Original Research Article

Effect of Spacing, Nitrogen and Boron on Yield and Yield Attributing Traits of Broccoli

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A B S T R A C T

The present study was planned with the objectives to evaluate the effect of different plant spacings and doses of nitrogen and boron on head size, head yield and quality. The investigation was conducted at the Agricultural Research Field, School of Agriculture, Lovely Professional University, Phagwara, Punjab during September 2017 to January 2018. The experimental material for the present investigation comprised one variety of broccoli viz. PalamSamridhi with nine different treatment combinations including two different spacings (60 x 60 cm and 60 x 30 cm), two levels of nitrogen (180 kg/ha and 120 kg/ha), two levels of boron (20 kg/ha and 10 kg/ha) and one control (60 x 45 + 150 kg N/ha + 15 kg B/ha). The evaluation was done in a randomized block design with nine different treatments and three replications. The observations were recorded for eighteen quantitative traits. The treatment T5 (60 x 30 cm + 180 kg N/ha + 20 kg B/ha) was found to be the optimum treatment combination which resulted in higher yield of broccoli (8.54 t/ha).

Keywords
Boron, broccoli, nitrogen, plant spacing, yield

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Introduction

Broccoli (Brassica oleracea var. italica L., 2n=18) is a major and highly nutritive exotic vegetable crop belonging to the family brassicaceae. From the ancient times, it has great economic significance because of its medicinal and dietetic properties. It is an excellent source of vitamin A and C and also a good source of folate. According to Thompson and Kelly (1985), broccoli is more nutritious than any other cole crops. Enriched in antioxidants, it can reduce the risk of some forms of cancer and heart diseases. Thus, broccoli can play a vital role in improving the nutritional status of the people. The stem of broccoli plant, whose core is soft and sweet, may also be eaten like vegetable (Sazzad, 1996). Plant density is a concerned factor to maximize the yield and to obtain uniform plant maturity. It has significant effect on canopy development, soil moisture loss, ability to control emerging weeds, light interception and crop growth rate. It depends upon root system of the crop, plant spread, vegetative growth, planting time and variety. It helps in efficient utilization of field by covering the whole field for productive
purpose. Generally, it is directly proportional to the production. The recommended plant spacing i.e. 60 cm x 45 cm for the production of broccoli gives high returns. It is directly related to spacing. With more spacing, the number of plants per unit area decrease. So, it provides more area for plant establishment. Fertilizers also have an important role for crop growth and yield. The balanced proportion of fertilizers should be applied especially nitrogen because it is the major fertilizer which is responsible for the vegetative growth of plants, constituent of protein and protoplasm of chlorophyll and enzymes. It is essential for photosynthesis. It is a part of protein and improves the photosynthetic efficiency of plants and ultimately the yield. Boron also an important micronutrient for the growth and development of plants is required in minute quantities as compared to nitrogen. High doses of nitrogen may reduce the effect of boron. It controls transportation of sugar in plants. Its deficiency effects vegetative and reproductive growth of plants. Therefore, the present investigation was carried out to observe the effect of plant spacing, nitrogen and boron on yield and yield contributing characters of broccoli.

Results and Discussion

The analysis of variance showed significant differences among the treatments for all the characters studied. There was an increasing trend in the values of plant spread, number of leaves/plant, leaf length, leaf width, fresh weight of leaves, stem, root and plant with an increased spacing and increasing dose of nitrogen and boron. Application of 180 kg N/ha and 20 kg B/ha gave significantly maximum values for most of the growth parameters viz. plant height (67.53 cm), number of leaves/plant (18.73), leaf length (61.43 cm) and leaf width (25.20 cm) of the biggest leaf and plant spread (81.33 cm).

The treatment T1 (60 x 60 cm + 180 kg N/ha + 20 kg B/ha) was found significantly superior over all the treatments as well as control T9 (60 x 45 cm + 150 kg N/ha + 15 kg B/ha) for all the growth characters viz. plant spread, leaf length, leaf width, number of leaves, stem stalk diameter, head diameter, head length, head weight and fresh weight of leaves, stem, root and plant.

Materials and Methods

The present investigation was conducted during September 2017 to January 2018, at the Agriculture Farm, LPU, Phagwara. One variety of Broccoli PalamSamridhi was taken with nine different treatment combinations including two different spacings (60 x 60 cm and 60 x 30 cm), two levels of nitrogen (180 kg/ha and 120 kg/ha) and two levels of boron (20 kg/ha and 10 kg/ha) including one control (60 x 45 + 150 kg N/ha + 15 kg B/ha). The evaluation was done in a randomized block design with three replications. The observations were recorded on the yield and yield related traits. The data were analyzed statistically according to the procedure described by Snedecor and Cochran (1989) to work out the effects of spacing, nitrogen and boron on the growth, yield and yield attributes of broccoli.
### Table 1: Effect of plant spacing, nitrogen and boron on yield and yield parameters of broccoli

| Sl. No. | Treatments | Mean | Plant height at harvest (cm) | Plant spread at harvest (cm) | Leaf length (cm) | Leaf width (cm) | Number of leaves | Stalk stem diameter (mm) | Head length (cm) | Head diameter (cm) |
|---------|------------|------|-----------------------------|-----------------------------|-----------------|----------------|-----------------|--------------------------|----------------|------------------|
| 1.      | T1         | 67.53| 81.33                       | 61.43                       | 25.20           | 18.73          | 34.82           | 17.43                    | 13.27          |                  |
| 2.      | T2         | 65.60| 80.93                       | 58.66                       | 23.46           | 16.30          | 33.54           | 16.53                    | 13.20          |                  |
| 3.      | T3         | 67.00| 78.63                       | 59.16                       | 24.20           | 17.47          | 34.61           | 16.93                    | 12.93          |                  |
| 4.      | T4         | 64.20| 77.13                       | 56.46                       | 21.73           | 15.73          | 32.91           | 15.73                    | 11.93          |                  |
| 5.      | T5         | 74.00| 78.53                       | 59.33                       | 23.06           | 15.47          | 33.24           | 16.47                    | 12.80          |                  |
| 6.      | T6         | 71.93| 75.93                       | 57.33                       | 22.73           | 15.07          | 32.96           | 15.60                    | 11.33          |                  |
| 7.      | T7         | 71.07| 74.63                       | 57.80                       | 22.86           | 15.33          | 33.11           | 15.80                    | 11.40          |                  |
| 8.      | T8         | 69.87| 73.87                       | 55.53                       | 21.13           | 14.93          | 32.70           | 14.80                    | 11.27          |                  |
| 9.      | T9         | 67.67| 77.07                       | 58.10                       | 22.93           | 16.03          | 33.01           | 15.93                    | 11.87          |                  |
| S.Em.±  |            | 1.57 | 1.27                        | 0.65                        | 0.69            | 0.26           | 0.40            | 0.46                     | 0.39           |                  |
| CD at 5% |            | 4.76 | 3.85                        | 1.97                        | 2.09            | 0.78           | 0.21            | 1.39                     | 1.18           |                  |
| CV (%)  |            | 3.96 | 2.84                        | 1.94                        | 5.20            | 2.80           | 2.08            | 4.95                     | 5.54           |                  |

T1 (60 x 60 cm + 180 kg N/ha + 20 kg B/ha), T2 (60 x 60 cm + 120 kg N/ha + 20 kg B/ha), T3 (60 x 60 cm + 180 kg N/ha + 10 kg B/ha), T4 (60 x 60 cm + 120 kg N/ha + 10 kg B/ha), T5 (60 x 30 cm + 180 kg N/ha + 20 kg B/ha), T6 (60 x 30 cm + 120 kg N/ha + 20 kg B/ha), T7 (60 x 30 cm + 180 kg N/ha + 10 kg B/ha), T8 (60 x 30 cm + 120 kg N/ha + 10 kg B/ha), T9 (60 x 45 cm + 150 kg N/ha + 15 kg B/ha)

### Table 2: Effect of plant spacing, nitrogen and boron on yield and yield parameters of broccoli

| Sl. No. | Treatments | Mean | Fresh weight of leaves (kg) | Fresh weight of root (kg) | Fresh weight of stem (kg) | Fresh weight of plant (kg) | Head yield (gm/head) | Yield (t/ha) |
|---------|------------|------|-----------------------------|---------------------------|---------------------------|--------------------------|----------------------|-------------|
| 1.      | T1         | 0.883| 0.107                       | 0.304                     | 1.463                     | 171.20                   | 4.75                 |             |
| 2.      | T2         | 0.714| 0.097                       | 0.262                     | 1.237                     | 162.47                   | 4.51                 |             |
| 3.      | T3         | 0.849| 0.103                       | 0.300                     | 1.407                     | 155.00                   | 4.31                 |             |
| 4.      | T4         | 0.674| 0.095                       | 0.270                     | 1.173                     | 136.07                   | 3.78                 |             |
| 5.      | T5         | 0.802| 0.102                       | 0.300                     | 1.353                     | 153.80                   | 8.54                 |             |
| 6.      | T6         | 0.558| 0.074                       | 0.219                     | 0.980                     | 131.00                   | 7.28                 |             |
| 7.      | T7         | 0.605| 0.097                       | 0.211                     | 1.053                     | 140.60                   | 7.81                 |             |
| 8.      | T8         | 0.554| 0.061                       | 0.215                     | 0.953                     | 123.20                   | 6.84                 |             |
| 9.      | T9         | 0.709| 0.083                       | 0.245                     | 1.187                     | 149.13                   | 5.52                 |             |
| S.Em.±  |            | 0.05 | 0.01                        | 0.01                      | 0.06                      | 4.01                     | 0.16                 |             |
| CD at 5%|            | 0.15 | 0.02                        | 0.04                      | 0.18                      | 12.14                    | 0.47                 |             |
| CV (%)  |            | 11.97| 12.82                       | 8.99                      | 8.47                      | 4.73                     | 4.58                 |             |

T1 (60 x 60 cm + 180 kg N/ha + 20 kg B/ha), T2 (60 x 60 cm + 120 kg N/ha + 20 kg B/ha), T3 (60 x 60 cm + 180 kg N/ha + 10 kg B/ha), T4 (60 x 60 cm + 120 kg N/ha + 10 kg B/ha), T5 (60 x 30 cm + 180 kg N/ha + 20 kg B/ha), T6 (60 x 30 cm + 120 kg N/ha + 20 kg B/ha), T7 (60 x 30 cm + 180 kg N/ha + 10 kg B/ha), T8 (60 x 30 cm + 120 kg N/ha + 10 kg B/ha), T9 (60 x 45 cm + 150 kg N/ha + 15 kg B/ha)
Similarly, Haque et al., (1996) reported higher leaf length at 180 kg N/ha than 120 kg N/ha; Kumar et al., (2007) and Saikia et al., (2010) reported that the plant spread increased when plant spacing was increased from 50 x 30 cm to 60 x 45 cm. The results are in conformity with the findings of El-Behcidi and El-Mansi (1973) in cabbage and Saikia et al., (2010) in broccoli. Katiyar et al., (2011) also found an increase in plant spread with increase in nitrogen doses and Hossain et al., (2011) also reported maximum number of leaves at 60 x 60 cm spacing. Similarly, in cabbage maximum leaf length (35.28 cm) and leaf width (32.98 cm) were recorded when planted at a spacing of 60 x 45 cm and minimum leaf length (34.84 cm) and leaf width (31.68 cm) from 60 x 40 cm spacing (Moniruzzaman, 2011). Singhal et al., (2009) also recorded maximum fresh weight of plant in broccoli at a spacing of 45 x 60 cm followed by 45 x 45 cm.

But in case of plant height and total yield per hectare T5 (60 x 30 cm + 180 kg N/ha + 20 kg B/ha) was found significant over control and all other treatments. Plant height was found to be higher at a narrower spacing of 60 x 30 cm. The cause of the increase in plant height could be the competition for light. It was observed that closely spaced plants grew very fast as compared to wider spaced plants. This may be because of competition for photosynthetic active radiation which stimulates growth. Yield may have increased due to the increase in plant population per hectare as a result of decrease in plant spacing. Similar results were also obtained by Haque et al., (1996) who reported higher plant height at 180 kg N/ha than 120 kg N/ha. Similarly, Giri et al., (2013) and El-Shikha et al., (2007) also reported increase in plant height with increased application of nitrogen. Saikia et al., (2010) also noticed maximum plant height when plants were sown at a narrow spacing of 30 x 30 cm.

It can be interpreted from the results that the yield was higher when plants were grown at a narrow spacing of 60 x 30 cm, rather than a wider spacing of 60 x 60 cm and 60 x 45 cm, as wider spacing led to decrease in plant population per hectare and resulted in lower yield. Higher dose of nitrogen @ 180 kg/ha and boron @ 20 kg/ha led to highest yield. Thus, it can be concluded that for maximising the productivity of broccoli per unit area, the plants should be grown at a narrow spacing of 60 x 30 cm with nitrogen and boron applications @ 180 kg/ha and 20 kg/ha respectively.

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