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Influence of phosphorus and sulphur on yield, yield attributes and biochemical composition of brinjal

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Abstract: A pot experiment was conducted in the net house of the department of Agricultural Chemistry, Bangladesh Agricultural University (BAU), Mymensingh to observe the influence of phosphorus (P) and sulphur (S) on yield, yield attributes and biochemical composition of brinjal cv. BARI brinjal-8 during the period from October, 2011 to May, 2012. The experiment was laid out in completely randomized design with 12 treatments and 3 replications using four (0, 30, 60 and 90 kg P ha^{-1}) levels of P and three (0, 15 and 30 kg S ha^{-1}) levels of S. The combinations of P and S were P_0S_0, P_0S_{15}, P_0S_{30}, $P_{30}S_0$, $P_{30}S_{15}$, $P_{30}S_{30}$, $P_{60}S_0$, $P_{60}S_{15}$, $P_{60}S_{30}$, $P_{90}S_0$, $P_{90}S_{15}$ and $P_{90}S_{60}$. Urea, muriate of potash, boric acid, zinc oxide, cowdung and poultry manure were applied with all the treatments as basal dose according to the fertilizer recommendation guide. The study revealed that yield and yield attributes such as plant height, no. of branches, no. of leaves, no. of flowers, no. of fruits, fruit length, fruit diameter, fruit weight, vitamin C and protein content of brinjal were significantly influenced by P, S and their interactions. Plant height, number of branches, leaves, flowers and fruits were increased 90, 60, 120 and 105 days after transplanting (DAT), respectively and then either decreased or remained constant. The highest values of all the parameters were obtained from P_{60} and S_{30} treatments except the vitamin C content which was maximum in P_{30} and S_{15} treatment. The results suggest that P and S @ 60 and 30 kg ha^{-1} along with basal doses of other inorganic fertilizers and organic manures can be used to increase brinjal yield and vitamin C content under the agro climatic condition of BAU.
Keywords: Phosphorus, Sulphur, Brinjal, Yield and Vitamin C.

Introduction

Plant nutrients are important for the growth, yield and yield attributing characters of vegetable crops. Brinjal is one of the most popular and widely grown vegetables in the world. It is grown extensively round the year in Bangladesh and ranks third in terms of consumption. Generally, solanaceous vegetables require large quantities of major nutrients like N, P and K. In addition, some secondary nutrients such as Ca and S also needed for better growth, fruit and seed yield. Among the plant nutrients P and S have a great influence on the yield and quality of brinjal. The efficient use of P can maximize the yield and minimize the production cost of brinjal. P is important constituent of nucleoproteins and nucleic acids of brinjal plant. It plays a vital role on root growth and development. It was believed that maximum height, highest no. of leaves, maximum no. of fruits, size and weight achieved through P application. The most obvious effect of P is on the plant root system; it promotes root formation and the formation of lateral fibrous and healthy roots (Parihar and Tripathi, 2003). S is also an essential plant nutrient. It’s function is somewhat like P in that it is involved in plant cell energetic. S also improves the yield and quality parameters of important vegetable crops. S is a constituent of secondary compounds *viz*., allin, cycloallin and thiopropanol which not only influence the taste, pungency and medicinal properties of vegetable crops but also induce resistance against pests and diseases (Tabatabai, 2001).

But imbalanced application of P and S as fertilizers increases production cost and hampers the morphological characters of brinjal. As a result, a positive interaction is required between P and S for better yield and quality of brinjal. Considering this matter, an experiment was conducted by interacting different levels of P and S along with other inorganic fertilizers and manures which aim was to evaluate the effect of P and S on yield, yield attributes and quality of brinjal.

Materials and Methods

The pot experiment was conducted in the net house of the department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh during the period from October, 2011 to May, 2012. Initial soil sample was collected from Genetics field laboratory of Bangladesh Agricultural University, Mymensingh. The collected soils from 0-15 cm depth were pulverized and inert materials, visible insect pests and plant residues were removed. The soil was air dried and then cowdung and poultry manure were mixed with soil 7 days before transplanting @ 2 t ha^{-1} and 3 t ha^{-1}, respectively. The processed soil samples were placed in the pots at the rate of 10 kg pot^{-1}. Initial soil was analyzed having soil pH (6.08), organic matter (0.71 %), total N (0.10 %), available P (12.60 µg g^{-1}), exchangeable K (0.14 cmol kg^{-1}) and available S (10.90 µg g^{-1}) by respective methods of analyses and adjusted the basal doses of urea, muriate of potash, boric acid and zinc oxide following fertilizer recommendation guide (BARC, 2010). P and S were added as per treatment and thoroughly mixed with the soil. Urea was applied in 3 installments, one-third during pot preparation and the rest two after 30 days and 60 days after transplanting (DAT). The treatments were mixed thoroughly with soil. Brinjal seeds were collected from Horticulture division of Bangladesh Agricultural Research Institute, Gazipur. Seeds were sown in pot having highly friable loose soil and one month aged three seedlings were transplanted to each prepared pot. Two seedlings were removed 15 and 30 days after transplanting from the pot keeping the healthy one undisturbed. All necessary intercultural operations (staking, weeding etc.) were performed as and when necessary throughout the growth period of the crop. Irrigation was given everyday upto 45 DAT and then every alternate day upto the harvest. Agronomic characteristics like plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$, number of cluster of flower $plant^{-1}$, number of fruits plant $^{-1}$, fruit length, fruit diameter, fruit weight, yield were collected and recorded. Fruits were harvested thrice at full maturity stage of brinjal. Vitamin C and total N contents of brinjal fruits were determined by indophenol dye extraction method (Ranganna, 1994) and semi-micro kjeldahl method (Page *et al.*, 1982). Protein content was calculated from total N content. Analysis of variance was done with the help of computer package program MSTAT-C according to Gomez and Gomez (1984) and adjudged the mean differences by DMRT test.

Results and Discussion

Yield contributing characters of BARI brinjal-8

Plant height: The plant height of brinjal varied significantly with different P fertilization and ranged from 5.89 to 79.56 cm throughout the growth period (Fig. 1). The highest plant height (79.56 cm) was recorded when P was applied @ 60 kg ha^{-1} and the lowest (73.67 cm) was recorded in control at harvesting stage. The plant height was increased with the advancement of growth period upto 90 DAT and then remained constant or slightly increased. These results were similar to those of Ahmed *et al.* (2001) who reported that the application of P @ 60 kg ha^{-1} progressively enhanced the plant height. Lower plant height of the controlled plant might be due to no application of any chemical fertilizers. The plant height of the experimental crop also varied significantly with different S levels. The tallest plant (81.25cm) was obtained when the crop was fertilized with 30 kg S ha^{-1} and the shortest plant (71.75cm) was found from control at the harvesting stage (Fig. 2). Ghosh *et al.* (2007) reported that S @ 30 kg S ha $^{-1}$ enhanced the plant height. This result was similar to Thakre *et al.* (2005) who reported that lack of S reduced plant height. Crop responses to P and S interaction for plant height have been presented in Fig. 3. It could be observed that the interaction of P and S levels had significant effect on plant height. The tallest plant was found when the crop was fertilized with 60 kg P ha^{-1} x 30 kg S ha^{-1} and the smallest was in control. It was occurred due to the synergistic effect of P and S fertilizers upto a certain level. Singh *et al.* (2000) got the similar result in chilli.

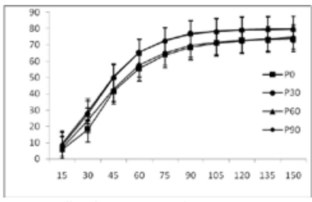

Fig.1. Effect of P on plant height of brinjal cv. BARI brinjal-8

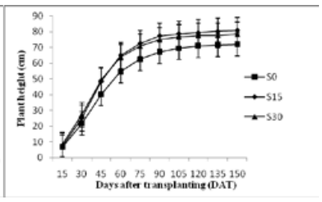

Fig.2. Effect of S on plant height of brinjal cv. BARI brinjal-8

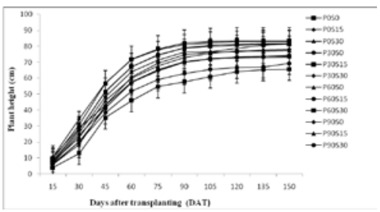

Fig.3. Interaction effect of P and S on plant height of brinjal cv. BARI brinjal-8

Number of branches plant^{-1}: From Fig. 4, it would be seen that the application of P increased the number of branches plant^{-1}. P @ 60 kg ha^{-1} produced maximum number of branches plant^{-1}, whereas control treatment produced the lowest one. All the P treatments were statistically identical with respect to this parameter. Branches were sharply increased upto 60 DAT irrespective of treatments and then slowly decreased upto 90 DAT because in this time the unwanted branches were removed and finally remained constant at 150 DAT. It is evident from the results that number of branches plant^{-1} was indeed influenced by P fertilizer but at higher level (P_{90}), the number of branches plant^{-1} was reduced. Similar type of result was found by Vijoy and Chauhan (2007) in lentil. S had a significant influence on number of branches plant^{-1}. S at the rate of 30 kg ha^{-1} produced maximum number of branches plant^{-1}, whereas control treatment produced the lowest one (Fig. 5). It appeared from the results that at high levels of S (S_{30}) the number of branches plant^{-1} again reduced. This result obtained in this regard is in accordance with the finidings of Ghosh *et al.* (2007) who reported that S increased the branch plant^{-1} of soybean up to 30 kg ha^{-1}. Result presented in Fig. 6 shows that P and S interaction on number of branch plant^{-1} was not significant. Among the treatments 60 kg P ha^{-1} x 30 kg S ha^{-1} gave the highest branch plant^{-1} and the lowest was on control treatment. Results showed that the treatment combination of P and S helped the number of branch plant^{-1}.

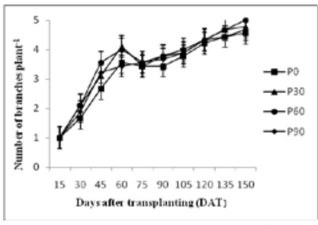

Fig.4. Effect of P on number of branches plant^{-1}

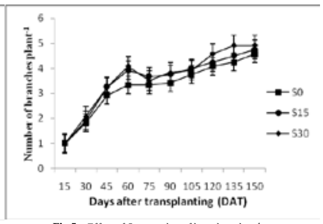

Fig.5. . Effect of S on number of branches plant^{-1}

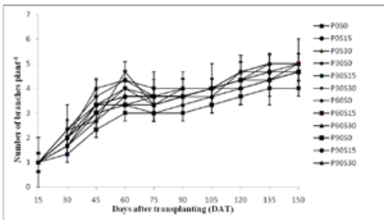

Fig.6. Interaction effect of P and S on number of branches plant^{-1}

Number of leaves plant^{-1}: The number of leaves plant^{-1} of brinjal under the study was also recorded at 15 days interval starting from transplanting up to 150 DAT. It was observed that the number of leaves was significantly influenced by the application of different doses of P and S fertilizers. Application of P rapidly increased the number of leaves upto 120 DAT and then it was drastically reduced. From Fig. 7, it would be seen that the application of P significantly increased the number of leaves plant^{-1}. The number of leaves was increased with the increased application of P but after a certain period the number was decreased because of the age of the plant. As a result, application of P @ 60 kg ha^{-1} showed the highest leaves number. But over this dose the number of leaves was decreased and similar to the application of no fertilizer which was found in P_{90} and P_0 doses. Singh *et al.* (2007) stated similar result in potato. S had a significant influence on number of leaves plant^{-1} (Fig. 8). Higher doses of S increased the number of leaves. As a result, the number of leaves was increased compared to control application. Babhulkar *et al.* (2003) stated that 35 kg S ha^{-1} application recorded a significant increase in the number of leaves in spinach. The interaction of P and S levels showed a significant effect on the number of leaves $plant^{-1}$. Fig. 9 shows that highest number of leaves was found in $P_{60}S_{30}$ treatment on 15, 30, 45, 60, 75, 90, 105, 120, 135 and 150 DAT and the lowest number of leaves was found in control treatment. But over doses of P with S fertilizers like $P_{90}S_0$, $P_{90}S_{15,}$ and $P_{90}S_{30}$ shows the approximately similar result to control.

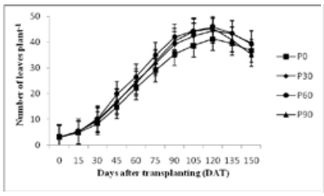

Fig.7. Effect of P on number of leaves $plant^{-1}$

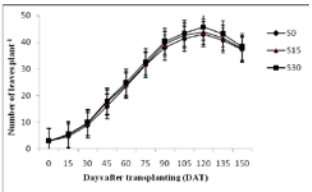

Fig.8. . Effect of S on number of leaves $plant^{-1}$

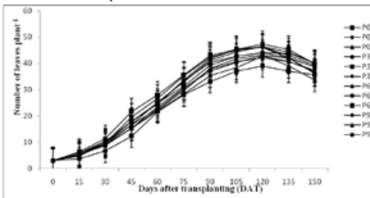

Fig.9. Interaction effect of P and S on number of leaves $plant^{-1}$

Number of cluster of flower $plant^{-1}$: The effect of different levels of P on the number of cluster of flower $plant^{-1}$ was statistically significant (except 135 DAT) (Fig. 10). From the observation it was clear that flowering started within 65 DAT and the number of flowers was gradually increased upto 105 DAT and then drastically reduced upto 120 DAT and finally became constant. The highest number of cluster of flower $plant^{-1}$ was observed (14.67) in P_{60} treatment at 105 DAT and the lowest number of cluster of flower $plant^{-1}$ was recorded in control treatment (P_0). The reasons of obtaining higher flower cluster at P_{60} treatment might be due to the contribution of optimum use of P fertilizer application. On the other hand, lower flower cluster of the controlled plant might be due to no application of any chemical fertilizers. Similar finding was found by Rathore *et al.* (2006) in mungbean. Different levels of S showed a significant effect (except 135 DAT) in the number of cluster of flower (Fig. 11). The number of clusters was gradually increased upto 105 DAT and then abruptly decreased upto 120 DAT and finally remained constant. The highest dose of S (S_{30}) produced highest number of cluster of flower at 65, 75, 90, 105, 120 and 135 DAT and the lowest was found from control. Singh *et al.* (2000) got the similar result in chilli. The interaction effects of P and S levels showed a significant effect on the number of cluster of flower $plant^{-1}$ except 65, 90 and 105 DAT. The number of flowers was gradually increased upto 105 DAT, then drastically reduced upto 120 DAT and finally remained constant. Fig. 12 showed that highest number of cluster of flowers was found in $P_{60}S_{30}$, $P_{60}S_{15}$, $P_{30}S_{15}$ and $P_{30}S_{30}$ treatments. At 65, 90 and 105 DAT the number of flower clusters is statistically significant. It was occurred due to the appropriate use and utilization of P and S at the early growth and flowering period.

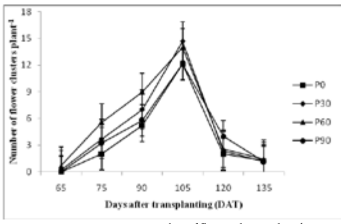

Fig.10. Effect of P on number of flower cluster $plant^{-1}$

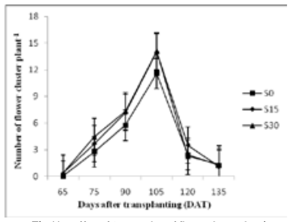

Fig.11. . Effect of S on number of flower cluster $plant^{-1}$

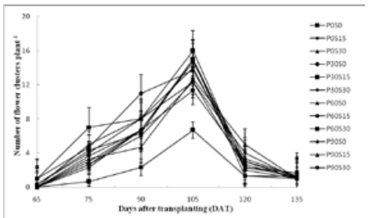

Fig.12. Interaction effect of P and S on number of flower cluster $plant^{-1}$

Number of fruits plant $^{-1}$: The number of fruits $plant^{-1}$ was significantly influenced (except 120, 135, 150 DAT) by the application of different levels of P fertilizers. Fruiting started from 78 DAT. The highest number of fruits $plant^{-1}$ was produced in P_{60} treatment, second highest achieved at P_{30} treatment whereas lowest was in P_0 treatment that was about similar to P_{90} treatment at 78, 90, 105, 120,135 and 150 DAT shown in Fig. 13. The number of the fruits was higher in P_{60} and P_{30} because of optimum utilization of fertilizer throughout the growth period. The number of the fruits was lower in control treatment where plants might not obtain sufficient amount of nutrient when necessary throughout the growth period and at P_{90} treatment the amount of P was higher than the optimum level. So, it performed negative impact resulted the lower number of fruits. Rajput and Verma (2002*)* stated that application of P increased the number of pods in groundnut. Stepwise increase in the application of S significantly increased the number of fruits $plant^{-1}$ (Fig. 14). Higher number of fruits per plant was obtained at S_{30} level (4.75 $plant^{-1}$) at 105 DAT compared to control. This was similar to the result of Tabatabai (2001). The lowest number of fruits $plant^{-1}$ noticed in P_0S_0 and the highest number was in $P_{60}S_{30}$ combination. However, the interaction effect found to be significant.

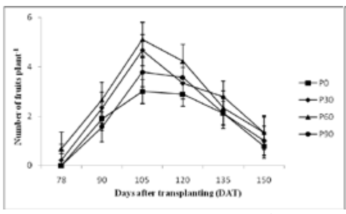

Fig.13. Effect of P on number of fruit $plant^{-1}$

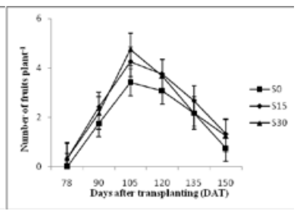

Fig.14 . Effect of S on number of fruit $plant^{-1}$

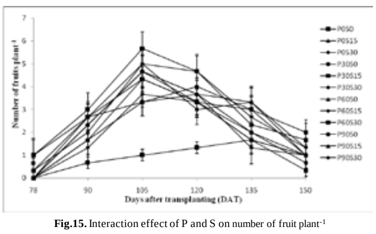

Fig.15. Interaction effect of P and S on number of fruit $plant^{-1}$

Fruit length: The fruit length was significantly influenced by P application (Table 1). The longest fruit (21.60 cm) was recorded with P_{60} level over P_{30} (21.14 cm), P_{90}

(18.82 cm) and P_0 (18.08 cm). Badiger *et al.* (2006) reported that fruit length of tomato increased significantly up to 50 kg P_2O_5 ha^{-1} application. Application of S significantly influenced the fruit length. The highest fruit length was noticed with S application @ 30 kg ha^{-1} (20.94 cm) followed by S_{15} (20.72cm) and the lowest fruit length was noticed in S_o (18.07cm). Bhagavantagoudra and Rokhade (2009) reported that higher dose of S (25-35 kg ha^{-1}) increases the size and shape of cabbage. Interaction effects of P and S was found significant with respect to fruit length (Table 3). However, $P_{60}S_{30}$ treatment combination recorded higher fruit length (23.04 cm) and control represented the lower (14.56 cm). It was obtained from Sivakumaran (2005) that different levels of P and S enhances the fruit size and shape of plant.

Fruit diameter: Application of P significantly increased the fruit diameter (Table 1). The highest fruit diameter (4.32 cm) was found at P_{60} treatment and the lowest diameter (3.43 cm) was found in P_0 treatment. Pramanick and Singh (2004) observed that P @ 60 kg ha^{-1} application showed the highest fruit diameter of tomato. There was no significant effect of S fertilizer on fruit diameter (Table 2). Actually, it increased the biochemical elements such as amino acids, chlorophyll etc. The highest fruit diameter (3.88 cm) was found in S_{15} treatment and the lowest (3.49 cm) in control treatment. Babhulkar *et al.* (2003) reported that S fertilizer helps in the chemical composition of vegetable crops. In general, the interaction effect was found non significant (Table 3). Nevertheless, $P_{60}S_{30}$ treatment combination recorded the highest fruit diameter (4.61cm). The lowest diameter of 2.52 cm was recorded in control (P_0S_0). Similar finding was found by Hariyappa (2006) that optimum levels of P and S increased the fruit diameter of onion.

Table 1. Effect of P on fruit length (cm), fruit diameter (cm), fruit weight $plant^{-1}$ (g), yield (kg) and yield (tha^{-1}) of brinjal cv. BARI brinjal-8

Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g $plant^{-1}$)	Yield (t ha^{-1})	Vitamin C (mg 100^{-1} g)	Protein content (%)
P_0	18.08b	3.43b	619.51b	18.43b	7.18b	4.62c
P_{30}	21.14a	3.55b	815.33a	23.91a	12.76a	5.62ab
P_{60}	21.60a	4.32a	894.12a	26.27a	11.03a	6.44a
P_{90}	18.82b	3.5b	591.50b	17.59b	10.54a	4.91bc
SE±	1.201	0.350	110.179	2.627	1.762	0.094
CV (%)	6.03	9.46	12.09	12.19	9.36	8.04

N.B.: Means following by the same letter in a column are not significantly different at 1% level by DMRT.CV=Coefficient of variation

Table 2. Effect of S on fruit length (cm), fruit diameter (cm), fruit weight $plant^{-1}$ (g), yield (kg) and yield (tha^{-1}) of brinjal cv. BARI brinjal-8

Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g $plant^{-1}$)	Yield (t ha^{-1})	Vitamin C (mg 100^{-1} g)	Protein content (%)
S_0	18.07b	3.49	605.21c	18.25b	8.51b	5.03b
S_{15}	20.72a	3.88	779.17b	22.88a	11.58a	5.38ab
S_{30}	20.94a	3.75	805.96a	23.52a	11.04ab	5.67a
SE±	1.387	0.405	127.224	3.033	2.034	0.109
CV (%)	6.03	9.46	12.09	12.19	9.36	8.04

N.B.: Means following by the same letter in a column are not significantly different at 1% and 5% level by DMRT. CV=Coefficient of variation

Fruit weight $plant^{-1}$: The fruit weight increased significantly with increase in P levels. The heaviest fruit (894.12 g) was recorded when P was applied @ 60 kg ha^{-1} which was significantly higher than P_{30} (815.33 g), P_0 (619.51 g) and P_{90} (591.50 g) $plant^{-1}$ (Table 1). Tiwari and Agarwal (2003) showed that fruit weight of garlic was increased by 60 kg ha^{-1} P application. Application of S resulted in a significantly higher fruit weight over control. The highest fruit weight (805.96g) was obtained with S_{30} level, which was significantly superior to S_{15} (779.17 g) and S_o (605.21 g). Jaggi (2005) reported that application of S @ 30 kg ha^{-1} resulted the highest fruit weight of onion. Interaction effects of P and S was found significant with respect to fruit weight (Table 2). However, $P_{60}S_{30}$ treatment combination recorded higher fruit weight (1069.15 g) and control represented the lowest weight (422.72 g). Singh and Agarwal (2007) reported that P in combination of optimum S produced highest fruit weight of potato.

Fruit yield: Phosphorus levels significantly influenced the fruit yield of brinjal. The treatment P_{60} level recorded significantly higher fruit yield (26.27 t ha^{-1}) compared to other phosphorus levels (Table 1). The lowest fruit yield was noticed in the P_{90} (17.59 t ha^{-1}). Badiger *et al.* (2006) found that application of P @ 60 $kgha^{-1}$ increases the yield of tomato. S fertilization resulted in significant increase in the fruit yield of brinjal. Application of S @ 30 kg ha^{-1} recorded significantly higher fruit yield (23.52 t ha^{-1}) compared to other S levels. Similar type of results were found by Agrawal and Mishra (2004) in brinjal. Interaction effects of P and S was found statistically significant with respect to yield (Table 3). However, $P_{60}S_{30}$ treatment combination recorded the highest yield (31.22 t ha^{-1}) and control (P_0S_0) showed the lowest (13.24 tha^{-1}). Jaggi *et al.* (2005) found that application of P fertilizers in combination with S fertilizer @ 60 kg P ha^{-1} x 30 kg S ha^{-1} statistically enhanced the yield in chilli.

Table 3. Interaction effect of P and S on fruit length (cm), fruit diameter (cm), fruit weight $plant^{-1}$ (g), yield (kg) and yield (t ha^{-1}) of brinjal cv. BARI brinjal-8

Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g $plant^{-1}$)	Yield (t ha^{-1})	Vitamin C (mg 100^{-1} g)	Protein content (%)
P_0S_0	14.56	2.52	422.72e	13.24e	4.62d	3.63g
P_0S_{15}	19.95	4.06	698.70bc	21.00bc	10.29bc	4.97def
P_0S_{30}	19.74	3.72	737.11bc	21.05bc	6.62cd	5.26cde
$P_{30}S_0$	19.41	3.77	742.89bc	21.77bc	10.29bc	4.50efg
$P_{30}S_{15}$	22.10	3.49	813.88b	23.24b	10.29bc	6.38b
$P_{30}S_{30}$	21.90	3.40	889.21a	26.71a	12.50ab	5.91bc
$P_{60}S_0$	20.17	4.15	683.21bc	19.81bc	8.82bcd	6.14b
$P_{60}S_{15}$	21.59	4.19	930.00a	27.79a	16.17a	5.73bcd
$P_{60}S_{30}$	23.04	4.61	1069.15a	31.22a	13.29ab	7.43a
$P_{90}S_0$	18.16	3.52	572.02cd	18.17cd	10.29bc	5.91bc
$P_{90}S_{15}$	19.22	3.76	674.09c	19.50c	9.56bc	4.56efg
$P_{90}S_{30}$	19.09	3.25	528.38de	15.10de	11.76b	4.21fg
SE±	0.693	0.202	63.612	1.517	1.017	0.054
CV (%)	6.03	9.46	12.09	12.19	9.36	8.04

N.B.: Means following by the same letter in a column are not significantly different at 1% level by DMRT. CV=Coefficient of variation

Biochemical composition of brinjal fruit: Vitamin C: Phosphorus had significant effect (Table 1) on vitamin C content of brinjal. The highest content (12.76 mg 100 g^{-1}) was observed from the treatment of 30 kg P ha^{-1} and the lowest content (7.18 mg 100 g^{-1}) was found in the control treatment. This finding was similar to those of Hariyappa (2006) who reported that vitamin C content increased from 19.05% to 21.09% with increase in P rate but above 40 kg P ha^{-1} application the content is decreased. S had significant effect on vitamin C content of brinjal. The highest content (11.58 mg 100 g^{-1}) was observed from treatment of 15 kg S ha^{-1} (Table 2) and the lowest content (8.51 mg 100 g^{-1}) was found in the control treatment. These findings were similar to those of Singh *et al.* (2000) who reported that application of S significantly increased the vitamin C content of fruit of chilli. The interaction effects of P and S on vitamin C content was significant (Table 3). The highest content (16.17 mg 100 g^{-1}) was found from the treatment of 60kg P ha^{-1} x 15 kg S ha^{-1} ($P_{60}S_{15}$) and the lowest content (4.62 mg 100 g^{-1}) was found in the control treatment. Singh *et al.* (2000) reported that the higher vitamin C content was recorded with the application of P @ 60 kg ha^{-1} and S @ 15 kg ha^{-1} in chilli.

Protein content: Phosphorus had significant effect on protein content of brinjal. The highest content 6.44% was observed from the treatment of 60 kg P ha^{-1} (Table 1) and the lowest (4.62%) content was found in the control treatment. The above findings were similar to those of Rathore *et al.* (2006) who reported that protein content in fruit was increased with the increasing rate of P application and P @ 60 kg ha^{-1} produced maximum protein content in mungbean. The protein content in brinjal fruits was statistically influenced due to S application. The maximum content (5.67%) was observed from treatment of 30 kg S ha^{-1} (Table 2) and the minimum content (5.03%) was found in the control treatment. The above findings are similar to those of Sivakumaran (2005) who reported that S application increased protein content in coriander fruit. It appears from the results that application of increased level of S up to 40 kg ha^{-1} because there is a synergistic effect between S and N. The interaction effects of P and S on protein content was statistically significant. The highest content (7.43%) was observed from the treatment of $P_{60}S_{30}$ and the lowest (3.63%) content was found in the control treatment (Table 3). This finding was similar to those of Hariyappa (2006) who reported that protein content increased in $P_{60}S_{30}$ level in onion.

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