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Influence of Sulphur and Boron on Growth and Yield of Garden Pea (*Pisum sativum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors KK and TM planned the experiment and lead the research. Authors SKD, KK and TM designed and carried out the research. Author MMH performed the statistical analysis. Authors SKD and MFS carried out the research on the field. Authors SKD, KF and FAT collected the data. Authors SKD and MMH wrote the manuscript. Authors FAT, AS, KF and MFS managed the literature searches. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from October, 2018 to March, 2019 to study the influence of sulphur and boron on growth and yield of garden pea. The experiment comprised of two factors. Factor A: Levels of Sulphur (4 levels); S0: 0 kg S/ha (Control), S1: 10 kg S/ha, S2: 20 kg S/ha, S3: 30 kg S/ha and Factor B: Levels of Boron (4 levels); B0: 0 kg B/ha (Control), B1: 1 kg B/ha, B2: 2 kg B/ha, B3: 3 kg B/ha. This experiment was laid out in Randomized Complete Blocked Design (RCBD) with three replications. Sulphur and Boron application influenced significantly on most of the parameters. In case of sulphur, maximum plant height (50.84 cm), number of pods per plant (14.00), pod length (8.95 cm), number of seeds per pod (5.56) and green pod yield (10.76 t/ha) were recorded from S3 treatment. In case of boron application, maximum plant height (49.17 cm),

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number of pods per plant (13.48), pod length (8.66 cm), number of seeds per pod (5.41) and green pod yield (10.14 t/ha) were found in B2 treatment. Among the treatment combination, S3B2 treatment gave the highest green pod yield (12.19 t/ha) and the lowest (5.38 t/ha) was obtained from S0B0 treatment. So, garden pea sown at 30 kg S/ha with 2 kg B/ha for suitable green pea production in Dhaka region.

Keywords: Boron; garden pea; growth; production; sulphur and yield.

1. INTRODUCTION

Garden pea (*Pisum sativum* L.), a member of Papilionaceae family, is one of the principal vegetable crops originated in Central Asia and Abyssinian region, grown during cool season throughout the world. At the global level, garden pea covers an area of about 2.58 million hectares with a production of 19.87 million tonnes and productivity of 7.67 tonnes per hectare [1]. It is a cool season crop now grown in many parts of the world. Pea is an annual herbaceous plant. The plants are succulent erect in case of garden pea while in case of field pea, they have a tendency to climb when provided support. Plants bear tap root system with nodules on the surface. Stem is hollow, slender, succulent and ridged. It bears pinnately compound leaves with three pairs of leaf-lets and terminal one is modified into a branched tendril. At the base of the petiole (on the stem) large pair of stipules on bracts is found and they cover the petioles in such a way that leaves look like sessile. The green pods and immature seeds are rich in vitamin and have a balanced amino acid composition. Moreover, some important mineral such as calcium, phosphorus, iron are present in abundant quantities in peas. The crop becomes popular for its high nutritive value and good taste. It contains 15-35% protein, 20-50% starch, 4-10% sugar, 0.6-1.5% fat and 2-4% minerals [2]. In Bangladesh people consumes 23 g vegetables per head per day but the minimum requirement is 200 g per head per day [3]. At present pea is being cultivated in an area of 17746 acres with a production of 8139 metric tons [4]. Use of sulphur free and less application of boron fertilizers has created deficiencies of these nutrients while as the organic manures are used in very less amount which are the source of different macro as well as micro-nutrients including sulphur and boron, this has resulted in the deficiencies of sulphur and boron in the soils. The deficiency of these nutrients in the soils limits the growth and yield of various vegetable crops including garden pea, indicating the need of their application [5]. Sulphur is a plant nutrient with a crop requirement similar to that of phosphorus. Sulphur is known as the fourth major plant nutrient [6]. It is essential constituent of sulphur containing amino acids cystine, cysteine and methionine and plays vital role in regulating the metabolic and enzymatic process including photosynthesis, respiration and symbiotic N fixation, besides being responsible for the synthesis of vitamins such as biotine, thiamine, vitamin B and certain coenzymes [7,8]. It has been observed when Sulphur is present in critical amount of soil (less than 10 ppm), the plant growth, quality and total production of crop is adversely affected [5]. Sulphur application in vegetable crops have been found to improve quality attributes, protein content, oils and vitamins [9,10]. Sulphur also helps in improving the nutrient content and uptake of nutrients in legume crops [11].

Boron is one of the essential micronutrient required for normal growth of most of the plants. Boron is required for proper development and differentiation of tissues besides being helpful in reducing sterility and malformation in reproductive organs [12]. The boron improves the grain and straw yield, nutrient content, nutrient uptake and quality in legume crops [13]. Sinha et al. [14] indicates that variation in boron supply influence plant growth in tomato cv. DL- 3, which became apparent after 32 days of sowing. Boron deficiency symptoms included the shortening of internode, and development of thick, brittle and outward curled young leaves. Under excessive boron, toxicity symptoms appeared on the growth of plants and was markedly reduced, old leaves developed marginal necrosis, and the number of size lamina were reduced. In low and excessive boron, the concentration of reducing, non-reducing and total sugars and phenols were high in fruits. The concentration of starch, ascorbic acid and dycopene were low in low boron situation.

The combined application of sulphur and boron improves the germination, seedling growth and yield attributes of garden pea [15]. Keeping in view the importance of secondary element sulphur and micronutrient boron, an investigation

has been carried out to assess the effects of sulphur and boron for higher yield and quality in garden pea under Dhaka agro-climatic conditions.

2. MATERIALS AND METHODS

2.1 Experimental Site and Experiment Frame Work

The experiment was conducted at the Horticulture Research Farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh during October 2018 to March 2019. Experimental site situated an elevation of 8 meters above the sea level in Agro-ecological zone of "Madhupur Tract" (AEZ-28) [16]. The soil was silty loam and medium high land in texture having pH with a pH 5.6. The experiment consisted of two factors. Factor A: Sulphur fertilizer (four levels) as- S_0= Control (No Sulphur), S_1=10 kg S/ha, S_2=20 kg S/ha and S_3=30 kg S/ha and Factor, B: Boron fertilizer (four levels) as- B_0= Control (No Boron), B_1=1 kg B /ha, B_2=2 kg B /ha, B_3=3 kg B/ha. The two factors experiment was laid out following Randomized Complete Block Design (RCBD) with three replications. The experiment was divided into three equal blocks where each block was divided into 16 plots. Then 16 treatment combinations were allotted at randomly in each block. Each unit of plot was 0.8m × 0.6 m in size. All together there were 48 plots in experiment. Distance between replication was 1 m and plot to plot was 0.5 m. The treatments were assigned randomly to each block as per design of the experiment.

2.2 Planting Materials

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

2.3 Application of Manure and Fertilizer

Urea, Triple super phosphate (TSP), Muriate of potash (MoP), zinc sulphate, gypsum and boric acid were used as a source of nitrogen, phosphorous, potassium, zinc, sulphur and boron respectively. Urea, Triple super phosphate (TSP), Muriate of potash (MoP) and zinc sulphate were applied at the rate of 90, 60, 60, and 2.0 kg/hectare, respectively following the BARI recommendation but sulphur and boron and were applied as per treatment. All of the fertilizers except urea were applied during final land preparation. The fertilizers were mixed thoroughly with the soil and rest nitrogen was applied in two equal splits on 05 December and 25 December, 2018.

2.4 Harvesting

Harvesting was done according to its maturity. Green pods were harvested at tender stage on 15 January. After harvest pods were separated from plants. Then plants and pods were weighed.

2.5 Statistical Analysis

The data obtained for different parameters were statistically analysed by MSTAT-C computer package. The significance of the difference among the treatment combinations means was compared by LSD test at 5% level of probability [17].

3. RESULTS AND DISCUSSION

3.1 Plant Height

Plant height of garden pea influenced significantly by the application of different levels of sulphur dose at 30, 45 days after sowing (DAS) and at harvesting (Fig. 1). At 30 DAS and 45 DAS, the tallest plant (31.40 cm and 41.49 cm, respectively) was recorded from S_3 while the shortest plant (23.10 cm and 32.72 cm, respectively) from S_0. At harvest, the tallest plant (50.84 cm) was observed in S_3 while the shortest plant (39.49 cm) was in S_0. This height was due to the temperature variation. Similar results had been reported by Khanna and Gupta, [18]. Plant height of garden pea influenced significantly by the application of different levels of boron (Fig. 2). The highest plant height for 30 DAS and 45 DAS was (30.29 cm and 40.38 cm, respectively) was found in B2 and the smallest plant height (24.10 cm, 33.95 cm, respectively) was found from B_0. At harvesting, the tallest plant (49.17 cm) was recorded from B2 and the shortest plant (40.72 cm) was recorded from B0. Similar finding have been reported by Prasad et al. [19]. The plant height was significantly influenced by the combined effect of the sulphur and boron dose at 30, 45 DAS and at harvesting (Table 1). At 30 DAS, the highest plant height (34.76 cm) was measured from the S3B2, which was statistically similar with S3B3 and the lowest (21.56 cm) was

recorded from S0B0. At 45 DAS, the highest plant height (44.56 cm) was measured from S3B2, which was statistically similar with S3B3 and S2B2 and the lowest (30.80 cm) from S0B0. At harvesting, the highest plant height (55.10 cm) was measured from S3B2, which was statistically similar with S3B3and S2B2, respectively and the lowest (37.73 cm) from S0B0. This result supports with the findings of Kaisher et al. [20].

3.2 Days to First Flowering

Statistically significant variation was recorded due to different levels of sulphur on the days to first flowering (Table 2). The S0 treatment took the shortest time (24.41 days) and S3 (30 kg S/ha) treatment took maximum time (27.41 days) to first flowering. This treatment was statistically identical with S2. There was significant variation was found on the days to first flowering due to the application of different levels of boron (Table 3). From this experiment it showed that B2 took maximum days (27.41) for flower initiation which was statistically similar with B3 treatment and B0 treatment took minimum days (24.41) for flower initiation. Boron helps to increase first flowering days of pea. Combined effect was found significantly influenced due to the different levels of sulphur and boron application dose on the days to first flowering (Table 4). The S2B2 took maximum days (29.0) to first flower initiation. This treatment was statistically similar with S2B3, S3B2 and S3B3, respectively. On the other hand, The S0B0 minimum days (23.33) to first flowering.

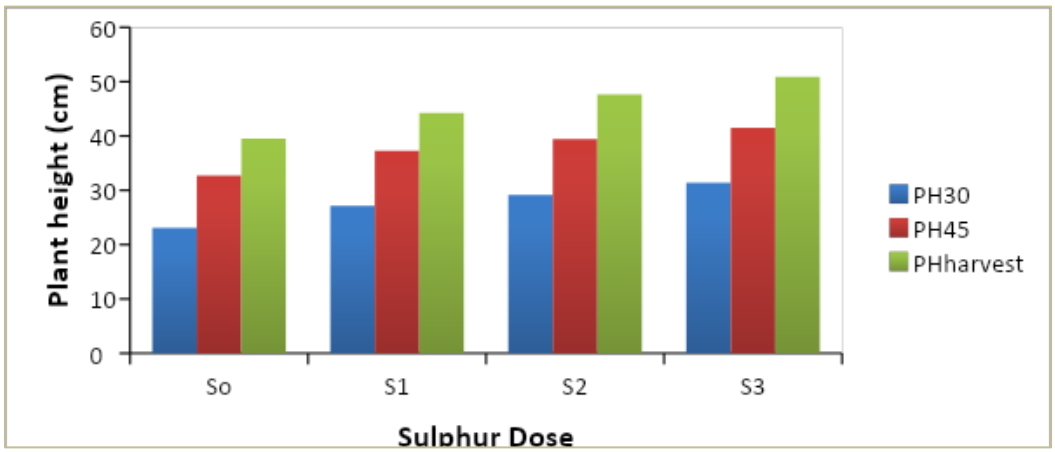

Fig. 1. Effect of different levels of sulphur on plant height of garden pea

Here, S0= Control (No Sulphur), S1= 10 kg S/ha, S2= 20 kg S/ha, S3= 30 kg S/ha, PH30= plant height at 30 days, PH45= plant height at 45 days, PHharvest= plant height at harvest

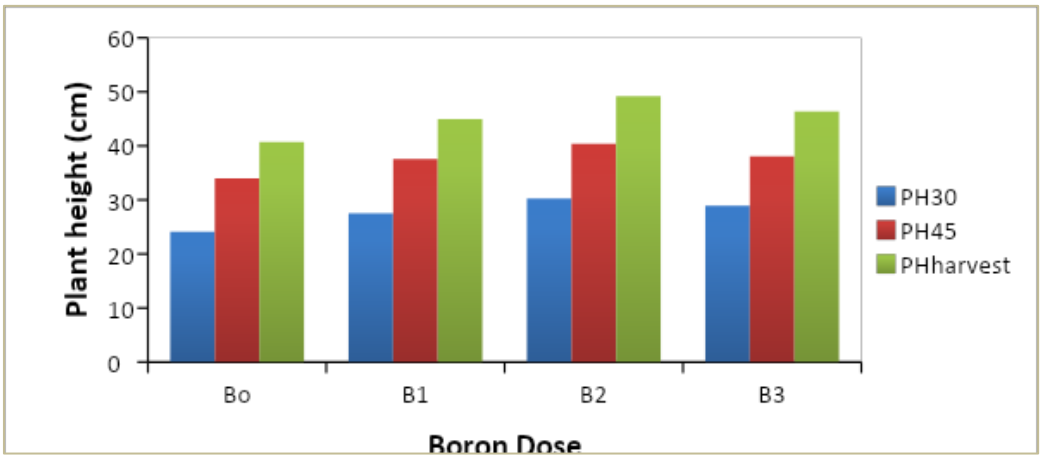

Fig. 2. Effect of different levels of boron on plant height of garden pea

Here, B0= Control (No Boron), B1= 1 kg B/ha, B2= 2 kg B/ha, B3= 3 kg B/ha; PH30= plant height at 30 days, PH45= plant height at 45 days, PHharvest= plant height at harvest

Table 1. The combined effect of different levels of sulphur and boron on plant height of garden pea

Treatments	Plant height at 30 DAS	Plant height at 45 DAS	Plant height at Harvest
S0B0	21.56 l	30.80 j	37.73 l
S0B1	22.43 kl	31.83 j	38.40 l
S0B2	24.63 i-k	34.80 hi	41.43 i-l
S0B3	23.80 j-l	33.46 ij	40.40 j-l
S1B0	23.06 j-l	32.73 ij	39.30 kl
S1B1	27.66 f-h	37.76 e-g	44.46 f-i
S1B2	29.56 d-f	40.13 c-e	47.73 d-f
S1B3	28.16 e-g	38.60 d-f	45.50 e-h
S2B0	25.26 h-j	35.40 g-i	42.50 h-k
S2B1	28.70 e-g	39.33 c-f	46.43 e-g
S2B2	32.20 bc	42.03 a-c	52.43 a-c
S2B3	30.46 c-e	40.83 b-d	49.16 c-e
S3B0	26.53 g-i	36.86 f-h	43.36 g-j
S3B1	31.23 b-d	41.26 b-d	50.53 b-d
S3B2	34.76 a	44.56 a	55.10 a
S3B3	33.10 ab	43.26 ab	54.36 ab
CV%	7.41	8.67	8.25
LSD	2.40	2.85	3.91

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0= Control (No Sulphur), S1= 10 kg S/ha, S2= 20 kg S/ha, S3= 30 kg S/ha and B0= Control (No Boron), B1= 1 kg B/ha, B2= 2 kg B/ha, B3= 3 kg B/ha; DAS= Days after sowing

3.3 Number of Pods per Plant

The number of pods per plant was significantly influenced by different levels of sulphur (Table 2). The highest number of green pods per plant (14.00) was recorded from S3 and the lowest number of pods per plant (10.00) was found in S0. Similar findings have been reported by Kasturikrishna and Ahlawat, [21]. The effect of different levels of boron on number of pods per plant was statistically significant (Table 3). The highest number of green pods per plant (13.48) was recorded from the B2 and the lowest number of pods per plant (10.49) was found in the B0. Combined effect of different levels of sulphur and boron showed a significant variation on the number of pods per plant (Table 4). Plant sowing S3B2 produced the highest number of pods per plant (15.50). This treatment was statistically similar with S3B3 and S2B2, respectively. The lowest number of pods per plant 9.20 found was in the treatment of S0B0. It was resemblance with the findings of Kaisher et al. [20].

3.4 Pod Length

The pod length differed significantly observed due to the effect of different levels of sulphur (Table 2). The highest pod length (8.95 cm) was recorded in S3. The lowest pod length (6.72 cm) was found in S0. These results are in agreement to the findings obtained by Khanna and Gupta, 2005 [18]. Significant variation was observed among the boron levels in respect of pod length of garden pea (Table 3). The highest pod length (8.66 cm) was recorded from B2 and the lowest pod length (7.02 cm) was found in B0. The combined effect of different levels of sulphur and boron on the pod length was significant (Table 4). The highest pod length (9.70 cm) was recorded from the treatment combination of S3B2 which was statistically similar with S2B2, respectively. The lowest pod length (6.24 cm) was found in the S0B0.

3.5 Pod Breadth

Difference in pod breadth was observed non-significant effect as to the varied levels of sulphur application (Table 2). The highest pod breadth (1.43 cm) was recorded from S3 and the lowest pod breadth (1.24 cm) was found in S0. There are no significant differences among the levels of boron in the pod breadth of garden pea (Table 3). The highest pod breadth (1.41 cm) was recorded from B2 and the lowest pod breadth (1.26 cm) was found in the B0. The combined effect of different levels of sulphur and boron

application was also observed statistically non-significant (Table 4). The highest pod breadth (1.51 cm) was obtained from the treatment combination of S3B2 and the lowest pod breadth (1.19 cm) was obtained from the S0B0.

Table 2. The effect of different levels of sulphur on yield and yield attributes of garden pea

Treatments	Days to first flowering	Number of pods/plant	Pod length (cm)	Pod breadth (cm)
S0	24.41 c	10.00 d	6.72 d	1.24
S1	25.66 b	11.90 c	7.85 c	1.33
S2	27.41 a	12.97 b	8.42 b	1.39
S3	27.41 a	14.00 a	8.95 a	1.43
CV%	11.46	9.98	8.16	10.97
LSD	0.68	0.74	0.16	----

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0=control (no sulphur), S1=10 kg S/ha, S2=20 kg S/ha, S3=30 kg S/ha

Table 3. The effect of different levels of boron on yield and yield attributes of garden pea

Treatments	Days to first flowering	Number of pods/plant	Pod length (cm)	Pod breadth (cm)
B0	24.41 c	10.49 c	7.03 d	1.26
B1	26.25 b	12.09 b	7.93 c	1.35
B2	27.41 a	13.48 a	8.66 a	1.41
B3	26.83 ab	12.08 b	8.33 b	1.38
CV%	11.46	9.98	8.16	10.79
LSD	0.59	0.61	0.24	----

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, B0=control (no Boron), B1=1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

Table 4. The combined effect of different levels of sulphur and boron on yield and yield attributes of garden pea

Treatments	Days to first flowering	Number of pods/plant	Pod length (cm)	Pod breadth (cm)
S0B0	23.33 i	9.20 m	6.24 n	1.19
S0B1	24.33 g-i	9.60 lm	6.42 n	1.22
S0B2	25.33 e-h	10.80 i-l	7.22 kl	1.28
S0B3	24.66 g-i	10.40 j-m	7.01 lm	1.26
S1B0	24.00 hi	10.03 k-m	6.77 m	1.24
S1B1	25.66 e-g	11.93 f-i	7.92 hi	1.34
S1B2	26.66 c-e	13.20 c-f	8.54 ef	1.40
S1B3	26.33 d-f	12.43 e-h	8.18 gh	1.36
S2B0	25.00 f-h	11.10 h-k	7.44 jk	1.30
S2B1	27.33 b-d	12.86 d-g	8.35 fg	1.38
S2B2	29.00 a	14.43 a-c	9.43 ab	1.46
S2B3	28.33 ab	13.50 b-e	8.70 de	1.42
S3B0	25.33 e-h	11.63 g-j	7.67 ij	1.32
S3B1	27.66 a-d	13.96 b-d	9.01 cd	1.44
S3B2	28.66 ab	15.50 a	9.70 a	1.51
S3B3	28.00 bc	14.90 ab	9.20 bc	1.48
CV%	11.46	9.98	8.16	10.97
LSD	1.35	1.48	0.33	----

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0= Control (No Sulphur), S1=10 kg S/ha, S2=2o kg S/ha, S3= 30 kg S/ha and B0= Control (No Boron), B1=1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

3.6 Green Pod Yield per Plant (g)

It was observed that the significant influence of different levels of sulphur application on green pod yield of garden pea (Table 5). The highest pod weight (46.41 g) was recorded from S3 whereas the lowest pod yield per plant (29.83 g) was observed from S0. This result is in agreement with the findings of Malik and Abraham, [22]. Different levels of boron showed statistically significant differences on pod weight of garden pea (Table 6). The highest pod weight (44.66 g) was found from B2, while the lowest pod yield per plant (31.0 g) was found from B0. These findings have the resemblance with the result of Prasad et al. [19]. The difference in fresh pod weight per plant was significantly influence by combined application of sulphur and boron in garden pea (Table 7). The highest pod yield/plant (54.0 g) was recorded from the treatment combination of S3B2 which was statistically similar with S3B3 treatment combination. On the other hand, the lowest pod yield/plant (26.66 g) was found from S0B0. Nasreen and Farid, [15] reported that combined application of sulphur and boron markedly improved the growth and yield related attributes of pea.

3.7 Number of Seeds per Pod

Statistically significant differences were found among the sulphur levels as to the number of seeds per pod (Table 5). The maximum number of seeds per pod (5.56) was found from S3 while the lowest number of seeds per pod (4.26) was obtained in S0. Similar results were recorded by Kasturikrishna and Ahlawat [21] in pea. Different levels of boron application had also significant effect on the number of seeds per pod (Table 6). The highest number of seeds per pod (5.41) was obtained when the application of boron with B2 which was statistically identical with B3 treatment and the lowest number of seeds per pod (4.45) was obtained in the B0. It was also resemblance with the findings of Kaiser et al. [20]. Distinct difference was found due to the varied levels of combined sulphur and boron application in respect of number of seeds per pod (Table 7). The highest number of seeds per pod (5.93) was obtained from the S3B2, which was statistically identical with S3B3. The lowest number of seeds per pod (3.80) was obtained from the S0B0. This might be due to optimum sulphur and boron improved pollen germination and pollen tube growth probably restricted fertilization. Boron in needed for the production and translocation of sugars to be used as energy source of pollen tube growth [23].

3.8 Weight of 10 Green Pods (g)

Different levels of sulphur varied significantly in terms of weight of 10 green pods of garden pea (Fig. 3). The highest weight of 10 green pods (46.16 g) was found from S3, while the lowest weight of 10 green pods (29.0 g) was recorded from S0. Weight of 10 green pods showed statistically significant differences due to different levels of boron (Fig. 4). The highest weight of 10 green pods (44.50 g) was recorded from B2, whereas the lowest weight of 10 green pods (31.0 g) was observed from B0. Statistically significant variation was recorded due to the combined effect of different levels of sulphur and boron levels in terms of weight of 10 green pods of garden pea (Table 7). The highest weight of 10 green pods (51.33 g) was observed from S3B2 which was statistically identical with S3B3 and statistically similar with S2B2 and S3B1. The lowest weight of 10 green pods (25.33 g) was recorded from S0B0.

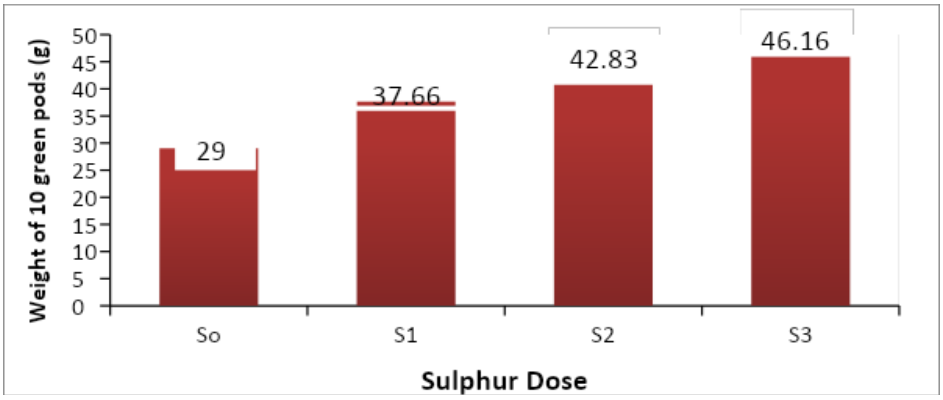

Fig. 3. The effect of different levels of sulphur on weight of 10 green pod (g) of garden pea
Here, S0=control (no sulphur), S1=10 kg S/ha, S2=20 kg S/ha, S3=30 kg S/ha

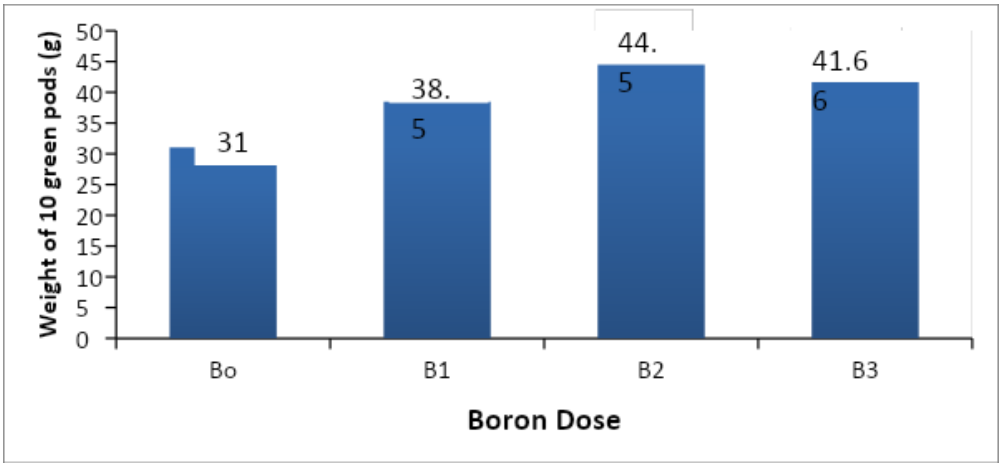

Fig. 4. The effect of different levels of boron on weight of 10 green pods (g) of garden pea
Here, B0= Control (No Boron), B1=1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

3.9 Weight of 100 Green Seeds

Different levels of sulphur significantly influenced 100 green seeds weight of garden pea (Table 5). The highest weight of 100 green seeds (36.72 g) found from S3 and lowest weight of 100 green seeds (24.65 g) were found in S0. Similar results were recorded by Singh and Singh, 2004 [24] in black gram. There was a significant difference on 100 green seeds weight among the different levels of boron (Table 6). The highest weight of 100 green seeds were found (35.04 g) in B2 which was statistically similar with B3 treatment and lowest weight of 100 green seeds were found (26.27 g) in the B0. The combined effect of different levels of sulphur and application of different levels of boron on weight 100 green seeds was found significant (Table 7). Treatment combinations of S3B2 recorded higher 100 green seeds weight (40.16 g) which was statistically similar with S3B3 and S2B2 and lowest weight of 100 green seeds was found (21.73 g) in S0B0.

Table 5. The effect of different levels of sulphur on yield and yield attributes of garden pea

Treatments	Green pod yield/plant(g)	Number of seeds/pod	Weight of 100 green seeds(g)
S0	29.83 d	4.26 d	24.65 d
S1	36.41 c	4.95 c	30.36 c
S2	41.83 b	5.28 b	33.75 b
S3	46.41 a	5.56 a	36.72 a
CV%	10.68	11.58	9.62
LSD	0.21	0.20	2.30

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0=control (no sulphur), S1=10 kg S/ha, S2=20 kg S/ha, S3=30 kg S/ha

Table 6. The effect of different levels of boron on yield and yield attributes of garden pea

Treatments	Green pod yield/plant (g)	Number of seeds/pod	Weight of 100 green seeds (g)
B0	31.00 d	4.45 c	26.27 c
B1	37.58 c	4.98 b	30.97 b
B2	44.66 a	5.41 a	35.04 a
B3	41.25 b	5.21 a	33.21 ab
CV%	10.68	11.58	9.62
LSD	0.02	0.22	2.09

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, B0= Control (No Boron), B1=1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

Table 7. The combined effect of and different levels of sulphur and boron on yield and yield attributes of garden pea

Treatments	Green pod yield/plant (g)	Number of seeds/pod	Weight of 10 green pods (g)	Weight of 100 green seeds (g)
S0B0	26.66 k	3.80 k	25.33 j	21.73 k
S0B1	28.33 jk	4.13 jk	27.33 ij	25.53 jk
S0B2	32.66 h-j	4.66 g-i	32.66 f-h	27.06 g-j
S0B3	31.66 h-j	4.46 h-j	30.66 g-i	26.30 h-k
S1B0	29.66 i-k	4.26 ij	29.33 h-j	25.06 i-k
S1B1	36.00 f-h	5.06 d-g	36.66 ef	30.80 d-h
S1B2	42.66 de	5.33 b-e	44.66 b-d	34.06 c-e
S1B3	37.33 fg	5.13 c-f	40.00 de	31.53 d-g
S2B0	33.33 g-i	4.80 f-h	34.00 f-h	28.43 f-i
S2B1	40.00 ef	5.20 c-f	42.66 cd	32.43 d-f
S2B2	49.33 bc	5.73 ab	49.33 ab	38.86 ab
S2B3	44.66 d	5.40 b-d	45.33 bc	35.30 b-d
S3B0	34.33 gh	4.93 e-g	35.33 e-g	29.86 e-h
S3B1	46.00 cd	5.53 bc	47.33 a-c	37.13 bc
S3B2	54.00 a	5.93 a	51.33 a	40.16 a
S3B3	51.33 ab	5.86 a	50.66 a	39.73 ab
CV%	10.68	11.58	10.45	9.62
LSD	0.43	0.40	4.75	3.61

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0= Control (No Sulphur), S1=10 kg S/ha, S2=20 kg S/ha, S3= 30 kg S/ha and B0= Control (No Boron), B1= 1 kg B/ha, B2= 2 kg B/ha, B3=3 kg B/ha

3.10 Dry Matter Percentage of Plant (%)

Dry matter percentage of plant differed significantly due to application of different levels of sulphur (Table 8). The highest dry matter percentage of plant (19.09) was recorded from S3 which was statistically identical with S2. The lowest dry matter percentage of plant (14.99) was recorded in S0. Dry matter percentage of plant differed significantly due to application of different levels of boron (Table 9). The highest dry matter percentage of plant (18.55) was recorded from B2 which was statistically similar with B3. The lowest dry matter percentage of plant (15.46) was recorded in B0. The significant difference was found on dry matter percentage of plant due to the combination of different levels of sulphur with application of different levels of boron (Table 10). The highest dry matter percentage of plant (20.58) was recorded in S3B2, which was statistically similar with S3B3. The lowest dry matter percentage of plant (14.32) was recorded in S0B0.

3.11 Green Pod Yield per Plot (kg)

The yield of green pods per plot different markedly as to the different levels of sulphur (Table 8). The highest green pod yield (0.516 kg/plot) was obtained when the crop was sown in S3. The lowest green pod yield (0.297 kg/plot) was found when the crop was sown in S0. The green pod yield per plot was found significantly influenced by different levels of boron application (Table 9). The highest green pod yield (0.486 kg/plot) was recorded in B2. The lowest green pod yield (0.321 kg/plot) was recorded in B0. Combined effect of different levels of sulphur and boron levels found significantly influenced in producing green pod yield per plot (Table 10). The highest average green pod yield of 0.585 kg/plot was found in the S3B2. The lowest yield of 0.258 kg/plot was found in the S0B0.

3.12 Green Pod Yield per Hectare (t)

Statistical variability was exhibited regarding per hectare yield as to the varied levels of sulphur (Table 8). The highest green pod yield (10.76 t/ha) was obtained when the crop was sown in S3. The lowest green pod yield (6.19 t/ha) was found the S0. These findings are corroborated with those reported by Prasad and Prasad, [25]. The green pod yield per hectare was found significantly influenced by different levels of boron application (Table 9). The highest green pod yield (10.14 t/ha) was recorded in. The lowest green pod yield (6.69 t/ha) was recorded in B0. Similar results with boron application have been report by Dwivedi et al. [26]. Wide variation was found as to the combined application of different levels of sulphur and boron in respect of

green pod yield per hectare (Table 10). The highest average green pod yield of 12.19 t/ha was obtained in the S3B2, which was statistically similar with S3B3 and S2B2, respectively. The lowest yield of 5.38 t/ha was recorded from the S0B0. Kaisher et al. [20] reported that combined application of 30 kg sulphur and 5 kg boron/ha significantly increased plant height, number of

Table 8. The effect of different levels of sulphur on yield and yield attributes of garden pea

Treatments	Dry matter percentage of plant (%)	Green pod yield/plot (kg)	Green pod yield/hectare (t)
S0	14.99 c	0.297 d	6.19 d
S1	16.91 b	0.398 c	8.30 c
S2	18.14 a	0.464 b	9.67 b
S3	19.09 a	0.516 a	10.76 a
CV%	9.27	9.56	12.87
LSD	1.20	17.78	0.37

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0= Control (no sulphur), S1= 10 kg S/ha, S2=20 kg S/ha, S3= 30 kg S/ha

Table 9. The effect of different levels of boron on yield and yield attributes of garden pea

Treatments	Dry matter percentage of plant (%)	Green pod yield/plot (kg)	Green pod yield/hectare (t)
B0	15.46 c	0.321 d	6.69 d
B1	17.19 b	0.413 c	8.61 c
B2	18.55 a	0.486 a	10.14 a
B3	17.93 ab	0.455 b	9.48 b
CV%	9.27	9.56	12.87
LSD	1.05	15.76	0.54

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, B0= Control (No Boron), B1=1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

Table 10. The combined effect of different levels of sulphur and boron on yield and yield attributes of garden pea

Treatments	Dry matter percentage of plant (%)	Green pod yield/plot (kg)	Green pod yield/hectare (t)
S0B0	14.32 j	0.258 n	5.38 n
S0B1	14.59 ij	0.276 mn	5.75 mn
S0B2	15.77 g-j	0.335 jk	6.98 jk
S0B3	15.29 h-j	0.319 kl	6.65 kl
S1B0	14.48 ij	0.298 lm	6.21 lm
S1B1	17.00 f-i	0.398 gh	8.29 gh
S1B2	18.34 d-f	0.473 de	9.86 de
S1B3	17.42 f-h	0.425 fg	8.86 fg
S2B0	16.11 h-j	0.355 ij	7.40 ij
S2B1	17.98 e-g	0.451 ef	9.40 ef
S2B2	19.51 bc	0.553 bc	11.52 ab
S2B3	18.97 b-e	0.497 cd	10.36 cd
S3B0	16.56 g-j	0.373 hi	7.87 hi
S3B1	19.20 b-d	0.538 bc	11.01 bc
S3B2	20.58 a	0.585 a	12.19 a
S3B3	20.02 ab	0.568 ab	11.61 ab
CV%	9.27	9.56	12.87
LSD	2.41	15.56	0.74

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0= Control (No Sulphur), S1=10 kg S/ha, S2=20 kg S/ha, S3= 30 kg S/ha and B0= Control (No Boron), B1= 1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

branches/plant, number of pods/plant, number of seeds/pod, 1000-seed weight and seed yield of mungbean.

3.13 Green Seed Yield per Plot (g)

The green seed yield per plot was found significantly influenced by different levels of sulphur (Table 11). The highest seed yield (178.27 g/plot) was obtained was obtained from S3 and lowest (95.75 g/plot) was obtained from S0. The seed yield per plot was significantly influenced by different levels of boron application (Table 12). The highest seed yield (167.97 g/plot) was obtained in B2 and the lowest (103.71 g/plot) was found in B0. The combined effect of different levels of sulphur and boron application on seed yield per plot of garden pea was significant (Table 13). The highest average green seed yield of (210.50 g/plot) was found in the S3B2 which was out yielded the other treatment combinations. The lowest yield of (79.03 g/plot) was found in the S0B0.

Table 11. The Effect of different levels of sulphur on yield and yield attributes of garden pea

Treatments	Green seed yield/plot (g)	Green seed yield/hectare (t)
S0	95.75 d	1.99 d
S1	134.01 c	2.79 c
S2	156.65 b	3.26 b
S3	178.27 a	3.71 a
CV%	9.37	10.42
LSD	12.80	0.26

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0= Control (no sulphur), S1= 10 kg S/ha, S2=20 kg S/ha, S3= 30 kg S/ha

3.14 Green Seed Yield per Hectare (t)

The green seed yield per hectare was significantly influenced by different levels of sulphur (Table 11). The highest seed yield (3.71 t/ha) was obtained was obtained when the crop was sown in S3 and the lowest (1.99 t/ha) was obtained when the crop was sown in S0. The findings similar of Malik and Abraham [22]. The green seed yield per hectare was significantly influenced by the application of different levels of boron (Table 12). The highest seed yield (3.49 t/ha) was obtained in B2 and the lowest (2.16 t/ha) was found in B0. The combined effect of different levels of sulphur and boron application on green seed yield of garden pea was found significant (Table 13). The highest average green seed yield of 4.38 t/ha was found in the S3B2, which was statistically similar with S3B3 and the lowest yield of 1.64 t/ha was found in the S0B0.

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

Treatments	Green seed yield/plot (g)	Green seed yield/hectare (t)
B0	103.71 d	2.16 d
B1	138.38 c	2.88 c
B2	167.97 a	3.49 a
B3	154.61 b	3.22 b
CV%	9.37	10.42
LSD	11.31	0.22

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, B0= Control (No Boron), B1=1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

Table 13. The combined effect of different levels of sulphur and boron on yield and yield attributes of garden pea

Treatments	Green seed yield/plot (g)	Green seed yield/hectare (t)
S0B0	79.03 n	1.64 m
S0B1	87.23 lm	1.81 lm
S0B2	111.40 i-l	2.32 i-l
S0B3	105.33 j-l	2.19 j-l
S1B0	96.43 k-m	2.00 k-m
S1B1	134.87 g-i	2.80 g-i
S1B2	161.60 d-f	3.36 d-f
S1B3	143.13 f-h	2.98 f-h
S2B0	115.23 i-k	2.40 i-k
S2B1	152.10 e-g	3.16 e-g
S2B2	188.40 bc	3.92 bc
S2B3	170.87 c-e	3.55 c-e
S3B0	124.13 h-j	2.58 h-j
S3B1	179.33 b-d	3.73 b-d
S3B2	210.50 a	4.38 a
S3B3	199.10 b	4.14 ab
CV %	9.37	10.42
LSD	10.60	0.53

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. Here, S0= Control (No Sulphur), S1=10 kg S/ha, S2=20 kg S/ha, S3= 30 kg S/ha and B0= Control (No Boron), B1= 1 kg B/ha, B2=2 kg B/ha, B3=3 kg B/ha

4. CONCLUSION

Both crop yield and yield contributing characters are important for the crop production. According to the results of the present experiment, it may

be concluded that proficient production of garden pea is increased by optimum Sulphur with optimum Boron application (S_3B_2). For obtaining the maximum green pod and seed yield, 30 kg S per hectare is the optimum for garden pea. The best for higher growth, pod and seed yield of garden pea 2 kg B per hectare application was found to be optimum. Thus, a combination of 30 kg S per hectare with 2 kg B per hectare application (S_3B_2) was the most suitable combination in respect of pod and seed yield of garden pea.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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