J. Sher-e-Bangla Agric. Univ., 11(1 & 2): 27-37, January & July 2020 ISSN 1997-6038

RESPONSE OF NITROGEN AND PHOSPHORUS FERTILIZERS EFFICIENCY ON GROWTH AND YIELD ATTRIBUTES OF SOYBEAN (*Glycine max* L. Merill.)

M. A. Hossain[1], M. M. Hossain[2], S. K. Mukherjee[3], S. Yesmin[4] and T. Zaman[5]

ABSTRACT

A study was conducted to study the response of inorganic fertilizers, nitrogen, and phosphorus on morpho-physiological and yield parameter of soybean, the experiment was laid out in a Randomized Complete Block Design (RCBD) by three replications at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh in 2019. Three levels (0, 25, and 40 kg N ha^{-1}) of nitrogen and four levels (0, 18, 36, and 54 kg P ha^{-1}) of phosphorus fertilizer used as a treatment for this experiment. Soybean plants responded to the nitrogen and phosphorus fertilizer for the crop growing, and improving yield contributing characters were significantly influenced. Significant effect on plant height, number of branches, seeds $plant^{-1}$, number of filled pods $plant^{-1}$, the weight of seeds $plant^{-1}$, dry weight of the plant, stover weight $plant^{-1}$, 1000-seed weight, seeds, and stover yield were observed from the collective application of 25 kg N with 54 kg P ha^{-1}. Therefore, the combined application of 25 kg nitrogen ha^{-1} and 54 kg phosphorus ha^{-1} might have suggested the best possible options to acquire soybean seed yield from a field experiment.

Keywords: growth and yield, nitrogen, phosphorus, soybean

INTRODUCTION

Soybean *(Glycine max L.* Merill) stands first as an oilseed crop of the world. It has a remarkable significance in agriculture as a first-rate source of high-quality plant protein and vegetable oils and nitrogen-fixing ability. It belongs to the family Leguminosae, subfamily Papilionaceae. Soybean is originated in East Asia, but now it is extensively cultivated in tropical, subtropical, and temperate climatic regions with an optimal mean temperature of 20-30°C (FAO, 2008). Soybean is rather widespread in different regions of the world and grows well from the tropics to the temperate zones with larger production in the United States, Brazil, China, Mexico, Indonesia, and Argentina (FAO, 2008). The world normal seed yield of soybean is 2.48 t ha^{-1} in 2013 and high in the USA (2.91 t ha^{-1}), Brazil (2.93 t ha^{-1}), Argentina (2.54 t ha^{-1}), Paraguay (2.95 t ha^{-1}) and Canada (2.86 t ha^{-1}) compared with China (1.89 t ha^{-1}), Japan (1.55 t ha^{-1}), India (0.98 t ha^{-1}) and Bangladesh (1.50 to 2.30 t ha^{-1}) (FAOSTAT, 2016). Worldwide production of soybean is estimated to be 324 million tons in 2016, a 5% increase from the 2014 world total. Soybean grain contains about 40% protein and 20% oil which afford just about 60% of the world's contribution of vegetable protein and 30% of the oil (Fehr, 1989). It has become the miracle crop of the 20th century in consequence of having high protein and oil content and is known as "Golden Bean". Soybean is now deciphered as "protein hope of future" for its relating to diet in Bangladesh. Soybean seed contains 40-45% protein, 20-22% oil, 20-26% carbohydrate, and a high amount of Ca, P, and different vitamins (Rahman *et al*., 2011). Prospects of soybean farming in Bangladesh are intense as it can profitably be grown under a wider-angle of climatic and edaphic conditions and cultivated the whole time of the year in Bangladesh (Rahman, 1982). Soybean helps to improve soil health by fixing atmospheric nitrogen. Steward (1966) observed that the soybean plants may fix 94 kg nitrogen ha^{-1} in the soil in a seasoned field. In Bangladesh, the area under soybean cultivation is about 5000 ha with a production of 4000 tons and the yield ranges from 1.50 to 2.30 t ha^{-1} (BARI, 2005). The poorer yield of soybean at the farmer's level is mainly accredited to the lack of superior agronomic management practices of which balanced fertilizer

[1&5]MS student, [2] Professor, Dept. of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, [3&4],Upazila Agriculture Officer, (Ministry of Agriculture), Bangladesh

application is a significant determinant for the superior yield of soybean. Among the essential plant nutrients, nitrogen has the quickest and most prominent effect on plant growth and yield of crops. It tends primarily to persuade above-ground vegetative growth and to convey deep green color to the leaves. In all plants, nitrogen plays a substantial degree of consumption of potassium, phosphorus, and other nutrients. Plants receiving inadequate nitrogen are stunted in growth with limited root systems. The leaves turn yellow or yellowish-green and tend to drop off. Aside from nitrogen, P can play an important position in seed yield as it is one of the limiting essential plant nutrients for the production of soybean (Rao *et al.,* 1995). Its uptake and consumption by soybean are essential for ensuring proper growth and improving yield and excellence in the quality of the crop. It influences the root growth, helps in the uptake of other nutrients and formation of a nodule, and balances the nitrogen insufficiency in soil, and supports seed maturation. Regardless of ample works done at home and abroad, further research is needed to denote the amount of nitrogen and phosphorus for exploiting the highest output of soybean, which is somewhat a new but dexterous crop in Bangladesh. As a consequence, it is needed to determine the appropriate quantity of nitrogen and phosphorus necessary for achieving a superior yield of soybean. Insight of the facts affirmed above, a field experiment was conducted to estimate the effect of different levels of nitrogen and phosphorus fertilizers and their interaction on the growth and yield of soybean.

MATERIALS AND METHODS

A field experiment was conducted at the Farm of the Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to study the effects of nitrogen (N) and phosphorus (P) on the growth and yield of soybean. The experimental field was a high land having sandy loam soil with pH 6.9. The initial soil (0- 15 cm depth) test result was 0.058% total N, 0.46% organic matter, 23 ppm available P, 5.0 ppm available S, and 0.13 ppm exchangeable K. Three levels (0, 25, and 40 kg N ha^{-1}) of nitrogen and four levels (0, 18, 36 and 54 kg P ha^{-1}) of phosphorus considered as a treatment for the experiment. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Half amount of the total N and whole of P were applied as per treatment in the individual plots. Besides, MoP and gypsum were applied @ 120 and 115 kg ha^{-1}, respectively on the same date. The remaining half of the N was top-dressed at 25 days after sowing. Weeding followed by thinning was done simultaneously twice at 21 and 45 days after sowing. Irrigation was done simultaneously twice on 25 and 55 days after sowing. Sumithion 50 EC @3mlL^{-1} and Dimethion 40 EC @ 2mlL^{-1} were sprayed to control leaf roller and caterpillar. Different growth and yield parameters-related data were collected at different days after sowing (DAS). The crop was harvested at full maturity. The collected data were analyzed statistically following the ANOVA technique using a statistical tool Statistix10 software program and the mean differences were adjudged as per Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of nitrogen on morphological characteristics in Soybean

The variations in growth and yield contributing characteristics of soybean are attributed to the differences in the genetic composition of the assortment and their differences in the utilization ability of the different rates of different nitrogen and phosphorus fertilizers applied in the field. Nitrogen had a significant effect on the growth and yield contributing characters of soybean (Fig. 1A-E). Plant height of soybean was significantly influenced by nitrogen fertilizer application. Soybean crop grown with 40 kg N ha^{-1} produced the tallest plant (34.18 cm) and with 0 kg N ha^{-1} untreated control plot produced the shortest plants (30.01cm). The highest dry matter weight $plant^{-1}$ (17.89 g), number of seeds pod^{-1} (1.94), number of seeds $plant^{-1}$ (94.93), seed weight $plant^{-1}$ (3.41 g), 1000-seed weight (111.26 g), number of filled pods $plant^{-1}$(47.59) but lowest empty pods $plant^{-1}$ (2.42) were observed with 25 kg N ha^{-1} treated plot followed by 40 kg N ha^{-1} application whereas, the soybean crop showed reduced performance compare with the best performance with untreated control (0 kg N ha^{-1}) plot.

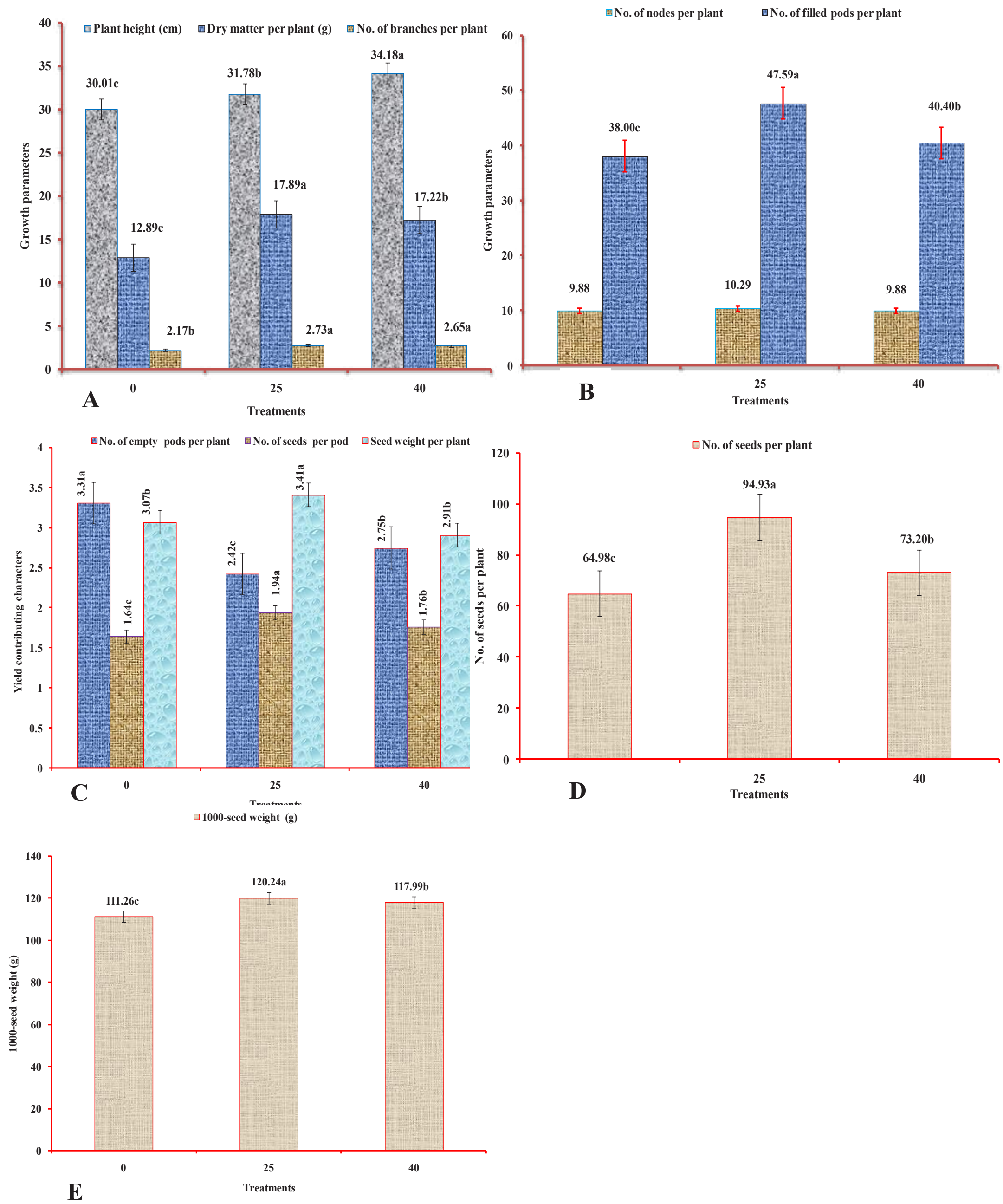

Fig. 1. Effect of nitrogen on morphological characteristics in soybean. A. Effect of nitrogen on plant height (cm), dry matter per plant (g) and number of branches per plant; B. Effect of nitrogen on number of nodes per plant and number of filled pods per plant; C. Effect of nitrogen on number of empty pods per plant, number seeds per plant and seed weight per plant (g); D. Effect of nitrogen on number seed per plant; E. Effect of nitrogen on 1000-seed weight (g)

Among the treatments, 25 kg N ha^{-1} produced the highest weight of 1000-seed (120.24 g) which was statistically significant than other treatments. Furthermore, the highest number of nodes per plant

(10.29) was found with 25 kg N ha^{-1} treated plot which was statistically non-significant. The lowest weight of 1000-seed (111.26 g) was obtained with untreated control plot and afterward lowers than others. This might be due to higher accessibility of nitrogen and uptake that increasingly improved the vegetative growth of the soybean plant in the field. It is recognized that essential plant nutrient nitrogen influences the photosynthetic pigments, the synthesis of the enzymes participating in the carbon diminution, the formation of the membrane coordination of chloroplast. Accordingly, the enhancement in growth and yield due to the fertilization of N fertilizers may be ascribed to the fact that these nitrogen being significant constituents of nucleotides, proteins, chlorophyll, and enzymes, engage in various metabolic processes which have a straight impact on vegetative and reproductive growth of crops and plants. This result conforms to the answer of other researchers, e.g. Agbenin *et al*. (1991) exposed that application of N significantly amplified plant height, seed yield, dry weight, crop growth rate, and nutrient uptake of soybean plant over control-treated plot. The result was comparable to the results of Suhartatik (1991) also reported that inorganic NPK fertilizers significantly improved the plant height of soybean. Another researcher also approved with the findings of Yadravi and Angadi (2015) found that application of nitrogen 60 kg ha^{-1} recorded significantly higher soybean plant height (50.6 cm), the number of branches $plant^{-1}$ (6.8), total dry matter yield $plant^{-1}$ (34.4 g), leaf area $plant^{-1}$ (10.9 dm^2) and leaf area index $plant^{-1}$ (3.6) compared to other treatments. The present result supports the findings of Raju and Verma (1984) as they found that a bigger N fertilizer rate has a beneficial role on a 1000-seed yield increase in the crop. The highest seed yield (1.95 t ha^{-1}) was obtained in 25 kg N ha^{-1} and the lowest (1.41t ha^{-1}) was recorded in the control (0 kg N ha^{-1}) treatment. The increase in seed yield may be due to the constant provision of nitrogen during crop growth and important responsibility played by nitrogen in energy transformations, the commencement of enzymes in carbohydrate metabolism, and accordingly superior transformation of photosynthates into the reproductive portion of the plant. These results are in proportion to the findings of Sikka *et al.* (2013) and Mohanyadravi and Angadi, (2016) who reported that application of higher doses of nitrogen to soybean recorded appreciably higher seed yield compared to the control plot. The highest seed yield in 25 kg N ha^{-1} might have resulted due to increasing encouraging effects of the number of seeds $plant^{-1}$, the weight of seeds $plant^{-1}$and 1000-seed weight. The result obtained is in accord with the findings of Singh *et al*. (1992) reported yield of soybean amplified with the increased rate of nitrogen fertilizer dose. The stover yield followed a similar tendency as observed for seed yield. It is significant to discuss these appealing essentials revealed by the results of Leelavathi *et al.* (1991) obtained similar findings of the straw yield of soybean.

Effect of phosphorus on morphological characteristics in soybean

The present outcome exposed that significant differences in respect of growth and yield contributing characters of soybean can be attributed to differences in the application of different levels of inorganic phosphorus fertilizer in the capability of the cultivars to take advantage of the fertilizer applied. Phosphorus had a noteworthy effect on soybean growth and yield (Fig. 2A-F). The yield and yield contributing characters showed better replies with the amplified level of phosphorus. The tallest plant (34.26 cm), maximum dry matter weight $plant^{-1}$ (18.89 g), and the maximum number of branches $plant^{-1}$ (3.37) were recorded with 54 kg P ha^{-1} which was significantly utmost than those of other treatments. With esteem to vegetative character, it was observed that different growth and development characters augmented significantly because phosphorus is two of the majority essential and necessary for plant growth. Plant height increased with enlarged phosphorus application up to 18 kg P ha^{-1}. This might be due to the truth that phosphorus being an essential ingredient of plant tissue significantly influences the plant height of crop (Kumar and Chandra, 2008; Shahid *et al*., 2009) were also a pragmatic significant enhancement in plant height of soybean by phosphorus fertilization. The potential reason might be that at the levels of phosphorus application, the majority of plants were dynamic and absorbed the nutrients more competently. The number of filled pods $plant^{-1}$ (54.49) was the highest in 54 kg P ha^{-1} which was

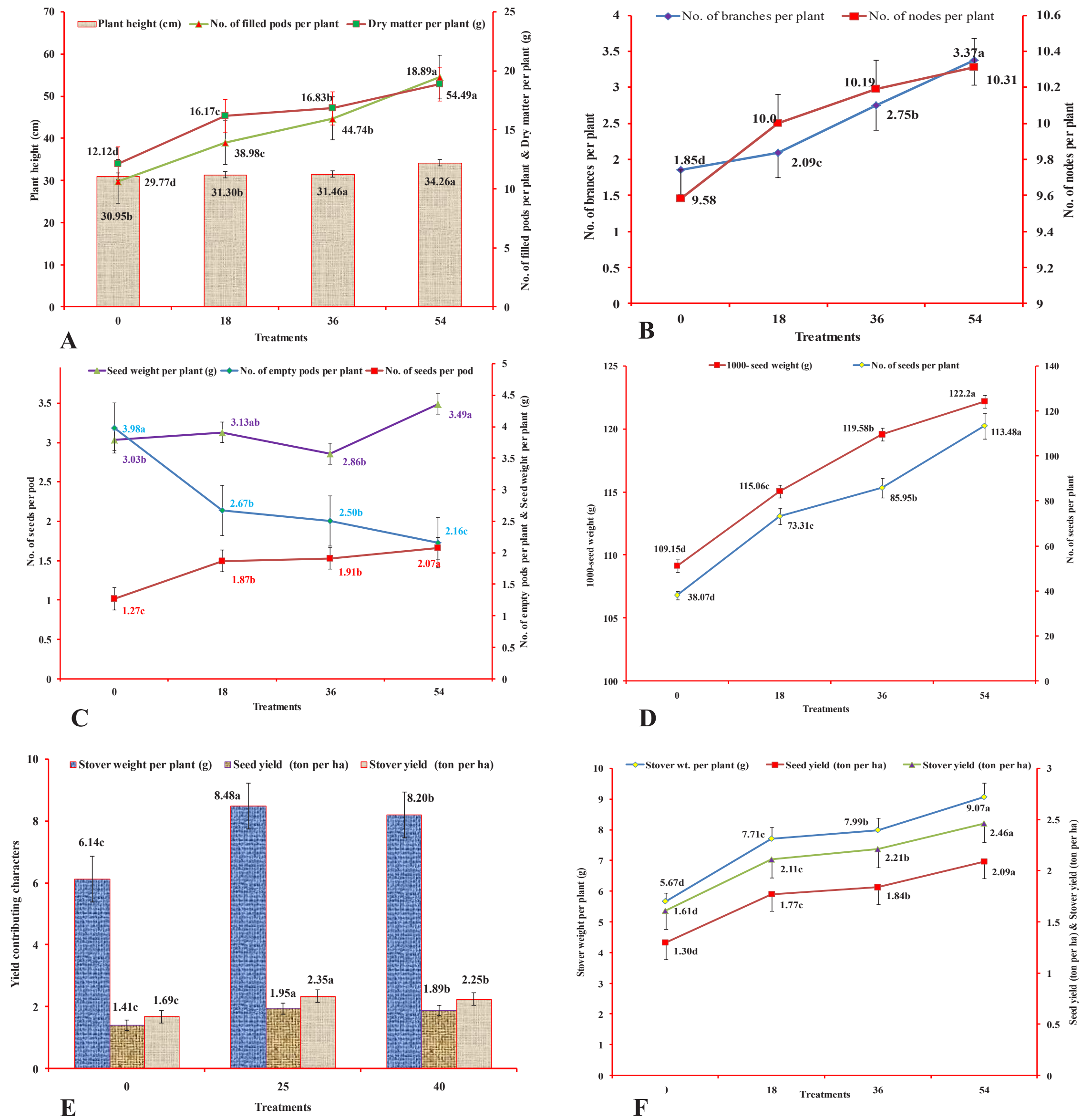

Fig. 2. Effect of phosphorus on morphological characteristics in soybean. A. Effect of phosphorus on plant height; B. Effect of phosphorus on number of branches per plant and number of nodes per plant; C. Effect of phosphorus on seed wt. per plant (g), number of empty pods per plant and number of seed per plant; D. Effect of phosphorus on 1000 seed weight (g) and number of seeds per plant; E. Effect of phosphorus on stover weight per plant (g), seed yield (ton ha^{-1}) and stover yield (ton ha^{-1}); F. Effect of phosphorus on stover weight per plant (g), seed yield (ton ha^{-1}) and stover yield (ton ha^{-1}).

significantly highest than of other treatments. The lowest number of filled pods $plant^{-1}$ was observed from 0 kg P ha^{-1} untreated control plot. The results of the experiment bring into being confirmed for the results of Singh and Bajpai (1990) who observed that rising phosphorus rate increased the number of pods plant-1 of soybean plant in field condition. Among the treatments, the control (0 kg P ha^{-1}) treated plot produced the highest number of empty pods (3.98) which was statistically significant with other treatments, and the lowest (2.16) was found in 54 kg P ha^{-1} treated plot. It is important to discuss these attractive facts exposed by the results of Islam *et al*. (2004) reported that the percentage of empty pods decreased with the enhancement of phosphorus application in the soybean plot. The number of seeds pod^{-1} was escalated with the increment of phosphorus dose.

The result of the present study conformed to the findings of Tomar *et al.* (2004) found that the number of seeds pod^{-1} and seeds $plant^{-1}$ of soybean increased with the increase of phosphorus application. The result obtained from the research is in agreement with the result of Islam *et al.* (2004). The maximum weight of seed $plant^{-1}$ (3.49 g) was observed in 54 kg P ha^{-1}. The highest weight of stover $plant^{-1}$ (9.07 g) and 1000 seed weight (122.2 g) was observed in 54 kg P ha^{-1} treated plot which was statistically significant than of other treatments whereas lowest from control (0 kg P ha^{-1}) treated plot. A significantly higher seed yield (2.09 t ha^{-1}) was observed in 54 kg P ha^{-1} and the lower (1.30 t ha^{-1}) was recorded in the control (0 kg P ha^{-1}) treated plot. The highest seed yield in 54 kg P ha^{-1} might have found due to collective effects of the number of seeds pod^{-1}, the number of seed $plant^{-1}$, and the weight of seeds $plant^{-1}$ of soybean. The present results sustain the reports of Syafruddin *et al.* (1990) who observed that seed yield was highest in 90 kg P ha^{-1} treated plot of soybean from the field condition. The stover yield followed a similar tendency as observed in the seed yield of soybean. The phosphorus fertilization of a sufficient amount promotes root growth, fast physiological maturity, flowering, prop up seed formation, progress cold tolerance, and ultimately better crop productivity (Malavolta, 1989). The solicitation of fertilizers is well thought-out as the most necessary feature in improving crop productivity. Amongst the many factors that can promote the success of soybean, phosphorus has significant implications on vegetative growth and yield contributing attributes (Kumaga and Ofori, 2004). It is important to emphasize the reality that Tomar *et al*. (2004) reported a higher tendency of stover yield with the higher dose of P fertilization of soybean. It is mainly ascribed to the application of nitrogen and phosphorus nutrients accelerated the photosynthetic rate important to more carbohydrates production, and involved in nodulation and being the component of ATP, which regulate imperative metabolic processes in the plant, helping in root growth and biological nitrogen fixation in soil. Dry matter production depends on the photosynthetic capacity of the plant which in the sequence depends on the dry matter buildup in leaves, leaf area, and leaf area index. This is in agreement with the findings of Shafii *et al.*, 2011; Geeta and Radder, 2015; Malik *et al.*, 2006; Singh *et al.,* 1992 and Yadravi, and Angadi, 2015. The results of the experiment found apparent sustain for the results of Fageria *et al.* (1995) have formerly reported that an enormous amount of phosphorus fertilizer may require for efficiency in soybean production. Nevertheless, some contradicted results of the phosphorous fertilizer on soybean were also observed. They showed that the plant growth and yield of soybean were not pointedly persuaded by the solicitation of phosphorous fertilizer (Erhabor *et al.,* 2001). While Chiezey (2001) reported that little amount of phosphorous in soil decreases the yield of soybean.

Combined effect of nitrogen and phosphorus fertilizers on different growth and yield contributing parameters of soybean

The interaction effect of nitrogen and phosphorus fertilizers on different growth and yield contributing parameters of soybean plant has been shown in Tables 1, 2 & 3. It is obvious from the findings that there was found a significant difference in plant height of soybean due to the interaction effect of N and P treated plots. The highest plant height (36.88 cm) was obtained from the highest fertilization of N and P, whilst, the lowest plant height (27.77 cm) was obtained from the combination of 0 kg N with 36 kg P ha^{-1} treated plot. The highest dry matter weight of the soybean plant (20.81 g) was obtained from the highest doses of nitrogen and phosphorus (25 kg N with 54 kg P ha^{-1}). While the lowest dry matter weight of the plant (9.82 g) was obtained from the combined doses of 0 kg N with 0 kg P ha^{-1} treated plot. It is apparent from the results that there was observed a significant difference in the number of branches $plant^{-1}$ and number of filled pods $plant^{-1}$ except for the number of nodes $plant^{-1}$ due to the interaction effect of N and P treatment. There is a trend of producing a reduced number of empty pods plant^{-1} due to the interaction effect of the highest levels of phosphorus irrespective of nitrogen. The highest number of empty pods plant^{-1} (4.08) was found from the 0 kg N with 0 kg P ha^{-1} combination which was statistically significant with the 25 kg N with 0 kg P ha^{-1} and 40 kg N with 0 kg P ha^{-1} treatment combination-treated plot. The lowest number of empty pods plant^{-1} (1.63) was obtained from 25 kg N with 54 kg P ha^{-1} combination-treated plot. The number of seeds pod^{-1} due to the interaction effect of nitrogen and phosphorus was found statistically non-significant. The maximum (134.48) seed plant^{-1} of soybean was recorded in 25 kg N with 54 kg P ha^{-1} treatment combination and the minimum (29.36) was observed from 25 kg N with 54 kg P ha^{-1} treatment combination-treated plot.

Table 1. Interaction effect of nitrogen and phosphorus (N×P) on the morpho-physiological characters of soybean

Nitrogen and phosphorus (N×P) interaction (kg ha^{-1})	Plant height (cm)	Dry matter plant^{-1} (g)	No. of branches plant^{-1}	No. of nodes plant^{-1}
N_0P_0 (0 kg N ha^{-1} + 0kg P ha^{-1})	31.73 de	9.82 j	1.63 fg	9.27
N_0P_1 (0 kg N ha^{-1} +18 kg P ha^{-1})	29.02 fg	11.79 h	1.43 g	10.00
N_0P_2 (0 kg N ha^{-1} +36 kg P ha^{-1})	27.77 g	13.28 g	2.73 bc	9.87
N_0P_3 (0 kg N ha^{-1} +54 kg P ha^{-1})	31.53 de	16.69 e	2.87 b	10.40
N_1P_0 (25 kg N ha^{-1} +0 kg P ha^{-1})	31.22 d-f	15.48 f	2.03 e	9.20
N_1P_1(25 kg N ha^{-1} +18 kg P ha^{-1})	33.15 cd	16.69 e	2.48 cd	10.07
N_1P_2 (25 kg N ha^{-1} +36 kg P ha^{-1})	35.48 ab	17.55 d	2.70 bc	10.83
N_1P_3 (25 kg N ha^{-1} +54 kg P ha^{-1})	36.88 a	20.81 a	3.71 a	11.07
N_2P_0 (40 kg N ha^{-1} +0 kg P ha^{-1})	30.95 d-f	11.07 i	1.88 ef	10.27
N_2P_1(40 kg N ha^{-1} +18 kg P ha^{-1})	30.68 ef	20.02 b	2.34 d	9.93
N_2P_2 (40 kg N ha^{-1} +36 kg P ha^{-1})	31.13 d-f	19.66 bc	2.83 b	9.87
N_2P_3 (40 kg N ha^{-1} +54 kg P ha^{-1})	34.36 bc	19.18 c	3.55 a	9.47
Sx	0.22	0.22	0.10	0.68
Level of significance	**	**	**	NS

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), Sx = Sample standard deviation; * = Indicates significant at 5% level of probability; ** = Indicates significant at 1% level of probability; NS = Indicates not significant

Table 2. Interaction effect of nitrogen and phosphorus (N×P) on the yield contributing characters of soybean

Nitrogen and phosphorus (N×P) interaction (kg ha^{-1})	No. of filled pods plant^{-1}	No. of empty pods plant^{-1}	No. of seeds pod^{-1}	No. of seeds plant^{-1}
N_0P_0 (0 kg N ha^{-1} + 0kg P ha^{-1})	23.5 h	4.08 a	1.25	29.36 i
N_0P_1 (0 kg N ha^{-1} +18 kg P ha^{-1})	36.48 ef	3.24 b	1.63	59.62 g
N_0P_2 (0 kg N ha^{-1} +36 kg P ha^{-1})	39.86 de	3.12 bc	1.78	70.94 ef
N_0P_3 (0 kg N ha^{-1} +54 kg P ha^{-1})	52.14 b	2.78 cd	1.92	100.01 c
N_1P_0 (25 kg N ha^{-1} +0 kg P ha^{-1})	35.41 f	3.85 a	1.41	50.11 h
N_1P_1(25 kg N ha^{-1} +18 kg P ha^{-1})	44.33 c	2.20 ef	1.98	87.98 bd
N_1P_2 (25 kg N ha^{-1} +36 kg P ha^{-1})	52.34 b	2.00 f	2.05	107.15 b
N_1P_3 (25 kg N ha^{-1} +54 kg P ha^{-1})	58.28 a	1.63 g	2.31	134.48 a
N_2P_0 (40 kg N ha^{-1} +0 kg P ha^{-1})	30.41 g	4.01 a	1.14	34.75 hi
N_2P_1(40 kg N ha^{-1} +18 kg P ha^{-1})	36.14 ef	2.56 de	2.00	72.34 e
N_2P_2 (40 kg N ha^{-1} +36 kg P ha^{-1})	42.01 cd	2.37 ef	1.96	79.76 de
N_2P_3 (40 kg N ha^{-1} +54 kg P ha^{-1})	53.05 b	2.07 f	2.00	105.94 bc
Sx	1.30	0.12	0.06	3.49
Level of significance	**	**	NS	*

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), Sx = Sample standard deviation; * = Indicates significant at 5% level of probability; ** = Indicates significant at 1% level of probability; NS = Indicates not significant

Table 3. Interaction effect of nitrogen and phosphorus (N×P) on the yield contributing characters of soybean

Nitrogen and phosphorus (N×P) interaction (kg ha^{-1})	Seed wt. plant^{-1} (g)	Stover wt. plant^{-1} (g)	1000 seed wt. (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
N_0P_0 (0 kg N ha^{-1} + 0kg P ha^{-1})	3.56 a-c	4.69 h	105.0 e	1.08 i	1.28 h
N_0P_1 (0 kg N ha^{-1} +18 kg P ha^{-1})	2.49 ef	5.77 f	111.23 d	1.33 g	1.50 g
N_0P_2 (0 kg N ha^{-1} +36 kg P ha^{-1})	2.64 d-f	6.18 f	114.47 d	1.42 f	1.77 f
N_0P_3 (0 kg N ha^{-1} +54 kg P ha^{-1})	3.60 a-c	7.94 d	114.20 d	1.83 d	2.19 d
N_1P_0 (25 kg N ha^{-1} +0 kg P ha^{-1})	2.30 f	5.12 g	107.60 e	1.66 e	2.07 e
N_1P_1(25 kg N ha^{-1} +18 kg P ha^{-1})	3.15 b-e	9.49 b	114.27 d	1.81 d	2.21 d
N_1P_2 (25 kg N ha^{-1} +36 kg P ha^{-1})	3.20 a-e	9.30 b	122.10 bc	1.95 c	2.26 d
N_1P_3 (25 kg N ha^{-1} +54 kg P ha^{-1})	3.89 a	10.01 a	127.98 a	2.30 a	2.63 a
N_2P_0 (40 kg N ha^{-1} +0 kg P ha^{-1})	3.23 a-d	7.20 e	114.73 d	1.18 h	1.49 g
N_2P_1(40 kg N ha^{-1} +18 kg P ha^{-1})	3.77 ab	7.86 d	119.67 c	2.13 b	2.48 c
N_2P_2 (40 kg N ha^{-1} +36 kg P ha^{-1})	2.75 d-f	8.49 c	122.16 bc	2.14 b	2.59 b
N_2P_3 (40 kg N ha^{-1} +54 kg P ha^{-1})	2.98 c-f	9.26 b	124.41 b	2.18 b	2.70 a
Sx	0.22	0.15	1.09	0.03	0.03
Level of significance	**	*	**	**	**

In a column figures with same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), Sx = Standard deviation; * = Indicates significant at 5% level of probability; ** = Indicates significant at 1% level of probability; NS = Indicates not significant

The approximately comparable tendency was observed in the interaction effect of N and P on the weight of seeds plant^{-1} as it was exhibited on plant height, the number of filled pods plant^{-1}, and the number of seeds plant^{-}1 of soybean. At this point, as well, the highest weight of seeds plant^{-1} (3.89 g), the weight of stover plant^{-1} (10.01 g) was obtained from 25 kg N with 54 kg P ha^{-1} and the lowest weight of stover plant^{-1} (4.69 g) from the 0 kg N with 0 kg P ha^{-1} treatment combination-treated plot of soybean. The interaction effect of nitrogen and phosphorus on the 1000 seed weight of soybean was found statistically significant. Nearly the comparable yield development of soybean plant was observed in the interaction effect of N and P on seed yield as it was exhibited on the dry weight of the plant, number of filled pods plant^{-1}, number of seeds plant^{-1}, and weight of seeds plant^{-1} and the weight of stover plant^{-1}. The treatment combination of 25 kg N ha^{-1} with 54 kg P ha^{-1} treated plot produced the highest seed yield (2.30 t ha^{-1}), which was similar with 40 kg N with 54 kg P ha^{-1} and significantly highest than of other treatments. On the other hand, 0 kg N with 0 kg P ha^{-1} treated plot produced the lowest (1.08 t ha^{-1}) seed yield. Stover yield varied significantly due to the interaction effect of nitrogen and phosphorus application. Results showed that the treatment treated plots resulted noticeably in more soybean seed production than that of untreated control plots. Increased seed yield production connected with supplementary fertilizers doses might be due to the increasing effect of amplified translocation of photosynthetic products to sink from sources consequential in the superior level of yield components of soybean. The increased productivity of soybean might also be due to healthier physical, chemical, and biological characteristics of soils due to improved N utilization effectiveness that caused a parallel increase in the individual yield components. This is explained by the fact that seed or grain yield is a purpose of the relationship of an assortment of yield components. Additionally, the availability of P fertilizer influenced the uptake of other essential plant nutrients due to the responsibility of P in the soybean plant roots. The lowest responses of P to seed yields in the untreated control plots were as a result of the inherent P content of the soil. One more reason is that superior seed yield of soybean owing to different levels of NP fertilizers was may be attributable to better fertilizers receptiveness of the soybean plant. Moreover, as well, might be caused by the support of flowering and fruiting formed by the cumulative inspiring effect of N on the vegetative growth characters. Furthermore, the potential reason might be due to the more carbohydrate fabrication and absorption in seed by the effect of N and P fertilizers effects. The results indicated that elevated stover yield in soybean possibly will be obtained by 40 kg N with 54 kg P ha^{-1} treated plot. It is principally attributed to the application of nitrogen and phosphorus accelerated the photosynthetic rate most important to supplementary production of carbohydrates, involved in nodulation and being the ingredient of ATP, which regulated fundamental metabolic processes in the plant, plateful in root formation and soils biological nitrogen fixation. Plant dry matter production depends on the photosynthetic competence of the plant which consecutively depends on the dry matter buildup in leaves, leaf area, and leaf area index. This is in agreement with the result of Shafii *et al*., 2011; Geeta and Radder, 2015; Malik *et al.,* 2006; Singh *et al.,* 1992 and Yadravi, and Angadi, 2015.

An additional rationale is generally recognized for the application of nitrogen and phosphorus involved in energy transformations, the commencement of enzymes in carbohydrate metabolism, and therefore the superior transformation of photosynthates into reproductive parts. The results of the experimentation found apparent support for the findings of Yadav and Chandel, 2010; Sohrabi *et al.*, 2010; Sikka *et al.*, 2013; Bhattacharjee *et al*., 2013 and Dhage *et al*., 2014.

CONCLUSION

The experiment results were the combined application of 25 kg N ha^{-1} and 54 kg P ha^{-1} recommended for superior grain yield of soybean. Soybeans field had a sensible and cost-effective response with these recommended doses for the highest amount of production. This research found that this amount of nitrogen and phosphorus fertilizer application either individually or collectively in the soybean field had enhanced the growth and yield contributing character. Therefore, additional research is considered necessary in this route with other improved varieties of soybean to ascertain the present result.

Acknowledgement

The authors wish to express appreciation to the Department of Soil Science of the Sher-e-Bangla Agricultural University, Dhaka, Bangladesh due to its provided facilities during carried out research in the field and laboratory.

REFERENCES

BARI (Bangladesh Agricultural Research Institute) 2005. Handbook on Agro-technology. 2nd Edn., BARI, Gazipur.

Bhattacharjee, S., Singh, A.K., Kumar, M. and Sharma, S.K. 2013. Phosphorus, sulfur and cobalt fertilization effect on yield and quality of soybean (*Glycine max* L. Merrill) in acidic soil of North-East India. *Indian J. Hill Farming.,* 26(2): 63-66.

Chiezey, U.F. 2001. Pod abortion and grain yield of soybean (*Glycine max* (L) Merrill) as influenced by nitrogen and phosphorous nutrition in the Northern Guinea savanna zone of Nigeria. *Tropical Oilseeds J.,* 6: 1-10.

Dhage, S.J., Patil, V.D. and Patange, M.J. 2014. Effect of various levels of phosphorus and sulphur on yield, plant nutrient content, uptake and availability of nutrients at harvest stages of soybean (*Glycine max* L. Merrill). *Int. J. Current Microbio. Applied Sci.,* 3(12): 833-844.

Erhabor, J.O., Agboola, A.A., Eneji, A.E. and Aghimien, A.E. 2001. Soil fertility changes under oil palm based intercropping system. *Tropical Oilseeds J.,* 4: 9-20.

Fageria, N.K, Zimmerman, F.J.P. and Batigar, V.C. 1995. Lime, priterathon on growth and nutrient uptake by upland rice, wheat, common bean and corn in an Oxisol. *J. Pl. Nutri.,* 18: 2519-2532.

FAO (Food and Agriculture Organization). 2008. FAO Year book Production. Food and Agricultural Organization of the United Nations Rome. 57: 115.

FAOSTAT crop production. 2016. http://faostat.fao.org/site/567/default.aspx#ancor

Fehr, W.R. 1989. Soybean in oil crops of the world edited by Robbelen G.R.K. Downey and A. Aghri, Mcgraw Hill publishing company, 283-300pp.

Geetha, G.P. and Radder, B.M. 2015. Effect of phosphorus cured with FYM and application of biofertilizers on productivity of soybean (*Glycine max* L. Merrill.) and phosphorus transformation in soil. *Karnataka J. Agri. Sci.,* 28(3): 414-415.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research. 2nd edn, International Rice Research Institute. John Wiley and Sons Inc, Singapore. 139-240pp.

Islam, M.K., Mondal, M.A.A., Mannaf, M.A., Mondal, M.A.A., Talukder, M.A.H. and Karim, M.M. 2004. Effects of variety, inoculum and phosphorus on the performance of soybean. Agricultural Research Station, Debigonj, Panchagar, Bangladesh. *Pakistan J. Biol. Sci.,* 7: 2072-2077.

Kumaga, F.K. and Ofori, K. 2004. Response of soybean to *Bradyrhizobia* inoculation and phosphorus application. *Int. J. Agri. Bio.,* 6(2): 324-327.

Kumar, R. and Chandra, R. 2008. Influence of PGPR and PSB on *Rhizobium leguminosarum* Bv. viciae competition and symbiotic performance in lentil. *World J. Agri. Sci.,* 4(3): 297-301.

Leelavathi, G.S.N.S, Subbaiah, G.V. and Pillai, R.N. 1991. Effect of different levels of nitrogen on the yield of mungbean (*Vigna radiata* L. Wilczek). *Andhra Agri. J.,* 38: 93-94.

Malavolta, E. 1989. Abc of fertilization. Agronômica Ceres, São Paulo, 304.

Malik, M.A., Cheema, M.A., Zhan, H.Z. and Wahid, M.A. 2006. Growth and yield response of soybean (*Glycine max* L. Merrill.) to seed inoculation and varying phosphorus levels. *J. Agril. Res.,* 1: 47-51.

Mandal, M.R. and Wahhab, M.A. 2001. Production Technology of Oil crops. Oilseed Research Centre, Bangladesh Agricultural Research Institute, Joydevpur, Gazipur. 1-10pp.

Mohanyadravi and Angadi, V.V. 2016. Effect of time and method of application of varied levels of nitrogen in soybean (*Glycine max* L.). *J. Farm Sci.,* 29 (3): 332-336.

Raju, M.S. and Varma, S.C. 1984. Response of mungbean (*Vigna radiata*) to rhizobial inoculation in relation to fertilizer nitrogen. *Legume Res.,* 7: 73-76.

Raman, R. and Venkataramana, K. 2011. Effect of foliar nutrition on NPK uptake, yield attributes and yield of green gram (*Vigna radiata* L.). *Crop Res. Hisar.,* 32(1): 21-23.

Rao, A.S., Reddy, D.D. and Takkar, P.N. 1995. Phosphorus management-A key to boost productivity of soybean-wheat cropping system on swell-shrink soils. Fertilizer. News. 40: 87-95.

Shafii, F., Ali, E., Sajed, K. and Amir, E. 2011. Soybean response to nitrogen fertilizer under waterdeficit conditions. *African J. Biotec.,*10(16): 3112-3120.

Shahid, M.Q., Saleem, M.F., Khan, H.Z. and Anjum, S.A. 2009. Performance of soybean (*Glycine max* L.) under different phosphorus levels and inoculation. *Pakistan J. Agril Sci.,* 46(4): 237-241.

Sikka, R., Singh, D. and Deol, J.S. 2013. Productivity and nutrient uptake by soybean (*Glycine max* L.) as influenced by integrated nutrient and some other agronomic management practices. *Legume Res.,* 36 (6): 545- 551.

Singh, H.N., Prasad, F.W. and Varshney, J.K. 1992. Effect of nitrogen and row spacing on nodulation, growth and yield of soybean (*Glycine max* L.) var. Gaurav. *New Agriculturist*. 3: 31-34.

Singh, P.N., Jeena, S.S. and Singh, J.R. 2001. Effect of N and P fertilizer on plant growth and root characteristics in soybean. *Legume Res.,* 24(2): 127-129.

Singh, V.K. and Bajpai, R.P. 1990. Effect of phosphorus and potash on the growth and yield of rainfed soybean. *Indain J. Agron.,* 35: 310-311.

Sohrabi, Y., Habibi, A., Mohammadi, K., Sohrabi, M., Heidari, G., Khalesro, S. and Khalvandi, M. 2012. Effect of nitrogen (N) fertilizer and foliar-applied iron (Fe) fertilizer at various reproductive stages on yield, yield component and chemical composition of soybean (*Glycine max* L. Merrill) seed. *African J. Biotec.,* 11(40): 9599-9605.

Steward, W.D.P. 1966. Nitrogen fixation in plants Alhloe Press, University of London. 130 P.

Syafruddin, R.M., Saenong, S. and Jamaluddin, D. 1990. Response of soybeans (*Glycine max* L. Merrill) to P and Zn application in calcareous alluvial soil. *Soybean Abstract.* 1992, 15: 220.

Tomar, S.S., Singh, R. and Singh, S.P. 2004. Response of phosphorus, sulphur and rhizobium inoculation on growth, yield and quality of soybean (*Glycine max*. L.). *Progressive Agri.,* 4: 72-73.

USDA. 2009. Nutrient Databas for Standard Reference Release 27 (Soybean). ndb.nal.usda.gov/ndb/

Yadav, R. and Chandel, A.S. 2010. Effect of nitrogen and phosphorus nutrition at different physiological stages of soybean on yield and grain quality in uttarakhand hills. *Progressive Agri.,* 10(2): 256-259.

Yadravi, M. and Angadi, V.V. 2015. Effect of time and method of application of varied levels of nitrogen in soybean. M. Sc. (Agri.) Thesis, University Agricultural Science, Dharwad, Karnataka (India).