International Journal for Asian Contemporary Research (2023), Volume 3, Number 1, Page 1-6

ISSN(e): 2789-4231 & ISSN (p): 2789-4223

International Journal for Asian Contemporary Research

www.ijacr.net

H&N Publications INTERNATIONAL

Research Article

Open Access

Effect of N P K Fertilizers on Growth, Yield and Nutritional Quality of Garden Pea

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Article info

Received: 04 January 2023
Accepted: 10 February 2023
Published: 20 February 2023
Available in online:
27Februaryl 2023

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A b s t r a c t

Garden pea (*Pisum sativum* L) is a year-round popular green edible pod and protein-rich edible seeds in Bangladesh. The study was conducted at the experimental field of Horticulture department, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur, Bangladesh to find out the effect of N P K fertilizer on growth, yield and nutritional quality of garden pea variety BARI Motorshuti-3. Five different levels of nitrogen (0, 30, 40, 50 and 60 kg N/ha), 5 levels of phosphorus (0, 10, 20, 30 and 40 kg P/ha), 4 levels of potassium (0, 15, 25 and 35 kg K/ha) and 3 levels of cow dung (0, 5 and 15 t/ha) were used in this study. Results revealed that growth, yield and nutritional quality of garden pea influenced significantly due to different fertilizer combination treatment. The tallest plant (47.23 cm), maximum number of nodes per plant (13.70), number of primary branches/plant (4.17), LAI (43.60), number of pods/plant (7.90), pod weight/plant at green pod stage (34.08g), pod weight/plant at brown pod stage (21.72 g), highest pod yield per hectare at green pod stage (17.04 tons), pod yield per hectare at brown pod stage (10.87 tons), number of seed/pod (5.53), weight of 100 dry seed (26.12 g), dry seed yield/plant (7.84g) and highest dry seed yield per hectare (3.92 tha^{-1}) as well as the maximum protein percent (26.53 %), phosphorus (178.51 mg/100g), potassium (256.30 mg/100g), total sugar (2.42) and β–carotene (342.50 µg/100g) were found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$). The results suggest that the application of $N_{40}P_{20}K_{25}CD_5$ kg ha^{-1} can support the higher yield of garden pea in shallow red brown terrace soils of Bangladesh.

Keywords: NPK fertilizer, growth, yield, nutritional quality and garden pea.

Introduction

Garden pea (*Pisum sativum* L) is a short-lived nutritious vegetable in Bangladesh and grown throughout the country. It is popular principally for green edible pod and protein rich edible seeds and availability almost around the year. It is rabi season crop and does not compete with cereal crop since occupy small area of land. The garden pea is a high value nutritive crop rich in protein. It is also valuable source of starch, calories, sugar, calcium, phosphorous, iron, sodium, potassium, insoluble fiber, vitamin C and other minerals and vitamins (Muehlbauer and McPhee, 1997). It is an excellent food for human consumption, taken either singly, mixed with other vegetables, noodles or in soup and also used as garnish to add colour to a variety of dishes. 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 layer or deeper layers. The biomass can be used as cattle feeds or can be incorporated into soil for supplementing nitrogen of the succeeding crops and increasing organic matter content of the soil. Peas in crop rotation help in improvement of soil fertility and yield of the succeeding crops (Rana and Sharma, 1993). Considering the importance of pea in the diet of the people and their beneficial effect on soil fertility, there is a need to enhance pea production in Bangladesh. Fertilizer management is one of the important factors that contribute to the production and yield of any crop. The requirement of fertilizer for any crop varies with the cultivars and soil types in agro-ecological zones (Mitra *et al*., 1990). Mineral nutrients are essential for plant growth and development (Marchner, 1995). Ferdous (2001)

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showed that application of N fertilizers exerted remarkable effects on plant growth, nutrient uptake and yield of edible podded pea. The green pod yield increases with the increase N rates up to 40 kg N ha^{-1} (Bhopal and Singh, 1990). Significant yield response was observed to the addition of 16 to 33 kg P ha^{-1} (Sen and Kavitkar, 1958; Singh, 1959). Vorob (2000) also recorded positive effect of joint applications of phosphorous and potassium at all proportions on growth and yield of peas. So research efforts should be strengthened to standardize the optimum fertilizer doses for specific varieties cultivated in specific agro-ecological zones. Considering the above facts, the study was undertaken to assess the effect of NPK on growth, yield and quality of garden pea.

Materials and Methods

The experiment was conducted at the experimental field of Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Salna, Gazipur, Bangladesh. The soil of the experimental plot was silty clay loam in texture having pH 6.3 and the soil type belongs to the shallow red brown terrace soil under Salna series of Madhupur tract in Agro Ecological Zone (AEZ) 28. The experiment was conducted with BARI Motorshuti-3 which is cultivated mainly for green pod purpose. The experiment consisted 5 different levels of nitrogen (0, 30, 40, 50 and 60 kg N/ha), 5 levels of phosphorus (0, 10, 20, 30 and 40 kg P/ha), 4 levels of potassium (0, 15, 25 and 35 kg K/ha) and 3 levels of cow dung (0, 5 and 15 t/ha) which made 15 treatment combinations. The treatment combinations were as follows: T_1- $N_0P_0K_0$, T_2- $N_0P_{20}K_{25}$, T_3- $N_{30}P_{20}K_{25}$,T_4- $N_{40}P_{20}K_{25}$, T_5- $N_{50}P_{20}K_{25}$, T_6- $N_{60}P_{20}K_{25}$, T_7- $N_{40}P_0K_{25}$, T_8- $N_{40}P_{10}K_{25}$, T_9- $N_{40}P_{30}K_{25}$, T_{10}- $N_{40}P_{40}K_{25}$, T_{11}- $N_{40}P_{20}K_0$, T_{12}- $N_{40}P_{20}K_{15}$, T_{13}- $N_{40}P_{20}K_{35}$, T_{14}- $N_{40}P_{20}K_{25}CD_5$, T_{15}- CD_{15}. The experiment was laid out in a Randomized Completely Block Design (RCBD) with three replications. The unit plot size was 2.0×1.5 m. The unit plots and blocks were separated by 0.50 m and 1.0 m, respectively. The plots were raised by 10 cm for proper irrigation. Every unit plot had 10 rows with 15 plants each. Plant to plant and row-to-row distance were 20 cm and 10 cm. Full doses of well decomposed cow dung, TSP and MOP (according to treatment combination) were incorporated into the prepared plots a few days before planting. Urea was applied in two equal installments i. e. half of the quantity of urea (according to treatment combination) was incorporated into the soil before sowing of seeds. Rest of urea was top dressed at 20 days after sowing (DAS) and the Urea, TSP and MOP were sources of N, P and k respectively. Seeds were sown @ 1 seeds per hill in furrows at 20 cm apart rows. Three to four cm deep straight furrows were drawn by iron rod. Seeds were placed in line along the furrows and then covered with loose soil. The plots were lightly irrigated after sowing to ensure uniform emergence. The experimental plot was kept weed free by hand weeding. Proper irrigation was done as and when necessary. Staking was done for 10 selected plants in each plot for green pod stage and matured seed stage observation separately. Pods were harvested at green pod stage and brown pod stage from randomly selected 10 plants of each plot. Data on growth, yield and quality of garden pea were recorded timely. Chemical analysis of garden pea seeds was done about 20-25 days after pod formation at green pod stage to assess the nutrient content of garden pea seeds. The sample was dried at 70^0C for at least 48 hours. Dried pea seeds were ground and processed for determination of different nutrient content. Chemical analysis of garden pea seeds was done to determine ascorbic acid, total sugar, β-carotene, protein, P, K and Ca at green pod stage. The ascorbic acid content was determined as per the procedure described by Pleshkov (1976). β - carotene was estimated as per the procedure described by Nagata *et al*.,1992. Sugar contents (total and reducing) were estimated according to Somogyi (1952) using Bertrand A, Bertrand B and Bertrand C solutions. Estimation of total nitrogen was done by "Colorimetric method" described by Linder (1944). The oven dried seeds were ground and total nitrogen content was determined by modified Kjeldahl digestion colorimetric method (Cataldo *et al*., 1975) by using $CuSO_4$ and K_2SO_4 mixture (1: 9) as catalyst. Pea seed samples containing minerals such as phosphorus (P), Potassium (K) and calcium (Ca) were estimated by "Perchloric acid digestion method" proposed by Yamakawa (1992). After digestion of pea seed sample the amount of phosphorus was determined by "Venamolybdate colorimetric method" by Yamakawa (1992). The recorded data on different parameters were compiled and statistically analyzed by using MSTAT software to find out the significance of variation resulting from the experimental treatments following the ANOVA technique. The mean separation was done by the DMRT at 5% or 1% level of probability.

Results and Discussion

Growth parameter of garden pea

Plant height

Plant height varied significantly due to the influence of different treatment combinations (Table 1). The tallest plant (47.23 cm) was found in T_{14} ($N_{40}P_{20}K_{25}CD_5$) which was statistically different from others. The shortest plant was found in control ($N_0P_0K_0$)(32.53 cm).

Number of nodes per plant

Significant variation was observed on number of nodes per plant (Table 1). The plants treated with $N_{40}P_{20}K_{25}$ in addition to 5 t/ha cow dung (T_{14}) produced maximum number of nodes per plant (13.70) which was statistically similar to all except $N_{40}P_{20}K_0$, $N_{40}P_0K_{25}$, $N_0P_0K_0$. The minimum number of nodes per plant (7.87) was in $N_0P_0K_0$.

Number of primary branches per plant

Due to influence fertilizers number of primary branches varied significantly (Table 1). The maximum number of primary branches/plant (4.17) was observed in the plants treated with $N_{40}P_{20}K_{25}$ + CD_5 (T_{14}) which was strategically similar to $N_{50}P_{20}K_{25}$. The lowest number of primary branches/plant (1.93) was found in $N_0P_0K_0$.

SPAD value

Significant variation in SPAD value was shown by different treatments (Table 1). The highest SPAD value (51.67) was found in $N_{40}P_{20}K_{25}$ which was statistically identical with $N_{40}P_{20}K_{25}CD_5$ (51.63), $N_{50}P_{20}K_{25}$ (47.16) and $N_{40}P_{20}K_{15}$ (45.47). The lowest SPAD value (34.64) was in $N_0P_0K_0$.

Leaf area index (LAI)

Significant variation was observed in LAI due to the influence of NPK fertilizers (Table 1). The plants under the treatment of $N_{40}P_{20}K_{25}CD_5$ showed maximum LAI (43.60) which was statistically similar to $N_0P_{20}K_{25}$ (41.70), T_{15} – CD_{15} (40.97), $N_{60}P_{20}K_{25}$ (40.30) $N_{40}P_{20}K_{25}$ (39.73), $N_{40}P_{40}K_{25}$ (38.23) and $N_{40}P_{20}K_{35}$ (38.17) whereas it was minimum (33.30) in $N_0P_0K_0$.

Days to first flowering

No significant variation was observed in days to first flowering due to different treatments of NPK fertilizers (Table 1). Numerically it varied from 30.37 to 32.70 days. Flowering was earliest (30.37 days) in the plants treated with $N_{40}P_{20}K_{15}$ and most delayed in $N_{30}P_{20}K_{25}$ (32.70 days).

From the above result (Table 1) it was found that all the growth parameters except days to first flowering differed significantly due to different fertilizer combination treatment. The tallest plant (47.23 cm), maximum number of nodes (13.70) per plant, maximum number of primary branches/plant (4.17), maximum LAI (43.60) were found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$) which was statistically different from others. Though the highest SPAD value (51.67) was found in $N_{40}P_{20}K_{25}$ which was statistically identical with $N_{40}P_{20}K_{25}CD_5$ (51.63). The plants under the treatment of $N_{40}P_{20}K_{25}CD_5$ showed higher growth parameters might be due to getting maximum available N, P, K and improved physical properties of soil. The available status of N, P and K in soil significantly increased with the application of N, P and K fertilizers in conjunction with FYM (Swarup and Yaduvanshi, 2000). This

results corroborates with the findings of Haque *et al* (2022) who reported higher growth parameters in garden pea with inorganic fertilizers and cow dung application.

Table 1. Effect of NPK on flowering and growth parameter of garden pea

Treatment	Plant height (cm)	Number of nodes/plant	Number of primary branches/plant	SPAD Value	LAI (cm^2)	Days to first flowering
T_1	32.53i	7.87c	1.93e	34.64f	33.30f	32.33
T_2	39.70h	11.92b	2.20de	37.44def	41.70ab	32.63
T_3	43.03d	12.31ab	2.77c	42.67bcd	33.87ef	32.70
T_4	45.90b	12.91ab	3.53b	51.67a	39.73a-e	32.67
T_5	46.17b	12.26ab	3.77ab	47.16ab	34.63def	31.50
T_6	43.87c	12.26ab	2.70cd	42.34bcd	40.30a-d	32.60
T_7	40.50g	11.79b	1.90e	35.53ef	34.87def	32.10
T_8	41.57f	12.20ab	2.30cde	42.92bcd	36.27b-f	30.40
T_9	42.77de	12.38ab	3.30b	43.48bcd	37.33b-f	32.40
T_{10}	42.03ef	12.17ab	2.50cd	39.90cdef	38.23a-f	32.30
T_{11}	41.27fg	11.77b	2.27de	36.61def	35.27c-f	31.83
T_{12}	43.37cd	12.33ab	2.27de	45.47abc	37.03b-f	30.37
T_{13}	45.53b	12.78ab	3.40b	42.82bcd	38.17a-f	30.93
T_{14}	47.23a	13.70a	4.17a	51.63a	43.60a	31.03
T_{15}	42.57de	12.63ab	2.40cde	43.39bcd	40.97abc	32.47
Level of Significance	**	**	**	*	*	NS
CV (%)	4.0	5.57	7.15	6.60	5.35	11.25

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability
* indicates significant at 1% level of probability, ** indicates significant at 1% level of probability, NS indicates non significant
Treatments: T_1- $N_0P_0K_0$, T_2- $N_0P_{20}K_{25}$, T_3- $N_{30}P_{20}K_{25}$, T_4- $N_{40}P_{20}K_{25}$, T_5- $N_{50}P_{20}K_{25}$, T_6- $N_{60}P_{20}K_{25}$, T_7- $N_{40}P_0K_{25}$, T_8- $N_{40}P_{10}K_{25}$, T_9- $N_{40}P_{30}K_{25}$, T_{10}- $N_{40}P_{40}K_{25}$, T_{11}- $N_{40}P_{20}K_0$, T_{12}- $N_{40}P_{20}K_{15}$, T_{13}- $N_{40}P_{20}K_{35}$, T_{14}- $N_{40}P_{20}K_{25}CD_5$, T_{15}- CD_5

Pod yield and yield contributing characters of garden pea

Number of pod per plant

Number of pods/plant varied significantly due the effect of different treatments of NPK fertilizers (Table 2). The crop under the treatment of $N_{40}P_{20}K_{25}CD_5$ produced maximum number of pods/plant (7.90) closely followed by $N_{40}P_{20}K_{25}$ (7.53) whereas it was minimum (4.50) in $N_0P_0K_0$.

Length of pod

The significant variation was observed in pod length due to different treatments of NPK fertilizers (Table 2). Length of pod was maximum (60.70 mm) in $N_{40}P_{20}K_{25}$ which was statistically identical with $N_{60}P_{20}K_{25}$ (59.03 mm), $N_{40}P_0K_{25}$ (58.47 mm), $N_{40}P_{10}K_{25}$ (58.60 mm), $N_{40}P_{30}K_{25}$ (57.40 mm), $N_{40}P_{20}K_{25}CD_5$ (58.27 mm) and CD_{15} (59.10 mm). Pod length was minimum (50.01 mm) in the plants treated with $N_0P_0K_0$.

Breadth of pod

Breadth of pod did not vary significantly among the plants treated with different levels of NPK fertilizers (Table 2). Numerically pod length was maximum (12.27 mm) in the plants under the treatment of $N_{40}P_0K_{25}$) and it was minimum (10.10 mm) in $N_0P_0K_0$.

Pod weight per plant at green pod stage

Wide variation in pod weight/plant at green pod stage was observed due to the influence of NPK fertilizers (Table 2). The highest pod weight/plant (34.08g) was in the plants treated with $N_{40}P_{20}K_{25}CD_5$ closely followed by $N_{40}P_{20}K_{25}$ (30.63 g), $N_{50}P_{20}K_{25}$ (29.96g), $N_{60}P_{20}K_{25}$ (29.24 g) and T_{15} – CD_{15} (28.80 g) whereas it was minimum (14.64 g) in $N_0P_0K_0$.

Pod weight/plant at brown pod stage

Significant variation in pod weight/plant at brown pod stage was observed among the plants treated with different levels of NPK fertilizers ((Table 2). The plants treated with $N_{40}P_{20}K_{25}CD_5$ produced maximum pod weight/plant (21.72 g) which was statistically similar to $N_{40}P_{20}K_{25}$ (20.52g) and it was minimum (10.10 g) in $N_0P_0K_0$.

Pod yield per hectare at green pod stage

Significant variation in pod yield per hectare at green pod stage was observed due to the influence of NPK fertilizers (Table 2). The highest pod yield per hectare (17.04 tons) was found in $N_{40}P_{20}K_{25}CD_5$ followed by $N_{40}P_{20}K_{25}$ (15.32 tons), $N_{50}P_{20}K_{25}$ (14.98 tons), $N_{60}P_{20}K_{25}$ (14.62 tons) and T_{15} –CD_5 (14.40 tons). The lowest per hectare yield (7.32 tons) was in $N_0P_0K_0$.

Pod yield per hectare at brown pod stage

Significant variation in pod yield per hectare at brown pod stage was observed among the plants treated with different levels of NPK fertilizers (Table 2). The plants treated with $N_{40}P_{20}K_{25}CD_5$ produced maximum pod yield per hectare (10.87 tons) which was statistically similar to $N_{40}P_{20}K_{25}$ (10.26 tons) and it was minimum (5.05 tons) in $N_0P_0K_0$).

From the above result (Table 2) it was found that pod yield and all the yield contributing parameters except breadth of pod differed significantly due to different fertilizer combination treatment. The maximum number of pods/plant (7.90), highest pod weight/plant at green pod stage (34.08g), maximum pod weight/plant at brown pod stage (21.72 g), highest pod yield per hectare at green pod stage (17.04 tons), maximum pod yield per hectare at brown pod stage (10.87 tons) were found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$) which was statistically different from others. Though the length of pod was maximum (60.70 mm) in T_4 ($N_{40}P_{20}K_{25}$) which was statistically identical with T_6 ($N_{60}P_{20}K_{25}$)(59.03 mm), T_7 ($N_{40}P_0K_{25}$)(58.47 mm), T_8 ($N_{40}P_{10}K_{25}$)(58.60 mm), T_9 ($N_{40}P_{30}K_{25}$)(57.40 mm), T_{14} ($N_{40}P_{20}K_{25}CD_5$)(58.27 mm) and T_{15} (CD_{15})(59.10 mm). This might be due to integration of organic and inorganic sources of nutrients enhanced the growth and nodulation of crop and in turn produced more pod yield (Gopinath and Mina, 2011). This results corroborates with the findings of Haque *et al* (2022) who reported higher pod yield and yield contributing characters of garden pea with inorganic fertilizers and cow dung application.

Table 2. Effect of NPK on pod yield and yield contributing characters of garden pea

Treatment	Number of pod/plant	Length of pod (mm)	Breadth of pod (mm)	Pod weight/plant (g)		Pod yield (t/ha)	
				Green pod stage	Brown pod stage	Green pod stage	Brown pod stage
T_1	4.50h	50.01c	10.10	14.64j	10.10i	7.32j	5.05i
T_2	5.60fg	55.83b	11.10	21.68ghi	14.79gh	10.84ghi	7.39gh
T_3	6.50de	57.07b	11.77	24.32efg	17.64de	12.16efg	8.82de
T_4	7.53b	60.70a	11.73	30.63b	20.52ab	15.32b	10.26ab
T_5	6.97c	55.97b	11.47	29.96b	18.30cd	14.98b	9.15cd
T_6	6.63d	59.03ab	11.50	29.24bc	18.02cde	14.62bc	9.02cde
T_7	5.80f	58.47ab	12.27	23.16fgh	15.86fg	11.58fgh	7.94fg
T_8	6.60d	58.60ab	11.70	25.36def	18.30cd	12.68def	9.15cd
T_9	6.80cd	57.40ab	11.87	27.28cd	19.57bc	13.64cd	9.79bc
T_{10}	6.53de	56.40b	11.80	25.68def	17.74de	12.84def	8.88de
T_{11}	5.77f	56.67b	11.53	21.48hi	16.49ef	10.74hi	8.25ef
T_{12}	6.23e	56.67b	11.60	24.24efg	17.99cde	12.12efg	9.00cde
T_{13}	6.20e	56.50b	11.60	26.04de	19.41bc	13.02de	9.71bc
T_{14}	7.90a	58.27ab	11.77	34.08a	21.72a	17.04a	10.87a
T_{15}	6.20e	59.10ab	11.63	28.80bc	15.43fg	14.40bc	7.72fg
Level of Significance	**	*	NS	*	**	*	**
CV (%)	3.15	3.28	7.86	6.36	4.65	7.35	4.66

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability
* indicates significant at 1% level of probability; ** indicates significant at 1% level of probability; NS indicates non significant
Treatments: T_1- $N_0P_0K_0$, T_2- $N_0P_{20}K_{25}$, T_3- $N_{30}P_{20}K_{25}$, T_4- $N_{40}P_{20}K_{25}$, T_5- $N_{50}P_{20}K_{25}$, T_6- $N_{60}P_{20}K_{25}$, T_7- $N_{40}P_0K_{25}$, T_8- $N_{40}P_{10}K_{25}$, T_9- $N_{40}P_{30}K_{25}$, T_{10}- $N_{40}P_{40}K_{25}$, T_{11}- $N_{40}P_{20}K_0$, T_{12}- $N_{40}P_{20}K_{15}$, T_{13}- $N_{40}P_{20}K_{35}$, T_{14}- $N_{40}P_{20}K_{25}CD_5$, T_{15}- CD_5

Seed parameters of garden pea

Number of seed per pod

Number of seed/pod varied significantly among the plants treated with different levels of NPK fertilizers (Table 3). The maximum number of seed/pod (5.53) was found in the plants treated with $N_{40}P_{20}K_{25}$ which was statistically identical with $N_{40}P_{20}K_{25}CD_5$ (5.17), $N_{40}P_{30}K_{25}$ (5.00), $N_{50}P_{20}K_{25}$ (4.93), $N_{40}P_{40}K_{25}$ (4.83), $N_{40}P_{20}K_{35}$ (4.83) and T_{15} –CD_{15} (4.77). The minimum number of seed per pod (3.41) was in $N_0P_0K_0$.

Weight of 100 green seed

Weight of 100 green seed did no vary significantly among the treatments (Table 3) but numerically it varied from 48.65 to 69.00g.

Weight of 100 dry seed

Weight of 100 dry seed varied significantly due to the influence of different treatments of NPK fertilizers (Table 3). The highest weight of 100 dry seed (26.12 g) was found in $N_{40}P_{20}K_{25}CD_5$ which was statistically similar to $N_{40}P_{20}K_{25}$ (24.15 g) and it was lowest (17.30 g) was in $N_0P_0K_0$.

Green seed yield per plant

Green seed yield/plant did not vary significantly among the treatments (Table 3). Numerically it was the highest (20.70 g) in $N_{50}P_{20}K_{25}$) and it was the lowest (14.59 g) in $N_0P_0K_0$.

Dry seed yield per plant

Significant variation was observed in dry seed yield per plant due to different treatments of NPK fertilizers (Table 3). The plants treated with $N_{40}P_{20}K_{25}CD_5$ produced maximum dry seed yield/plant (7.84g) which was statistically identical with $N_{40}P_{20}K_{25}$ (7.25 g). The minimum dry seed yield/plant (5.15 g) was observed in $N_0P_0K_0$.

Green seed yield per hectare

No significant variation was observed in green seed yield per hectare due to different treatments NPK fertilizers (Table 3). Numerically, green seed yield per hectare was the highest (10.35 t/ha) in $N_{50}P_{20}K_{25}$ closely followed by $N_{40}P_{20}K_{25}CD_5$ (10.29 t/ha) and it was minimum (7.29 t/ha) in $N_0P_0K_0$.

Dry seed yield per hectare

Dry seed yield per hectare varied significantly due to influence of different treatments of NPK fertilizers (Table 3). The crop treated with $N_{40}P_{20}K_{25}CD_5$ produced the highest dry seed yield per hectare (3.92 tons) which was statistically similar to $N_{40}P_{20}K_{25}$ (3.63 tons). The lowest dry seed yield per hectare (2.57) was found in the plants treated with $N_0P_0K_0$.

From the result (Table 3) it was found that all the seed parameters of garden pea except weight of 100 green seed (g), green seed yield/plant (g) and green seed yield (t/ha) differed significantly due to different fertilizer combination treatment. The maximum number of seed/pod (5.53), highest weight of 100 dry seed (26.12 g) maximum dry seed yield/plant (7.84g) and highest dry seed yield per hectare (3.92 tha^{-1}) were found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$) which was statistically different from others. Treatment T_{14} comprises higher seed yield due to higher yield contributing characters. Only inorganic sources failed to show higher seed yield but combination of organic and inorganic fertilizer responded significantly. These results are in line with those reported by Hassan *et al*. (2012); Feleafel and Mirdad, (2014).

Nutrient status of green seed of garden pea

Protein

Protein content of green seed of garden pea varied significantly due to the influence of different levels of NPK fertilizers (Table 4). Percentage of protein was maximum (26.53 %) in the seeds of plants treated with $N_{40}P_{20}K_{25}CD_5$ which was statistically identical to all except $N_{40}P_{20}K_{35}$ (22.60), $N_{40}P_{20}K_{15}$ (22.57), $N_{40}P_0K_{25}$ (22.21), $N_0P_{20}K_{25}$ (23.43) and $N_0P_0K_0$ (20.33) which had minimum percentage of protein. This can be explained on the basis as demonstrated by Tisdale et al (1995) that the amount of protein produced may be due to the effect of N supplied to the crop. On the other hand, added organics play an important role in synthesis of protein by enhancing the availability of N and S through

Table 3. Effect of NPK on seed parameters of garden pea

Treatment	Number of seed/pod	Weight of 100 seed (g)		Seed yield/plant (g)		Seed yield (t/ha)	
		Green	Dry	Green	Dry	Green	Dry
T_1	3.41c	48.65	17.30d	14.59	5.15d	7.29	2.57d
T_2	4.47bc	60.42	21.33cd	18.12	6.39cd	9.06	3.19cd
T_3	4.63bc	62.10	21.53bc	18.63	6.45bc	9.31	3.23bc
T_4	5.53a	65.15	24.15ab	19.54	7.25ab	9.77	3.63ab
T_5	4.93abc	69.00	21.35bc	20.70	6.41bc	10.35	3.21bc
T_6	4.67bc	64.00	17.62cd	19.20	5.29cd	9.60	2.65cd
T_7	4.43bc	59.80	15.90d	17.94	4.77d	8.97	2.39d
T_8	4.60bc	62.85	20.24bcd	18.85	6.07bcd	9.42	3.04bcd
T_9	5.00abc	63.61	21.15bc	19.08	6.35bc	9.54	3.18bc
T_{10}	4.83abc	59.40	19.18cd	17.82	5.75cd	8.91	2.88cd
T_{11}	4.50bc	59.04	17.15cd	17.71	5.15cd	8.85	2.58cd
T_{12}	4.60bc	66.30	19.55bcd	19.89	5.87bcd	9.94	2.94bcd
T_{13}	4.83abc	60.55	21.53bc	18.16	6.46bc	9.08	3.23bc
T_{14}	5.17ab	68.60	26.12a	20.58	7.84a	10.29	3.92a
T_{15}	4.77abc	62.85	18.02cd	18.85	5.41cd	9.42	2.71cd
Level of Significance	**	NS	**	NS	**	NS	**
CV (%)	6.83	6.50	9.57	6.50	9.57	6.50	9.57

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability
* indicates significant at 1% level of probability; ** indicates significant at 1% level of probability; NS indicates non-significant.
Treatments: T_1- $N_0P_0K_0$, T_2- $N_0P_{20}K_{25}$, T_3- $N_{30}P_{20}K_{25}$, T_4- $N_{40}P_{20}K_{25}$, T_5- $N_{50}P_{20}K_{25}$, T_6- $N_{60}P_{20}K_{25}$, T_7- $N_{40}P_0K_{25}$, T_8- $N_{40}P_{10}K_{25}$, T_9- $N_{40}P_{30}K_{25}$, T_{10}- $N_{40}P_{40}K_{25}$, T_{11}- $N_{40}P_{20}K_0$, T_{12}- $N_{40}P_{20}K_{15}$, T_{13}- $N_{40}P_{20}K_{35}$, T_{14}- $N_{40}P_{20}K_{25}CD_5$, T_{15}- CD_5

mineralization, which help in formation of sulphur containing amino acids. Similar findings have been reported by Kumar *et al* (2012).

Phosphorus

Significant variation was observed in phosphorus content of green seed due to different treatment of NPK fertilizers (Table 4). The maximum content of phosphorus (178.51 mg/100g) was found in the seeds of plants treated with $N_{40}P_{30}K_{25}$ which was statistically similar to the plants treated with $N_{40}P_{20}K_{25}$ (177.55 mg/100g), and $N_{40}P_{20}K_{25}CD_5$ (17.55 mg/100g) and it was minimum (131.01 *mg/100g) in* $N_0P_0K_0$.

Potassium

The amount of potassium in greed seed varied significantly due to different treatment of NPK fertilizers (Table 4). The highest quantity of potassium (256.30 mg/100g) was observed in the seeds of plants treated with $N_{40}P_{20}K_{25}CD_5$ which was statistically identical with $N_{40}P_{20}K_{15}$ (237.30 mg/100g) and $N_{50}P_{20}K_{25}$ (252.00 mg/100g) and it was minimum (230.70 mg/100g) in $N_0P_0K_0$.

Calcium

The content of calcium in seed of garden pea varied significantly due to different treatment of NPK fertilizers (Table 4). The seeds of plants treated with $N_{30}P_{20}K_{25}$ showed maximum calcium content (21.53 mg/100g) which was statistically similar to $N_{40}P_{20}K_{25}CD_5$ (20.73 mg/100g), $N_{40}P_{20}K_{25}$ (20.00 mg/100g), $N_{50}P_{20}K_{25}$ (20.00 mg/100g), $N_{40}P_{30}K_{25}$ (19.83 mg/100g) and $N_{40}P_0K_{25}$ (19.13 mg/100g). The minimum calcium content (13.87 mg/100g) was in the seeds of plants treated with $N_0P_0K_0$.

Total sugar

The percentage of total sugar in green seeds also varied significantly due to the influence of NPK fertilizers (Table 4). The percentage of total sugar was maximum (2.42) in the seeds of plants treated with $N_{40}P_{20}K_{25}CD_5$ which was statistically different from others closely followed by $N_{40}P_{20}K_{15}$ (2.18%) and $N_{40}P_{20}K_{35}$ (2.14%) and it was minimum (1.59%) in the seeds of plants treated with $N_0P_0K_0$. Such a favourable impact of organics and NPK fertilization on total sugar content of pea seeds has earlier been reported by Kumar et al (2012).

Ascorbic acid

Significant variation was observed on the content of ascorbic acid in green seed due to the effect of NPK fertilizers (Table 4). The seeds of plants treated with $N_{40}P_{20}K_{25}$ showed maximum content of ascorbic acid (27.55 mg/100g) which was statistically similar to $N_{40}P_{10}K_{25}$ (27.26 mg/100g), $N_{40}P_{30}K_{25}$ (27.01 mg/100g) and $N_{40}P_{20}K_{15}$ (26.83 mg/100g) while it was minimum (13.49 mg/100g) in the seeds of plants treated with $N_0P_0K_0$.

β-carotene

β-carotene content of green seed also varied significantly due to the influence of NPK fertilizers (Table 4). The amount of β–carotene was maximum (342.50 µg/100g) in the seeds of plants treated with $N_{40}P_{20}K_{25}CD_5$ which was statistically identical with $N_{40}P_{20}K_{35}$ (293.40 µg/100g), $N_{40}P_{20}K_{15}$ (285.50 µg/100g), $N_{40}P_0K_{25}$ (266.00 µg/100g), $N_{50}P_{20}K_{25}$ (258.90 µg/100g) and $N_{30}P_{20}K_{25}$ (264.30 µg/100g) while it was minimum (123.60 µg/100g) in the seeds of plants treated with $N_0P_0K_0$.

From the above result it was found that all the nutrient status of green seed of garden pea differed significantly due to different fertilizer combination treatment. The maximum protein percent (26.53 %), maximum content of phosphorus (178.51 mg/100g), highest quantity of potassium (256.30 mg/100g), maximum total sugar (2.42) and maximum β–carotene (342.50 µg/100g) were found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$) which was statistically superior from others. Though the seeds of plants treated with $N_{30}P_{20}K_{25}$ showed maximum calcium content (21.53 mg/100g) which was statistically similar to $N_{40}P_{20}K_{25}CD_5$ (20.73 mg/100g). The seeds of plants treated with $N_{40}P_{20}K_{25}$ showed maximum content of ascorbic acid (27.55 mg/100g). The plants under the treatment of $N_{40}P_{20}K_{25}CD_5$ showed higher nutrient status of green seed of garden pea might be due to getting maximum available N, P, K and improved physical properties of soil.

From the above discussion (Table 4) it may be concluded that growth, yield and nutritional quality of garden pea influenced significantly due to different fertilizer combination treatment. The tallest plant (47.23 cm), maximum number of nodes (13.70) per

Table 4. Effect of NPK on nutrient status of green seed of garden pea

Treatment	Protein (%)	Phosphorus (mg/100g)	Potassium (mg/100g)	Calcium (mg/100g)	Total sugar (%)	Ascorbic acid (mg/100g)	β-carotene (µg/100g)
T_1	20.33d	131.01k	230.70f	13.87d	1.59g	13.49f	123.60d
T_2	23.43bc	160.87i	236.00ef	18.50a-d	1.83def	21.74c	236.90bc
T_3	23.77abc	172.13d	242.00de	21.53a	1.92d	19.18d	264.30ab
T_4	24.89abc	177.55a	244.00cd	20.00abc	1.89de	27.55a	240.30bc
T_5	25.37ab	166.33g	252.00ab	20.00abc	1.95cd	25.54b	258.90ab
T_6	24.48abc	173.50bc	240.00de	15.87bcd	1.99cd	18.65d	248.50b
T_7	22.21cd	163.31h	224.00g	19.13abcd	1.67fg	16.81e	266.00ab
T_8	23.77abc	165.41g	240.00de	14.10d	1.96cd	27.26ab	215.70bc
T_9	24.55abc	178.51a	239.30de	19.83abc	1.97cd	27.01ab	228.10bc
T_{10}	25.34ab	167.76f	239.70de	14.23d	1.99cd	21.12c	157.40cd
T_{11}	24.94abc	169.79e	236.00bc	15.67bcd	1.69fg	22.25c	256.20b
T_{12}	22.57bcd	173.60b	237.30a	14.57d	2.18b	26.83ab	285.50ab
T_{13}	22.60bcd	172.30cd	248.00bc	15.00cd	2.14bc	20.95c	293.40ab
T_{14}	26.53a	177.55a	256.30a	20.73ab	2.42a	22.08c	342.50a
T_{15}	24.55abc	155.09j	195.83h	14.07d	1.72efg	21.08c	208.70bc
Level of Significance	**	*	**	**	*	**	*
CV (%)	3.60	2.30	1.80	2.18	2.04	2.44	7.01

Means bearing same letter (s) do not differ significantly at 1 or 5% level of probability
* indicates significant at 1% level of probability; ** indicates significant at 1% level of probability; NS indicates non significant
Treatments: T_1- $N_0P_0K_0$, T_2- $N_0P_{20}K_{25}$, T_3- $N_{30}P_{20}K_{25}$, T_4- $N_{40}P_{20}K_{25}$, T_5- $N_{50}P_{20}K_{25}$, T_6- $N_{60}P_{20}K_{25}$, T_7- $N_{40}P_0K_{25}$, T_8- $N_{40}P_{10}K_{25}$, T_9- $N_{40}P_{30}K_{25}$, T_{10}- $N_{40}P_{40}K_{25}$, T_{11}- $N_{40}P_{20}K_0$, T_{12}- $N_{40}P_{20}K_{15}$, T_{13}- $N_{40}P_{20}K_{35}$, T_{14}- $N_{40}P_{20}K_{25}CD_5$, T_{15}- CD_5

plant, maximum number of primary branches/plant (4.17), maximum LAI (43.60) were found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$). The maximum number of pods/plant (7.90), highest pod weight/plant at green pod stage (34.08g), maximum pod weight/plant at brown pod stage (21.72 g), highest pod yield per hectare at green pod stage (17.04 tons), maximum pod yield per hectare at brown pod stage (10.87 tons) were found in similar treatment ($N_{40}P_{20}K_{25}CD_5$). The maximum number of seed/pod (5.53), highest weight of 100 dry seed (26.12 g) maximum dry seed yield/plant (7.84g) and highest dry seed yield per hectare (3.92 tha^{-1}) were also found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$). As well as the maximum protein percent (26.53 %), maximum content of phosphorus (178.51 mg/100g), highest quantity of potassium (256.30 mg/100g), maximum total sugar (2.42) and maximum β–carotene (342.50 µg/100g) were found in treatment T_{14} ($N_{40}P_{20}K_{25}CD_5$).

Conclusion

Obtained results indicated that growth, yield and nutritional quality of garden pea influenced significantly due to different inorganic fertilizer in combination with organic manure. The results suggest that the application of $N_{40}P_{20}K_{25}CD_5$ kg ha^{-1} can support the higher growth, yield and nutritional quality of garden pea in shallow red brown terrace soils of Bangladesh.

Acknowledgement

The authors are grateful to the Hon'ble Vice chancellor of BSMRAU, Department of Horticulture and Soil Science, for taking their keen interest, encouragement and support to carry out the research work.

Conflict of Interest: No conflict among the authors.

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To cite this article: Uddin, S.N., Zakaria, M., Hossain, M.M., Hossain, T., Karim, A.J.M.S., and Hossain, G.M.A. (2023). Effect of N P K Fertilizers on Growth, Yield and Nutritional Quality of Garden Pea. *International Journal for Asian Contemporary Research,* 3 (1): 1-6.

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