70
LSD	0.54	0.87	1.37

Mean followed by the same letter do not differ from each other by the XXX test.
Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing

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Table 3. Effect of different levels of phosphorus on plant height of garden pea

Treatments	Plant height at 30 DAS	Plant height at 45 DAS	Plant height at Harvest
P_0	21.60 d	32.43 d	39.46 c
P_1	25.96 c	36.90 c	43.93 b
P_2	29.43 a	40.46 a	48.56 a
P_3	27.40 b	38.60 b	45.23 b
CV%	7.68	8.82	11.70
LSD	0.63	1.02	1.59

Mean followed by the same letter do not differ from each other by the XXX test.
Here, P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

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Table 4. The combined effect of sowing time and different levels of phosphorus on plant height of garden pea

Treatments	Plant height at 30 DAS	Plant height at 45 DAS	Plant height at Harvest
S_1P_0	21.90 i	32.20 jk	39.50 hi
S_1P_1	26.80 ef	37.60 ef	44.80 c-e
S_1P_2	30.30 b	41.40 b	48.80 b
S_1P_3	28.40 cd	39.60 cd	46.10 b-d
S_2P_0	22.50 hi	33.80 ij	40.60 g-i
S_2P_1	27.60 de	38.70 de	45.60 cd
S_2P_2	32.20 a	43.20 a	53.40 a
S_2P_3	29.20 c	40.50 bc	47.30 bc
S_3P_0	20.40 j	31.30 k	38.30 i
S_3P_1	23.50 h	34.40 hi	41.40 f-h
S_3P_2	25.80 f	36.80 fg	43.50 d-f
S_3P_3	24.60 g	35.70 gh	42.30 e-g
CV%	7.68	8.82	11.70
LSD	1.09	1.74	2.75

Mean followed by the same letter do not differ from each other by the XXX test.
Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing and P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

3.2 Days to first flowering

Sowing time had a significant effect on the days to first flowering (Table 5 and Fig.1). Early sowing plants require significantly more time compared to late sown plants for first flowering. Sowing on S_3 (5 December) took shortest time (24.25 days) and in S_2 (25 November) sowing took maximum time (28 days) to first flowering. Shinohara [17] reported that, in all type pea variety flowering individual in low temperature. Different levels of phosphorus showed a significant variation on days to first flowering (Table 6 and Fig. 2). The maximum days required to first flowering (27.02) was observed in P_2, while the minimum (25.30) was observed in P_0. This might be due to the fact that optimum absorption of ~~phosphorus~~ P nutrients might improve physiological activities which resulted endogenous growth resulting maximum days for flowering in plants.

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The ~~Combined~~ combined effect was found significantly influenced due to the different date of sowing and phosphorus application dose on the days to first flowering (Table 7). The maximum (28.5) days required to first flowering was recorded ~~from~~ in S_2P_2, while S_3P_0 showed the minimum (23.5) days required to first flowering. This might due to the fact that optimum sowing time and ~~phosphorus~~ P involved in the reproductive process of plants ~~and influence~~ induced first flowering.

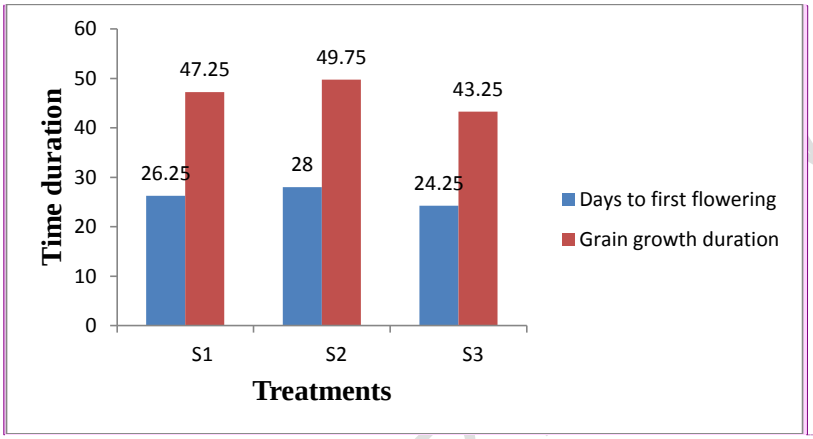

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Fig.1. Effect of different sowing time on days to first flowering and grain growth duration of garden pea.

Here, S_1=15 November sowing, S_2=25 November sowing, S_3=5 December sowing

3.3 Grain growth duration

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Noticeable significant variation was observed among different date of sowing on grain growth duration (Table 5 and Fig.1). The maximum days required to grain growth (49.75) was obtained in~~from~~ S_2 while the minimum (43.25) was in S_3. Similar results were observed by Gardner *et al.* [18], Savin and Nicolas [19] who reported that high temperature reduced the length of reproductive period. Different levels of P~~phosphorus~~ application showed ~~a~~ significant variation on grain growth duration (Table 6 and Fig. 2). The maximum days required to grain growth (47.50) was obtained in~~from~~ P_2 while the minimum (46) was in P_0.

The combined effect of different sowing time and ~~phosphorus~~ P on grain growth duration of garden pea showed significant difference (Table 7). S_2P_2 requires maximum 50.50 days and S_3P_0 requires minimum 42.50 days for grain growth.

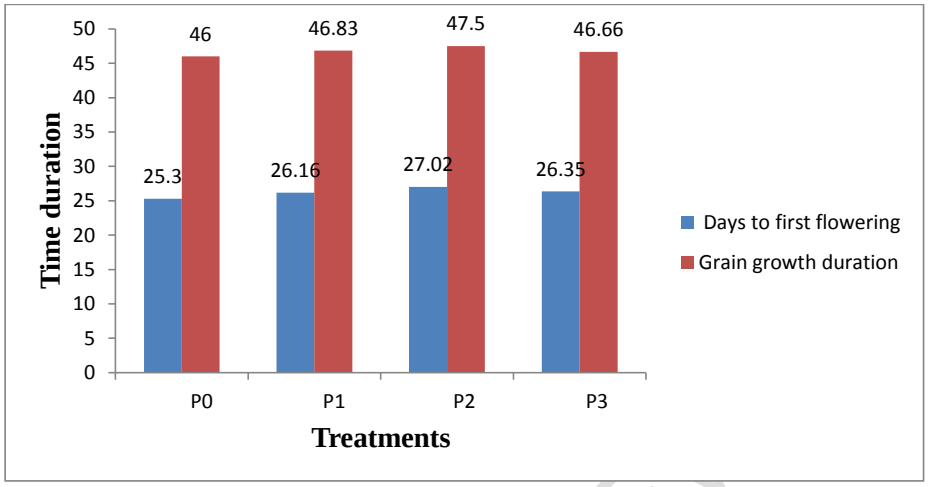

Fig. 2. Effect of different levels of phosphorus on days to first flowering and grain growth duration of garden pea.

Here, P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

Table 5. The effect of different sowing time on yield and yield attributes of garden pea

Treatments	Days to first flowering	Grain growth duration	Number of pods per plant	Pod length (cm)	Pod yield per plant (g)
S_1	26.25 b	47.25 b	11.70 b	7.98 b	42.07 b
S_2	28.00 a	49.75 a	12.10 a	8.30 a	45.52 a
S_3	24.25 c	43.25 c	10.45 c	7.13 c	33.10 c
CV%	9.34	7.75	9.26	10.05	7.46
LSD	0.81	0.62	0.42	0.29	1.55

Mean followed by the same letter do not differ from each other by the XXX test.

Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing

3.4 Number of pods per plant

The number of pods per plant was significantly influenced by different sowing time (Table 5). The highest number of pods per plant (12.10) was recorded ~~from~~ in S_2 and the lowest number of pods per plant (10.45) was found in S_3. Similar findings have been reported by [20].

The number of pods per plant was significantly varied with different levels of ~~phosphorus~~ P (Table 6). The highest number of pods per plant (12.70) was recorded ~~from~~ in P_2 and the lowest number of pods per plant (9.63) was found in P_0. Vijay *et al*. [21] reported that the highest number of pods per plant of garden pea was obtained with higher doses P application.

Combined effect of different sowing time and different levels of ~~phosphorus~~ Ps showed significant effect on number of pods per plant (Table 7). The maximum (13.60) was recorded from S_2P_2 which was statistically similar to S_2P_3, S_1P_2 and S_1P_3~~.~~ ~~while~~ While, S_3P_0 gave the minimum (9.30) number of pods, i~~.~~ It was resemblance with the findings of [22].

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Table 6. Effect of different levels of phosphorus on yield and yield attributes of garden pea

Treatments	Days to first flowering	Grain growth duration	Number of pods/plant	Pod length (cm)	Pod yield per plant (g)
P_0	25.30 c	46.00 c	9.63 c	6.44 c	27.90d
P_1	26.16 b	46.83 b	11.33 b	7.87 b	39.13c
P_2	27.02 a	47.50 a	12.70 a	8.68 a	48.90a
P_3	26.35 b	46.66 bc	12.00 b	8.22 b	45.00b
CV%	9.34	7.75	9.26	10.05	7.46
LSD	0.52	0.48	0.51	0.32	1.79

Mean followed by the same letter do not differ from each other by the XXX test.
Here, P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

3.5 Pod length

The pod length differed significantly observed due to the effect of different date of sowing (Table 5). The highest pod length (8.30 cm) was recorded in S_2 and the lowest pod length (7.13 cm) was found in S_3. These results are in agreement to the findings obtained by [23]. Significant variation was observed among the ~~phosphorus~~ P levels in respect of pod length of garden pea (Table 6). The highest pod length (8.68 cm) was recorded from P_2 and the lowest pod length (6.44 cm) was found in P_0.
The combined effect of sowing time and ~~phosphorus~~ P on the pod length was significant (Table 7). The highest pod length (9.32 cm) was recorded from the treatment combination of S_2P_2 which was statistically similar with S_1P_2 (8.92), S_1P_3 (8.54) and S_2P_3 (8.72) respectively. The lowest pod length (6.16 cm) was found in the S_3P_0.

3.6 Pod yield per plant (g)

Statistically significant variation was recorded in terms of pod yield per plant of garden pea due to different dates sowing (Table 5). The highest pod yield per plant (45.52g) was recorded ~~from~~ in S_2, whereas the lowest pod yield per plant (33.10 g) was observed ~~from~~ in S_3. This study indicated that rise in temperature reduced the grain growth duration resulted in yield reduction, which is in agreement with the findings of [24] and [25].
Different levels of ~~phosphorus~~ P showed ~~statistically~~ significant differences on pod yield per plant of garden pea (Table 6). The highest pod yield per plant (48.90 g) was found ~~from~~ in P_2, while the lowest pod yield per plant (27.90) was found ~~from~~ in P_0. Pod yield of garden pea was gradually increased with increasing level of ~~phosphorus~~ P up to 75 kg P_2O_5 per hectare then decreased. These findings have the resemblance with the result of [26]. Combined effect of different date of sowing and ~~phosphorus~~ P levels varied significantly in terms of pod yield per plant of garden pea (Table 7). The highest pod yield per plant (57.70 g) was recorded ~~from~~ in the treatment combination of S_2P_2. On the other hand, the lowest pod yield per plant (25.40 g) was found ~~from~~ in S_3P_0.

Table 7. The combined effect of owing time and different levels of phosphorus on yield and yield attributes of garden pea

Treatments	Days to first flowering	Grain growth duration	Number of pods/plant	Pod length (cm)	Pod yield per plant (g)
S_1P_0	25.50 e-g	46.50 e	9.60 gh	6.32 gh	27.90 hi

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S_1P_1	26.00 d-f	47.50 de	11.60 c-f	8.16 b-d	40.50 e
S_1P_2	27.00 b-d	48.00 cd	13.20 ab	8.92 ab	52.40 b
S_1P_3	26.50 c-e	47.00 de	12.40 a-d	8.54 a-c	47.50 cd
S_2P_0	27.50 bc	49.00 bc	10.00 gh	6.85 f-h	30.40 gh
S_2P_1	28.00 ab	50.00 ab	12.00 b-e	8.32 bc	44.40 d
S_2P_2	28.50 a	50.50 a	13.60 a	9.32 a	57.70 a
S_2P_3	28.00 ab	49.50 ab	12.80 a-c	8.72 ab	49.60 bc
S_3P_0	23.50 h	42.50 g	9.30 h	6.16 h	25.40 i
S_3P_1	24.50 f-h	43.00 fg	10.40 f-h	7.14 e-g	32.50 g
S_3P_2	25.00 f-h	44.00 f	11.30 d-f	7.80 c-e	36.60 f
S_3P_3	24.00 gh	43.50 fg	10.80 e-g	7.41 d-f	37.90 ef
CV%	9.34	7.75	9.26	10.05	7.46
LSD	1.60	1.21	1.24	0.86	3.10

Mean followed by the same letter do not differ from each other by the XXX test.
Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing and P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

3.7 Weight of 10 green pods (g)

Comment [H9]: Poor in discussion.

Different date of sowing varied significantly in terms of weight of 10 green pods of garden pea (Table 8). The highest weight of 10 green pods (36.12 g) was found ~~from~~ in S_2, while the lowest weight of 10 green pods (30.22 g) was recorded ~~from~~ in S_3. Weight of 10 green pods showed ~~statistically~~ significant differences due to different levels of ~~phosphorus~~ P (Table 9). The highest weight of 10 green pods (37.50 g) was recorded ~~from~~ in P_2, whereas the lowest weight of 10 green pods (27.41) was observed ~~from~~ in P_0.
~~Statistically s~~Significant variation was recorded due to the combined effect of different sowing time and ~~phosphorus~~ P levels in terms of weight of 10 green pods of garden pea (Table 10). The highest weight of 10 green pods (40.40 g) was observed ~~from~~ in S_2P_2, which was ~~statistically~~ similar ~~with~~ to the (39.60 g) S_1P_2 and the lowest weight of 10 green pods (25.50 g) was recorded ~~from~~ in S_3P_0.

3.8 Number of seeds per pod

Comment [H10]: Poor in discussion.

Number of seeds per pod significantly differed due to different time of sowing (Table 8). The maximum number of seeds per pod (4.62) was found ~~from~~ in S_2, which was ~~statistically~~ identical (4.46) with S_1 while the lowest number of seed per pod (3.96) was obtained in S_3.
Different levels of ~~phosphorus~~ P application had also significant effect on the number of seeds per pod (Table 9). The highest number of seeds per pod (4.90) was obtained ~~from~~ in P_2 and the lowest number of seeds per pod (3.60) was obtained ~~from~~ in P_o. Similar results have been reported by previous workers in French bean by [27]. It was also resemblance with the findings of Rahman *et al.* [22] who reported that ~~phosphorus~~ P fertilizer produced the ~~significantly~~ highest number of seeds per pod in chickpea.
The combined effects of different sowing time and application of ~~phosphorus~~ P on seeds per pod was found to be significant (Table 10). The highest number of seeds per pod (5.35) was obtained ~~from~~ in~~the~~ S_2P_2 which was ~~statistically~~ similar (5.00) ~~with~~ to the S_1P_2. The lowest number of seed per pod (3.40) was obtained ~~from~~ in~~the~~ S_3P_0.

Table 8. The effect of different sowing time on yield and yield attributes of garden pea

Treatments	Weight of 10 green pods (g)	Number of seeds/pod	Weight of 100 green seeds (g)	Dry matter percentage of plant (%)

S_1	34.87 b	4.46 a	23.07 a	17.77 b
S_2	36.12 a	4.62 a	23.70 a	18.60 a
S_3	30.22 c	3.96 b	21.15 b	15.80 c
CV%	8.12	9.13	11.54	6.39
LSD	1.13	0.27	0.86	0.77

Mean followed by the same letter do not differ from each other by the XXX test.
Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing

3.9 Weight of 100 green seeds

Comment [H11]: Poor in discussion.

The effects of different sowing time significantly on 100 green seeds weight of garden (Table 8). The highest weight of 100 green seeds (23.70 g) found ~~from~~ inm S_2, which was ~~statistically~~ identical (23.07 g) with S_1 and lowest weight of 100 green seeds (21.15 g) were found in S_3. Similar results were recorded by Gardner and Loomis [28] in orchard grass;,and Lindsey and Peterson [29] in *Poa pratensis* L. There was a significant difference on 100 green seeds weight among the different levels of ~~phosphorus~~ P (Table 9). The highest weight of 100 green seeds were found (24.70 g) in P_2 and lowest weight of 100 green seeds were found (20.06) in the P_0.
The combined effect of different sowing time and application of different levels of ~~phosphorus~~ P on weight 100 green seed was found significant (Table 10). The highest weight of 100 green seeds were found (26.40 g) in S_2P_2, which was ~~statistically~~ similar with S_1P_2 (25.50) and lowest weight of 100 green seed was found (19.30) in S_3P_0.

3.10 Dry matter percentage of plant (%)

Comment [H12]: Poor in discussion.

There was found significant difference among the ~~different~~ date of sowing on dry matter percentage of plant (Table 8). The highest dry matter percentage of plant (18.60) was recorded ~~from~~ in S_2 and the lowest dry matter percentage of plant (15.80) was recorded in S_3. Dry matter percentage of plant was found significant variation due to the application of different levels of ~~phosphorus~~ P (Table 9). The highest dry matter percentage of plant (20.06) was recorded in P_2 and the lowest dry matter percentage of plant (14.13) was recorded in P_0.
The significant difference was found on dry matter percentage of plant due to the combination of different sowing dates with application of different levels of ~~phosphorus~~ P (Table 10). The highest dry matter percentage of plant (21.50) was recorded in S_2P_2, which was ~~statistically~~ similar with S_1P_2 (20.80). The lowest dry matter percentage of plant (13.50) was recorded in S_3P_0 (5 December sowing with no phosphorus) treatment combination.

Table 9. Effect of different levels of phosphorus on yield and yield attributes of garden pea

Treatments	Weight of 10 green pods (g)	Number of seeds/pod	Weight of 100 green seeds (g)	Dry matter percentage of plant (%)
P_0	27.41 d	3.60 c	20.06 c	14.13 d
P_1	34.06 c	4.31 b	22.43 b	17.10 c
P_2	37.50 a	4.90 a	24.70 a	20.06 a
P_3	35.98 b	4.58 b	23.36 b	18.26 b
CV%	8.12	9.13	11.54	6.39
LSD	1.31	0.31	1.03	0.89

Mean followed by the same letter do not differ from each other by the XXX test.

Here, P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

Table 10. The combined effect of sowing time and different levels of phosphorus on yield and yield attributes of garden pea

Treatments	Weight of 10 green pods	Number of seeds/pod	Weight of 100 green seeds (g)	Dry matter percentage of plant (%)
S_1P_0	27.50 hi	3.65 fg	20.10 hi	14.10 gh
S_1P_1	34.70 de	4.45 c-e	22.80 c-f	17.50 de
S_1P_2	39.60 ab	5.00 ab	25.50 ab	20.80 ab
S_1P_3	37.70 bc	4.75 bc	23.90 b-d	18.70 cd
S_2P_0	29.25 gh	3.75 fg	20.80 g-i	14.80 f-h
S_2P_1	36.50 cd	4.55 b-d	23.20 c-e	18.30 cd
S_2P_2	40.40 a	5.35 a	26.40 a	21.50 a
S_2P_3	38.35 bc	4.85 bc	24.40 bc	19.80 bc
S_3P_0	25.50 i	3.40 g	19.30 i	13.50 h
S_3P_1	31.00 fg	3.95 ef	21.30 f-h	15.50 fg
S_3P_2	32.50 ef	4.35 c-e	22.20 e-g	17.90 d
S_3P_3	31.90 f	4.15 d-f	21.80 f-h	16.30 ef
CV%	8.12	9.13	11.54	6.39
LSD	2.17	0.54	1.73	1.54

Mean followed by the same letter do not differ from each other by the XXX test.

Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing and P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

3.11 Green pod yield per plot (g)

Distinct variation was found as to the green pod yield per plot due to different sowing time (Table 11). The highest green pod yield (509.18 g) was obtained when the crop was sown in S_2. The lowest green pod yield (366.12 g) was found when the crop was sown in S_3. The green pod yield per plot was found significantly influenced by different levels of ~~phosphorus~~ P application (Table 12). Green pod yield of garden pea was gradually increased with increasing level of ~~phosphorus~~ P up to 75 kg P_2O_5/ha and then decreased. The highest green pod yield (554.53 g) was recorded in P_2 and the lowest green pod yield (302.18g) was recorded in P_0.

Combined effect of different sowing time and ~~phosphorus~~ P levels found significantly influence~~d~~ in producing green pod yield per plot (Table 13). The highest average green pod yield of (630.24 g) was found in the S_2P_2 and the lowest yield of (269.28 g) was found in the S_3P_0.

Table 11. The effect of different sowing time on yield and yield attributes of garden pea

Treatments	Green pod yield/plot (g)	Green pod yield/hectare (t)	Green seed yield/plot (g)	Green seed yield/hectare (t)
S_1	478.40 b	7.96 b	143.64 b	2.39 b
S_2	509.18 a	8.48 a	157.58 a	2.62 a
S_3	366.12 c	6.09 c	102.36 c	1.70 c
CV%	7.31	9.87	10.35	11.93

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LSD	5.71	0.32	7.71	0.11

Mean followed by the same letter do not differ from each other by the XXX test.

Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing

3.12 Green pod yield per hectare (t)

The green pod yield per hectare was found significantly influenced by different sowing time (Table 11). The highest green pod yield (8.48 t/ha) was obtained when the crop was sown in S_2. The lowest green pod yield (6.09 t/ha) was found when the crop was sown in S_3. These findings are corroborated with those reported by [30].

The green pod yield per hectare was found significantly influenced by different levels of ~~phosphorus~~ P application (Table 12). Green pod yield of garden pea was gradually increased with increasing level of ~~phosphorus~~ P up to 75 kg P_2O_5/ha then decreased. The highest green pod yield (9.23 t/ha) was recorded in P_2 and the lowest green pod yield (5.03 t/ha) was recorded in P_0. Similar results with ~~phosphorus~~ P application have been report by [31]. Combined effect of different date of sowing and ~~phosphorus~~ P application showed significant influence on producing pod yield per hectare (Table 13). The highest average green pod yield of 10.50 t/ha was obtained in S_2P_2, which was statistically identical (10.13 t/ha) to S_1P_2. The lowest yield of 4.48 t/ha was recorded ~~from~~ in ~~the~~ S_3P_0.

3.13 Green seed yield per plot (g)

The green seed yield per plot was found significantly influenced by different sowing time (Table 11). The highest seed yield (157.58 g) was obtained when the crop was sown in S_2 and lowest (102.36 g) was obtained when the crop was sown in S_3. This study indicated that rise in temperature reduced the grain growth duration resulted in yield reduction. The seed yield per plot was significantly influenced by different levels of ~~phosphorus~~ P application (Table 12). The highest seed yield (180.82 g) was obtained in P_2 and the lowest (79.75 g) was found in P_0. The seed yield of garden pea was gradually increased with increasing level of ~~phosphorus~~ P up to 75 kg P_2O_5/ha and then decreased.

The combined effect of different sowing time and ~~phosphorus~~ P application on seed yield per plot of garden pea was significant (Table 13). The highest average green seed yield per plot of (220.33 g) was found in the S_2P_2 and the lowest yield of (69.29 g) was found in the S_3P_0.

Table 12. Effect of different levels of phosphorus on yield and yield attributes of garden pea

Treatments	Green pod yield/plot (g)	Green pod yield/hectare (t)	Green seed yield/plot (g)	Green seed yield/hectare (t)
P_0	302.18 d	5.03 d	79.75 d	1.32 d
P_1	446.96 c	7.45 c	127.67 c	2.11 c
P_2	554.53 a	9.23 a	180.82 a	3.26 a
P_3	500.81 b	8.34 b	149.87 b	2.49 b
CV%	7.31	9.87	10.35	11.93
LSD	8.90	0.37	10.06	0.12

Mean followed by the same letter do not differ from each other by the XXX test.

Here, P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

3.14 Green seed yield per hectare (ton)

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Comment [H15]: Poor in discussion.

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The green seed yield per hectare was significantly influenced by different sowing time (Table 11). The highest seed yield (2.62 t/ha) was obtained was obtained when the crop was sown in S_2 and lowest (1.70 t/ha) was obtained when the crop was sown in S_3. This study indicated that raise in temperature reduced the grain growth duration resulted in yield reduction, which is in agreement with the findings of [32] and [33]. The green seed yield per hectare was significantly influenced by the application different levels of Pphosphorus (Table 12). The highest seed yield (3.26 t/ha) was obtained in P_2 and the lowest (1.32 t/ha) was found in P_0.

The combined effect of sowing time and phosphorus P application on green seed yield of garden pea was found significant (Table 13). The highest average green seed yield of 3.67 t/ha was found in the S_2P_2 and the lowest yield of 1.15 t/ha was found in the S_3P_0.

Table 13. The combined effect of sowing time and different levels of phosphorus on yield and yield attributes of garden pea

Treatments	Green pod yield/plot (g)	Green pod yield/hectare (t)	Green seed yield/plot (g)	Green seed yield/hectare (t)
S_1P_0	300.30 k	5.00 h	80.11 ij	1.33 i
S_1P_1	462.20 f	7.70 d	135.14 ef	2.25 f
S_1P_2	608.25 b	10.13 a	195.84 b	3.26 b
S_1P_3	542.88 d	9.04 b	163.47 d	2.72 d
S_2P_0	336.96 j	5.61 g	89.85 hi	1.49 i
S_2P_1	508.08 e	8.46 c	146.93 e	2.44 e
S_2P_2	630.24 a	10.50 a	220.33 a	3.67 a
S_2P_3	561.44 c	9.35 b	173.24 c	2.88 c
S_3P_0	269.28 l	4.48 h	69.29 j	1.15 j
S_3P_1	372.00 i	6.20 f	100.96 h	1.68 h
S_3P_2	425.10 g	7.08 e	126.31 f	2.10 g
S_3P_3	398.11 h	6.63 f	112.90 g	1.88 h
CV%	7.31	9.87	10.35	11.93
LSD	15.42	0.64	17.42	0.22

Mean followed by the same letter do not differ from each other by the XXX test.

Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing and P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha

3.15 Economic analysis of garden pea production

Comment [H17]: Poor in discussion.

The combination of sowing time and P phosphorus dose has different value in terms of gross return (Table 14). The highest gross return (BDT 315000/ha) was obtained from S_2P_2 and the lowest gross return (BDT 134400/ha) was obtained from S_3P_0.The highest net return (BDT 181248.3/ha) was found from S_2P_2 and the lowest net return (BDT 3145.8/ha) was obtained from S_3P_0. In the combination of sowing time and phosphorus P dose, the highest benefit cost ratio (2.35) was estimated from S_2P_2. The lowest benefit cost ratio (1.02) was obtained from S_3P_0. From economic point of view, it is apparent from the above results that the combination of S_2P_2 treatment was better than rest of the combination in garden pea cultivation.

Table 14. Economic analysis of garden pea (*Pisum sativum*) production as influenced by different sowing time and phosphorus application

Treatments	Green pod yield/ha (t)	Total cost of production (tk)	Gross return/ha (tk)	Net return/ha (tk)	Benefit Cost Ratio (BCR)
S_1P_0	5.0	131254.2	150000	18745.8	1.14
S_1P_1	7.7	133252.2	231000	97747.8	1.70
S_1P_2	10.13	133751.7	303900	170148.3	2.27
S_1P_3	9.04	135250.2	271200	135949.8	2.00
S_2P_0	5.61	131254.2	168300	37045.8	1.28
S_2P_1	8.46	133252.2	253800	120547.8	1.90
S_2P_2	10.5	133751.7	315000	181248.3	2.35
S_2P_3	9.35	135250.2	280500	145249.8	2.07
S_3P_0	4.48	131254.2	134400	3145.8	1.02
S_3P_1	6.2	133252.2	186000	52747.8	1.39
S_3P_2	7.08	133751.7	212400	78648.3	1.58
S_3P_3	6.63	135250.2	198900	63649.8	1.47

Mean followed by the same letter do not differ from each other by the XXX test.

Here, S_1=15 November sowing, S_2=25 November sowing, S_3= 5 December sowing and P_0= Control (No Phosphorus), P_1=50 kg P_2O_5/ha, P_2=75 kg P_2O_5/ha, P_3=100 kg P_2O_5/ha.
Sale of green pod @ 30000 Tk per ton.

4. CONCLUSION

Both crop yield and economic benefit of crop are important for the crop production. According to the results of the present experiment, it may be concluded that efficient production of garden pea is increased by optimum sowing time with optimum ~~phosphorus~~ P application. For obtaining the maximum green pod and seed yield, 25 November is the optimum sowing ~~time~~ moment for garden pea. The best for higher growth, pod and seed yield of garden pea, was the level of 75 kg P_2O_5 per hectare application ~~was found to be optimum~~. Thus, a combination of 25 November sowing with 75 kg P_2O_5 per hectare application (S_2P_2) was the most suitable combination in respect of pod and seed yield of garden pea.

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