

## Effect of Boron and Yeast Extract Foliar Application on Growth, Pod Setting and both Green Pod and Seed Yield Of Broad Bean (*Vicia Faba* L)

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**Abstract:** A field experiment with broad bean (*Vicia faba* L) cv Super Aquadulse was conducted to study the effect of separate and combined foliar applications of boron (0, 25 and 50 ppm) and yeast extract (0, 2.5 and 5 ml/L) on growth, yield and some biochemical constituents. The results revealed that, foliar application with boron and yeast extract either individually or in a mixture, significantly stimulate many growth aspects as number of leaves per plant, dry weights of both stems and leaves per plant, total leaf area and absolute growth rate as compared with the control treatment. In addition, foliar spraying with boron at 50 ppm and yeast extract at 5 ml/L increased photosynthetic pigments, NPK, B, total sugars, total free amino acids and crude protein content in leaves at 70 and 85 days after sowing. Moreover, boron and yeast extract treatments not only increased auxins and cytokinins but also decreased abscisic acid at 75 days after sowing during second season. All treatments not only increased number of formed flowers, setted pods per plant, green pod and dry seed yields, as well as **satis** factory effect upon shedding percentage, i.e. reduced it. Hence, it could be recommended that foliar spraying with boron at 50 ppm and yeast extract at 5 ml/L can be used to increase the final green pods and seed yield as well as seed quality of broad bean plants.

[A. Abou EL-Yazied and M. A. Mady. **Effect of Boron and Yeast Extract Foliar Application on Growth, Pod Setting and both Green Pod and Seed Yield Of Broad Bean (*Vicia Faba* L).** *Journal of American Science*. 2012; 8(4): 517-534]. (ISSN: 1545-1003). <http://www.americanscience.org>. 69

**Keywords:** boron, yeast extract broad bean, *Vicia faba*, chlorophyll, endogenous phytohormones, flowering, pod setting, yield, seed quality

### 1. Introduction

Broad bean (*Vicia faba* L.) is one of the most important leguminous crops grown in winter season in different types of Egyptian soils. Also, it is considered as the basic source of protein for human consumption, so, it is important to get maximized yield of broad bean. In this respect, the phenomena of shedding in broad bean plant especially for its buds, flowers and immature pods usually took place in serious values leading to a great reduction in yield of this economic plant. Therefore, plant physiologists are studying insensitivity the problem of shedding in order to find out a solution for reducing the high abscission percentage of buds, flowers and immature pods to develop into fully mature green pods in this plant. Many trials has been carried out for increasing flower set, minimizing pre-harvest abscission of immature pods of broad bean or other plants by the use of different factors including plant growth regulators and mineral nutrients (Bastawisy and Sorial, 1998; Abd El-Dayem and El-Deeb, 2000 ; El- Desouky *et al.*, 2001 ; 2002).

Boron is an essential micronutrient and plays a major role for plant growth and development (Pilbeam and Kirkby, 1983; Marschner, 1995). In commercial plant production, providing a sufficient B supply is particularly important for yield formation (pollination) (Khayyat *et al.*, 2007; Wojcik *et al.*, 1999) and fruit quality (Wojcik *et al.*, 1999; Dordas, 2006; Dordas *et al.*, 2007). Boron deficiency in crops is more

widespread than the deficiency of any other micronutrients (Gupta, 1993).

Many studies indicated that yeast is a natural source of cytokinins and has stimulatory effects on bean plants (Amer, 2004). Moreover, yeast extract was suggested to participate in a beneficial role during vegetative and reproductive growth stages through improving flower formation and their set in some plants due to its high auxin and cytokinin content and enhancement carbohydrate accumulation (Barnett *et al.*, 1990). Also, it was reported its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (El- Desouky *et al.*, 1998 ; Wanas 2002; Wanas, 2006), in addition to its content of cryoprotective agent, i.e. sugars, protein , amino acids and also several vitamins ( Mahmoud, 2001). Moreover, the improving growth, flowering and fruit set of some plants by using foliar application with yeast extract was reported by Fathy *et al.* (2000), Abou-Aly (2005) and Wanas (2006). Also, foliar application with micro nutrients especially boron not only have major effects upon flower formation, carbohydrate and protein metabolism, pollen germination and pollen tube growth and increase yield (Gerendas and Sattelmacher, 1990), but also required for chloroplast formation and sink limitations (Tersahima and Evans, 1988). Also, boron plays a key role in higher plants by facilitating the short- and long-distance transport of sugar *via* the formation of borate-sugar complexes (Dugger, 1983). However, such a

proposal is unacceptable because, the prevalent sugar transport in the phloem forms only weak complexes with boron, and in the mechanisms of phloem loading of sucrose boron is not involved (Marschner, 1995).

Furthermore, foliar spray of boron and yeast extract represents the more quick and efficient treatments in many cases which lead to vigorous vegetative growth and plenty of chemical constituents (El-Sherbeny *et al.*, 2007).

Thereby, the present study aimed to use foliar spray with boron and yeast extract on broad bean plants to reduce the shedding percentage of flowers and immature pods as well as to increase the final yield and improve quality of broad bean plant.

## 2. Material and Methods

The field experiment was carried out at the Experimental Farm of Faculty of Agriculture at Moshtohor, Benha University, during two successive winter growing seasons (2009/2010 and 2010/2011) to investigate the effects of foliar spraying with boron and yeast extract on some growth aspects, photosynthetic pigments, endogenous phytohormones, flowering, shedding, yield and its chemical components of broad bean (*Vicia faba* L.) cv Super Aquadulse. Seeds of broad bean were secured from Simply Seed Co. UK. The experimental soil was clay loam.

Boron was used at three levels, i.e. 0 (control, sprayed with distilled water), 25 and 50 ppm. Boric acid ( $H_3BO_3$  17% boron) was used as a source of boron and applied as foliar application at 30, 45 and 60 days after sowing. Yeast extract was used at three levels, namely 0 (control, sprayed with distilled water), 2.5 and 5 ml/L applied as foliar application at 35, 50 and 65 days after sowing. All treatments were applied triple as foliar spray on plants using hand operated compressed air sprayer at the rate of 10 liter/plot.

### Preparation of yeast extract:

Yeast extract, species *Saccharomyces cerevisiae*, was prepared using a technique that allowed yeast cells (pure active dry yeast 100 gram/liter) to be grown and multiplied efficiently during conducive aerobic and nutritional conditions that allowed to produce denovo beneficial constituents (carbohydrates, sugars, proteins, amino acids, fatty acids, hormones, etc.), then these constituents could be released out of yeast cells in readily form by two cycles of freezing and thawing for disruption of yeast cells and releasing their content. Such technique for yeast preparation was modified after Spencer *et al.* (1983). Chemical analysis of yeast extract after Mahmoud (2001) is presented in Table (A).

**Table A. Chemical analysis of yeast extract.**

| Amino acid<br>mg/100g dry weight |      | Vitamins and Carbohydrates<br>mg/100g dry weight |       |
|----------------------------------|------|--|-------|
| Arginine                         | 1.99 | Vit.B1   | 2.23  |
| Histidine                        | 2.63 | Vit.B2   | 1.33  |
| Isoleucine                       | 2.31 | Vit.B6   | 1.25  |
| leucine                          | 3.09 | Vit B12  | 0.15  |
| Lysine                           | 2.95 | Thimain  | 2.71  |
| Methionine                       | 0.72 | Riboflavin                                       | 4.96  |
| Phenyl alanine                   | 2.01 | Inositol   | 0.26  |
| Threonine                        | 2.09 | Biotin   | 0.09  |
| Tryptophan                       | 0.45 | Nicotinic acid                                   | 39.88 |
| Valine                           | 2.19 | Panthothenic acid                                | 19.56 |
| Glutamic acid                    | 2.00 | P amino benzoic acid                             | 9.23  |
| Serine                           | 1.59 | Folic acid                                       | 4.36  |
| Aspartic acid                    | 1.33 | Pyridoxine                                       | 2.90  |
| Cystine                          | 0.23 | Total carbohydrates                              | 23.2  |
| Proline                          | 1.53 |  |       |
| Tyrosine                         | 1.49 | Glucose  | 13.33 |

The experiments were arranged in a randomized complete block design with three replicates. The plot area was 10.5 m<sup>2</sup> (3x 3.5m) with five rows. Broad bean seeds were sown in hills spaced 15 cm on ridges on the 1<sup>st</sup> of November in the two seasons.

A total of 200 kg/fed. calcium super phosphate (15.5% P<sub>2</sub>O<sub>5</sub>), 100 kg/fed. ammonium nitrate (33% N) and 50 kg/fed. potassium sulphate (48% K<sub>2</sub>O) were

applied during soil preparation. Different recommended agricultural practices for this plant were followed as recommended by the Ministry of Agric., Egypt. The other required culture practices for growing broad bean were followed as recommended.

### Sampling and collecting data Vegetative growth

Five plants were randomly chosen from central row of each plot at 70 and 85 days after sowing in both seasons to estimate plant height, stem dry weight, number of leaves, leaf and shoot dry weights and total leaf area using the disc method as described by Deriaux *et al.* (1973).

Absolute growth rate (AGR) is defined as the increase of plant material per unit of time, according to Radford (1967).

$$\text{AGR} = w_2 - w_1 / t_2 - t_1 .$$

where:  $w_1$  = dry weight at  $t_1$ .

$w_2$  = dry weight at  $t_2$ .

$t_1$  = first measurements (70 days)

$t_2$  = second measurements (85 days)

### Photosynthetic pigments

Chlorophyll a, b and carotenoids were colorimetrically determined in fresh leaves of broad bean plants at 70 and 85 days after sowing during the two seasons according to the methods described by Wettstein (1957).

### Chemical composition

Samples of leaves at 70 and 85 days after sowing and dry seeds at harvest stage were taken to determine total nitrogen (Horneck and Miller, 1998), phosphorus (Sandell, 1950), potassium (Horneck and Hanson, 1998). Boron was determined according to Chapman and Pratt (1961). Crude protein was calculated according to the following equation: Crude protein = total nitrogen x 6.25 (A.O.A.C., 1990). Total carbohydrates and total sugars were determined according to Thomas and Dutcher (1924) and Dubois *et al.* (1956), respectively. Also, total free amino acids was determined according to Rosed (1957).

### Endogenous phytohormones

Endogenous phytohormones were quantitatively determined in broad bean leaves at 75 days after sowing in the second season using High- Performance Liquid Chromatography (HPLC) according to Koshioka *et al.* (1983) for auxin (IAA), and abscisic acid (ABA) while, cytokinins were determined according to Nicander *et al.* (1993).

### Yield characteristics

Five plants were randomly chosen in each plot and were marked in the field from the start of flowering to harvest time and the following characteristics were studied and recorded:

- a- No. of opened flowers / plant : Counting was started at 60 days of plant age with 3-day intervals until 100 days
- b- No. of setted pods/ plant: Counting was started at 75 days of plant age with 3-days intervals until 125 days.

c- No. of marketable green pods/ plant: It was recorded at harvest time.

d-

$$\text{Shedding percentage} = \frac{\text{Total No. of flowers/plant} - \text{No. of setted pods/plant} \times 100}{\text{Total No. of flowers/plant}}$$

e- Green pod yield/plant, dry seed weight / pod, dry seed yield / plant, and seed index [100 seed weight] were recorded at harvest time.

### Statistical analysis

Data obtained in this study were statistically analyzed by using the least significant differences test (L.S.D) according to Snedecor and Cochran (1980).

## 3. Results and Discussion

### Growth characteristics:

Data presented in Tables (1 and 2) show that the foliar application of 50 ppm boron gave the highest values of plant height, number of leaves, total leaf area, stem and leaf dry weights per plant at 70 and 85 days after sowing in the two seasons as compared with the other foliar application treatments. In the other words, boron foliar application was effective in stimulation of plant growth compared to the control treatment. Boron treatment could improve growth by increasing IAA content and IAA/cytokinin ratio (Table 8) in leaves by blocking IAA oxidase inhibitors by forming complexes with these inhibitors (Puzina, 2004).

Respecting foliar application of yeast extract, the concentration of 5 ml/L was the most favourable for increasing plant growth, i.e. plant height, number of leaves, total leaf area, stem and leaf dry weights per plant, at 70 and 85 days after sowing, in the two seasons as compared with the other studied foliar application of yeast extract treatments.

These findings are in agreement with the results of El-Tohamy and El-Greadly (2007) and El-Tohamy *et al.* (2008) who indicated that the application of yeast increased eggplant growth. The improvement of plants growth in response to the foliar application of active dry yeast may be attributed to its contents of different nutrients, higher percentage of proteins, higher values of vitamins, especially B (Table A) which may play an important role in improving growth and controlling the incidence of fungi diseases. These results could be also due to the fact that yeast extract contains growth factors and a relatively larger proportion of free amino acids and short peptides of two or three amino acids long chain protein hydrolyses (Bevilacqua *et al.*, 2008).

The combination between yeast extract and boron foliar application with all concentrations gave the highest values of growth parameters at 70 and 85 days after sowing during the two growing seasons as compared with either individual foliar application or control plants. Maximum stimulatory effect was

existed in plants treated with 5 ml/L yeast extract and boron at 50 ppm as foliar application during the two seasons. Such enhancement effect of boron and yeast extract might be attributed to the favourable influence of them on metabolism and biological activity and their stimulating effect on photosynthetic pigments and enzyme activity which in turn encourage vegetative growth of broad bean (Wanas, 2002 ; El-Sherbeny *et al.*, 2007).

The percentage of dry matter distribution in leaves was significantly increased in all treatments at 70 and 85 days after sowing while that dry matter of stems was insignificantly decreased by boron or yeast application when compared with control plants during the two seasons. The enhancement of dry matter distribution in broad bean leaves may be attributed to the improvement of photosynthesis process that led to accumulation of more dry matter in leaf and these assimilates could be temporally stored to the account of next will form flowers and pods.

Concerning the absolute growth rate (AGR), foliar application with yeast extract and boron either individually or in mixture significantly increased the absolute growth rate of stem and leaf dry weight between 70-85 days after sowing in both seasons (Table, 3). The plants sprayed with the highest concentrations of yeast extract and (or) boron exhibited the highest values in comparison with those sprayed with the low concentrations in both seasons. The results are in harmony with those reported by Marschner (1995) and Wanas (2002). Moreover, foliar application with boron or yeast extract enhanced partitioning of photo assimilates from leaves (source) to flowers and immature fruits (sink) (Hopkins, 1995). These results are in agreement with those obtained by Bastawisy and Sorial (1998) and Wanas (2002).

### Photosynthetic pigments

Data in Tables (4 and 5) indicate that boron foliar application at 50 ppm gave the highest values for different photosynthetic pigments as compared with other foliar applications of boron in the two seasons.

As for foliar application of yeast extract, the concentration of 5 ml/L gave significantly the highest chlorophyll a, b and carotenoids when compared with other foliar applications of yeast extract during the two seasons. The improvement of photosynthetic pigments in response to the foliar application of active dry yeast may be attributed to bioregulators (Table A) which affect the balance between photosynthesis and photorespiration in plants (Olaiya, 2010; Abou El-Yazied and Mady, 2011). Shalaby and El-Nady (2008) reported that the increase in photosynthetic pigments could be attributed to the role of yeast cytokinins in delaying the aging of leaves by reducing the degradation of chlorophyll and enhancing the protein and RNA synthesis. The present results are in

agreement with those of El-Tohamy and EL-Greadly (2007), they found that application of yeast extract increased chlorophyll a and b as well as carotenoids in snap bean plants. Also, Fathy *et al.* (2000) found that foliar application with yeast extract and other natural treatments increased photosynthetic pigments in tomato plants. The increase of chlorophyll and carotenoid contents may enhance the photosynthetic efficiency and consequently increase plant growth (Tables, 1 and 2).

The interaction between yeast extract and boron gave the highest values of chlorophyll a, b and carotenoids as compared with the control plants. Moreover, increase of chlorophyll and carotenoid contents may enhanced photosynthesis efficiency and that is a good explain to the increasing of dry matter production. Also, this enhancement could be an indicator for expectable high yielded fruits.

### Minerals and some bioconstituents

Data in Tables (6 and 7) clearly indicate that foliar application with 50 ppm boron increased N, P, K, boron, total sugar, total free amino acid and crude protein when compared with other foliar applications of boron in both seasons. There is no convincing evidence of a direct effect for boron on nitrogen metabolism and amino acid concentration, which might be higher or lower depending upon plant age, and plant organ (Marschner, 1995).

As for foliar application with yeast extract, it could be noticed that foliar application with 50 ppm yeast extract was superior in rising the values of mineral and bioconstituents (Tables 6 and 7) compared with other foliar applications of yeast extract in both seasons. These results are in harmony with the findings of Fathy *et al.* (2000) who found that the application of yeast to tomato plants resulted in increases in nitrogen and potassium contents of leaves. Our data also confirmed the positive effect of yeast extract as reported by Bevilacqua *et al.* (2008).

Yeast extract and boron increased the absorption of different elements by roots and also their translocation and accumulation in leaves. The high content of total sugars and some bioconstituents could be considered as a direct result for high rates of photosynthesis with great efficiency, that was preceded with large photosynthetic area (Tables, 1 and 2) and high content of photosynthetic pigments (Tables, 4 and 5).

In addition, these results have economic values because the increases of chlorophylls, sugars and protein in leaves of broad bean could be reflected upon the reduction of flower shedding percentage and increasing pod setting. Similar results were obtained by Mahady (1990), Xia and Xiong (1991) and Wanas (2002).

### Endogenous phytohormones

Data in Table (8) clearly indicate that foliar application with 50 ppm boron increased all promoters (auxins and cytokinins), yet, abscisic acid was decreased when compared with other foliar applications of boron in both seasons.

As for foliar application with yeast extract, it could be noticed that foliar application with 50 ppm yeast extract was superior compared with other foliar applications of yeast extract. Yeast extract has been reported to be a rich source of vitamins, phytohormones and many other growth factors (El-Desouky *et al.*, 1998). This may explain the increase of cytokinins and other promoting hormones in response to yeast application (Amer, 2004).

All promoters (auxins and cytokinins) were increased by using yeast extract with boron, yet, abscisic acid was decreased. Foliar application with yeast extract at 5 ml/L combined with boron at 50 ppm gave the maximum values in auxins and cytokinins while gave the highest reduction of abscisic acid in leaves of broad bean at 75 days after sowing during 2010/2011 season. Other studies have been got similar results (Davis and Zhang, 1991; Marschner, 1995 ; Nakhlla, 1998). They concluded that boron is required for flower formation, carbohydrate and protein metabolism, pollen germination and pollen tube growth and increase yield.

### Flowering and green pod yield

As shown in Tables (9 and 10) foliar applications with boron at 50 ppm or yeast extract at 5 ml/L significantly increased number of flowers per plant, fruit setting, green pod yield and its components compared with control ones. Many workers observed that B fertilizer application increased yields of several crops (Hill and Morrill, 1975; Moraghan and Mascagni, 1991; Fageria *et al.*, 2002). This might be due to that boron increased the rate of photosynthesis by affecting photophosphorylation process into chloroplasts and shift the hormonal balance in leaves and tubers especially IAA which is important for yield (Puzina, 2004). Also, it has roles in cell elongation and nucleic acid synthesis (Shelp 1993). On the other hand, the increased yield can be attributed to higher dry matter in reproductive parts and higher fruit set (Sridhar *et al.*, 2009).

These findings are also in agreement with the results of El-Tohamy and El-Greadly (2007) on snap bean and El-Tohamy *et al.* (2008) on eggplant who indicated that the application of yeast extract increased yields and their component. It has been reported that, yeast extract treatments were suggested to participate beneficial role during vegetative and reproductive growths through improving flower formation and their set in some plants due to its high auxins and cytokinins content and its beneficial effect on carbohydrates

accumulation (Barnett *et al.*, 1990). Also, its contents of cryoprotective agents, i.e. sugars and amino acids as well as several vitamins (Shady, 1978 ; Mahmoud, 2001).

The combination between yeast extract and boron gave the lowest shedding percentage and the highest increase in number of flowers per plant, number of green pods per plant, pod setting percentage, average pod length, average green pod weight , weight of green pod per plant and estimated green pods yield per feddan in the two seasons. It could be concluded that reduction in shedding percentage of flowers and pods as well as enhancement of pod setting and development which obtained with yeast extract at 5 ml/L and (or) boron at 50 ppm treatments may be due to the high content of total sugars and protein in leaves (Tables 6 and 7) as well as endogenous auxins and cytokinins especially (Table 8) at full blooming and setting stages.

### Seed yield and its components

As shown in Tables (11 and 12), application of yeast extract at 5 ml/L or boron at 50 ppm increased NPK, crude protein, total carbohydrates content in seeds, number of seeds per pod, weight of 100 seeds, seed yield per plant and per feddan. The interaction between yeast extract and boron were more effective when compared with individual foliar applications regarding different estimated seed yield and its components.

Also, foliar application with yeast extract and boron treatments improved seed yield of broad bean plants due to increasing flower formation and the reduction of flowers and pod shedding as well as increasing their ability to accumulate more bioconstituents (Tables, 9 and 10). These positive effects of yeast extract and boron treatments upon seed yield and its characteristics could be considered as a reflection of their effects upon the early vigorous growth of broad bean plants (Tables, 1 and 2). Other studies also, reported nearly similar results. (Mahady, 1990; Sakr *et al.*, 1996; Fathy *et al.*, 2000 ; Wanas, 2002).

The previously obtained results on green pod and seed yields (Tables, 8, 9, 10 and 11) could be attributed to the stimulation effect of boron and yeast extract on plant growth (Tables, 1 and 2), photosynthetic pigments (Tables, 4 and 5), mineral and some bioconstituents (Tables, 6 and 7) and endogenous phytohormones (Table, 8 ) in leaves.

**Table 1.** Effect of boron and yeast extract foliar application on vegetative characteristics of broad bean plant at 70 and 85 days after sowing in the first season (2009/2010).

| Treatments             | Days after sowing |                     |  |                           |                           |                            |                           |        |                   |                     |  |                           |                           |                            |                           |        |       |
|------------------------|-------------------|---------------------|--|---------------------------|---------------------------|----------------------------|---------------------------|--------|-------------------|---------------------|--|---------------------------|---------------------------|----------------------------|---------------------------|--------|-------|
|                        | 70 days           |                     |  |                           |                           |                            |                           |        | 85 days           |                     |  |                           |                           |                            |                           |        |       |
|                        | Plant height (cm) | No. of leaves/plant | Total leaf area (cm <sup>2</sup> )/plant | Stem dry weight (g)/plant | Leaf dry weight (g)/plant | Shoot dry weight (g)/plant | Dry matter distribution % |        | Plant height (cm) | No. of leaves/plant | Total leaf area (cm <sup>2</sup> )/plant | Stem dry weight (g)/plant | Leaf dry weight (g)/plant | Shoot dry weight (g)/plant | Dry matter distribution % |        |       |
|                        |                   |                     |  |                           |                           |                            | stem                      | Leaves |                   |                     |  |                           |                           |                            | stem                      | Leaves |       |
| <b>Main effects</b>    |                   |                     |  |                           |                           |                            |                           |        |                   |                     |  |                           |                           |                            |                           |        |       |
| Boron (B)              | 0 ppm             | 44.89               | 24.86                                    | 573.4                     | 4.81                      | 3.86                       | 8.68                      | 55.51  | 44.35             | 87.23               | 64.18                                    | 1544                      | 11.73                     | 9.76                       | 21.49                     | 54.71  | 45.29 |
|                        | 25 ppm            | 48.28               | 26.98                                    | 663.7                     | 5.26                      | 4.52                       | 9.78                      | 53.72  | 46.28             | 91.26               | 70.36                                    | 1659                      | 13.32                     | 11.23                      | 24.55                     | 54.26  | 45.74 |
|                        | 50 ppm            | 48.84               | 28.54                                    | 705.9                     | 5.45                      | 4.78                       | 10.23                     | 53.28  | 46.72             | 93.11               | 72.47                                    | 1725                      | 13.60                     | 11.76                      | 25.36                     | 53.66  | 46.34 |
|                        | LSD at 5%         | 2.17                | 1.36                                     | 28.3                      | 0.13                      | 0.21                       | 0.27                      | 0.81   | 0.63              | 2.27                | 1.24                                     | 34                        | 0.17                      | 0.28                       | 0.40                      | 0.55   | 0.89  |
| Yeast extract (YE)     | 0 ml/L            | 43.43               | 23.95                                    | 538.2                     | 4.17                      | 3.55                       | 7.72                      | 54.05  | 45.81             | 87.02               | 63.19                                    | 1542                      | 11.11                     | 9.12                       | 20.23                     | 54.99  | 45.01 |
|                        | 2.5 ml/L          | 46.90               | 27.31                                    | 657.7                     | 5.44                      | 4.54                       | 9.98                      | 54.54  | 45.46             | 89.96               | 69.36                                    | 1635                      | 13.32                     | 11.44                      | 24.75                     | 53.78  | 46.22 |
|                        | 5 ml/L            | 51.67               | 29.11                                    | 747.3                     | 5.91                      | 5.07                       | 10.98                     | 53.92  | 46.08             | 94.62               | 74.46                                    | 1751                      | 14.23                     | 12.20                      | 26.42                     | 53.86  | 46.14 |
|                        | LSD at 5%         | 2.89                | 1.60                                     | 31.0                      | 0.17                      | 0.17                       | 0.35                      | 0.59   | 0.56              | 2.73                | 1.88                                     | 48                        | 0.17                      | 0.41                       | 0.72                      | 0.43   | 0.82  |
| <b>Interactions</b>    |                   |                     |  |                           |                           |                            |                           |        |                   |                     |  |                           |                           |                            |                           |        |       |
| 0 ppm B + 0 ml/L YE    | 42.70             | 21.75               | 514.8                                    | 3.96                      | 3.05                      | 7.04                       | 56.25                     | 43.32  | 85.11             | 61.40               | 1478                                     | 10.72                     | 8.17                      | 18.89                      | 56.75                     | 43.25  |       |
| 0 ppm B + 2.5 ml/L YE  | 45.24             | 25.98               | 561.5                                    | 5.11                      | 4.18                      | 9.29                       | 55.01                     | 44.99  | 86.95             | 62.73               | 1543                                     | 11.85                     | 10.32                     | 22.17                      | 53.45                     | 46.55  |       |
| 0 ppm B + 5 ml/L YE    | 46.72             | 26.84               | 643.9                                    | 5.36                      | 4.34                      | 9.70                       | 55.26                     | 44.74  | 89.64             | 68.42               | 1612                                     | 12.63                     | 10.79                     | 23.42                      | 53.93                     | 46.07  |       |
| 25 ppm B + 0 ml/L YE   | 43.81             | 24.35               | 546.7                                    | 4.19                      | 3.74                      | 7.93                       | 52.84                     | 47.16  | 87.54             | 63.20               | 1562                                     | 11.19                     | 9.45                      | 20.64                      | 54.22                     | 45.78  |       |
| 25 ppm B + 2.5 ml/L YE | 48.20             | 27.64               | 659.6                                    | 5.48                      | 4.63                      | 10.11                      | 54.20                     | 45.80  | 90.39             | 71.57               | 1653                                     | 13.83                     | 11.85                     | 25.68                      | 53.86                     | 46.14  |       |
| 25 ppm B + 5 ml/L YE   | 52.83             | 28.96               | 784.9                                    | 6.12                      | 5.19                      | 11.31                      | 54.11                     | 45.89  | 95.84             | 76.32               | 1764                                     | 14.94                     | 12.38                     | 27.32                      | 54.69                     | 45.31  |       |
| 50 ppm B + 0 ml/L YE   | 43.78             | 25.76               | 553.2                                    | 4.35                      | 3.85                      | 8.20                       | 53.05                     | 46.95  | 88.42             | 64.97               | 1587                                     | 11.42                     | 9.73                      | 21.15                      | 53.99                     | 46.01  |       |
| 50 ppm B + 2.5 ml/L YE | 47.27             | 28.31               | 752.1                                    | 5.74                      | 4.81                      | 10.55                      | 54.41                     | 45.59  | 92.53             | 73.78               | 1710                                     | 14.27                     | 12.14                     | 26.41                      | 54.04                     | 45.97  |       |
| 50 ppm B + 5 ml/L YE   | 55.46             | 31.54               | 812.4                                    | 6.25                      | 5.68                      | 11.93                      | 52.39                     | 47.61  | 98.38             | 78.65               | 1879                                     | 15.11                     | 13.42                     | 28.53                      | 52.96                     | 47.04  |       |
| LSD at 5%              | 2.34              | 1.28                | 32.4                                     | 0.14                      | 0.19                      | 0.46                       | 1.02                      | 1.05   | 2.03              | 1.48                | 59                                       | 0.13                      | 0.52                      | 0.85                       | 1.04                      | 1.06   |       |

**Table 2.** Effect of boron and yeast extract foliar application on vegetative characteristics of broad bean plant at 70 and 85 days after sowing in the second season (2010/2011).

| Treatments             | Days after sowing |                     |  |                           |                           |                            |                           |       |                   |                     |  |                           |                           |                            |                           |       |       |
|------------------------|-------------------|---------------------|--|---------------------------|---------------------------|----------------------------|---------------------------|-------|-------------------|---------------------|--|---------------------------|---------------------------|----------------------------|---------------------------|-------|-------|
|                        | 70 days           |                     |  |                           |                           |                            |                           |       | 85 days           |                     |  |                           |                           |                            |                           |       |       |
|                        | Plant height (cm) | No. of leaves/plant | Total leaf area (cm <sup>2</sup> )/plant | Stem dry weight (g)/plant | Leaf dry weight (g)/plant | Shoot dry weight (g)/plant | Dry matter distribution % |       | Plant height (cm) | No. of leaves/plant | Total leaf area (cm <sup>2</sup> )/plant | Stem dry weight (g)/plant | Leaf dry weight (g)/plant | Shoot dry weight (g)/plant | Dry matter distribution % |       |       |
| stem                   |                   |                     |  |                           |                           |                            | Leaves                    | stem  |                   |                     |  |                           |                           |                            | Leaves                    |       |       |
| <b>Main effects</b>    |                   |                     |  |                           |                           |                            |                           |       |                   |                     |  |                           |                           |                            |                           |       |       |
| Boron (B)              | 0 ppm             | 45.36               | 27.15                                    | 694.6                     | 5.04                      | 4.42                       | 9.46                      | 53.56 | 46.44             | 87.32               | 64.98                                    | 1595                      | 12.12                     | 10.39                      | 22.50                     | 53.91 | 46.09 |
|                        | 25 ppm            | 50.45               | 31.17                                    | 776.2                     | 5.62                      | 5.16                       | 10.77                     | 52.26 | 47.74             | 91.10               | 71.88                                    | 1737                      | 13.51                     | 12.01                      | 25.52                     | 52.95 | 47.05 |
|                        | 50 ppm            | 52.09               | 32.06                                    | 815.6                     | 5.96                      | 5.49                       | 11.46                     | 52.03 | 47.97             | 92.33               | 73.08                                    | 1792                      | 14.07                     | 12.91                      | 26.98                     | 52.12 | 47.88 |
|                        | LSD at 5%         | 2.31                | 1.21                                     | 31.2                      | 0.18                      | 0.30                       | 0.34                      | 0.50  | 0.34              | 2.03                | 1.30                                     | 36                        | 0.28                      | 0.31                       | 0.63                      | 0.37  | 0.66  |
| Yeast extract (YE)     | 0 ml/L            | 45.26               | 25.06                                    | 567.2                     | 4.24                      | 3.71                       | 7.94                      | 53.49 | 46.51             | 86.05               | 64.08                                    | 1570                      | 11.33                     | 9.81                       | 21.14                     | 53.64 | 46.36 |
|                        | 2.5 ml/L          | 50.11               | 31.41                                    | 811.2                     | 5.97                      | 5.29                       | 11.27                     | 53.03 | 46.97             | 91.09               | 71.38                                    | 1717                      | 13.41                     | 12.20                      | 25.61                     | 52.41 | 47.59 |
|                        | 5 ml/L            | 52.53               | 33.92                                    | 908.1                     | 6.41                      | 6.07                       | 12.48                     | 51.33 | 48.67             | 93.60               | 74.49                                    | 1836                      | 14.95                     | 13.30                      | 28.25                     | 52.94 | 47.06 |
|                        | LSD at 5%         | 2.39                | 1.18                                     | 33.9                      | 0.24                      | 0.76                       | 0.37                      | 0.69  | 0.72              | 2.24                | 1.80                                     | 39                        | 0.37                      | 0.42                       | 0.87                      | 0.34  | 0.74  |
| <b>Interactions</b>    |                   |                     |  |                           |                           |                            |                           |       |                   |                     |  |                           |                           |                            |                           |       |       |
| 0 ppm B + 0 ml/L YE    | 43.32             | 23.32               | 523.5                                    | 3.94                      | 3.12                      | 7.06                       | 55.81                     | 44.19 | 84.21             | 62.65               | 1542                                     | 11.16                     | 9.05                      | 20.21                      | 55.22                     | 44.78 |       |
| 0 ppm B + 2.5 ml/L YE  | 45.88             | 28.20               | 763.6                                    | 5.63                      | 4.83                      | 10.46                      | 53.82                     | 46.18 | 88.25             | 65.47               | 1601                                     | 12.44                     | 10.83                     | 23.27                      | 53.46                     | 46.54 |       |
| 0 ppm B + 5 ml/L YE    | 46.89             | 29.94               | 796.7                                    | 5.54                      | 5.31                      | 10.85                      | 51.06                     | 48.94 | 89.51             | 66.83               | 1643                                     | 12.75                     | 11.28                     | 24.03                      | 53.06                     | 46.94 |       |
| 25 ppm B + 0 ml/L YE   | 45.67             | 25.43               | 549.6                                    | 4.28                      | 3.78                      | 8.06                       | 53.10                     | 46.9  | 86.44             | 64.74               | 1573                                     | 11.35                     | 9.86                      | 21.21                      | 53.51                     | 46.49 |       |
| 25 ppm B + 2.5 ml/L YE | 51.33             | 32.78               | 827.4                                    | 5.84                      | 5.37                      | 11.21                      | 52.11                     | 47.9  | 92.16             | 73.45               | 1745                                     | 13.50                     | 12.42                     | 25.92                      | 52.08                     | 47.92 |       |
| 25 ppm B + 5 ml/L YE   | 54.36             | 35.31               | 951.6                                    | 6.73                      | 6.32                      | 13.05                      | 51.57                     | 48.43 | 94.71             | 77.48               | 1893                                     | 15.67                     | 13.75                     | 29.42                      | 53.26                     | 46.74 |       |
| 50 ppm B + 0 ml/L YE   | 46.80             | 26.43               | 628.4                                    | 4.49                      | 4.22                      | 8.71                       | 51.55                     | 48.45 | 87.52             | 64.88               | 1596                                     | 11.48                     | 10.52                     | 22.00                      | 52.18                     | 47.82 |       |
| 50 ppm B + 2.5 ml/L YE | 53.12             | 33.25               | 842.5                                    | 6.45                      | 5.68                      | 12.13                      | 53.17                     | 46.83 | 92.87             | 75.21               | 1807                                     | 14.29                     | 13.36                     | 27.65                      | 51.68                     | 48.32 |       |
| 50 ppm B + 5 ml/L YE   | 56.34             | 36.51               | 975.9                                    | 6.95                      | 6.58                      | 13.53                      | 51.37                     | 48.63 | 96.59             | 79.15               | 1974                                     | 16.43                     | 14.86                     | 31.29                      | 52.51                     | 47.49 |       |
| LSD at 5%              | 2.49              | 1.33                | 33.2                                     | 0.31                      | 0.89                      | 0.45                       | 1.03                      | 1.07  | 2.90              | 1.73                | 31.56                                    | 0.48                      | 0.31                      | 1.32                       | 1.00                      | 1.02  |       |

**Table 3.** Effect of boron and yeast extract foliar application on absolute growth rate of broad bean plant from 70 to 85 days after sowing the two seasons (2009/2010 and 2010/2011).

| Treatments             |           | Absolute growth rate (AGR) g/day |              |              |              |              |              |
|------------------------|-----------|----------------------------------|--------------|--------------|--------------|--------------|--------------|
|                        |           | Stem                             |              | Leaves       |              | Shoot        |              |
|                        |           | 2009/2010                        | 2010/2011    | 2009/2010    | 2010/2011    | 2009/2010    | 2010/2011    |
| <b>Main effects</b>    |           |                                  |              |              |              |              |              |
| Boron<br>(B)           | 0 ppm     | 0.462                            | 0.477        | 0.393        | 0.400        | 0.855        | 0.875        |
|                        | 25 ppm    | 0.537                            | 0.526        | 0.447        | 0.457        | 0.984        | 0.983        |
|                        | 50 ppm    | 0.544                            | 0.540        | 0.466        | 0.495        | 1.009        | 1.035        |
|                        | LSD at 5% | <b>0.072</b>                     | <b>0.076</b> | <b>0.031</b> | <b>0.038</b> | <b>0.107</b> | <b>0.103</b> |
| Yeast extract<br>(YE)  | 0 ml/L    | 0.463                            | 0.473        | 0.371        | 0.407        | 0.833        | 0.880        |
|                        | 2.5 ml/L  | 0.525                            | 0.501        | 0.460        | 0.463        | 0.985        | 0.962        |
|                        | 5 ml/L    | 0.555                            | 0.570        | 0.475        | 0.482        | 1.030        | 1.051        |
|                        | LSD at 5% | <b>0.073</b>                     | <b>0.051</b> | <b>0.037</b> | <b>0.033</b> | <b>0.103</b> | <b>0.117</b> |
| <b>Interactions</b>    |           |                                  |              |              |              |              |              |
| 0 ppm B + 0 ml/L YE    |           | 0.451                            | 0.481        | 0.341        | 0.395        | 0.790        | 0.876        |
| 0 ppm B + 2.5 ml/L YE  |           | 0.449                            | 0.469        | 0.409        | 0.407        | 0.859        | 0.869        |
| 0 ppm B + 5 ml/L YE    |           | 0.485                            | 0.481        | 0.430        | 0.398        | 0.915        | 0.879        |
| 25 ppm B + 0 ml/L YE   |           | 0.467                            | 0.471        | 0.381        | 0.405        | 0.847        | 0.877        |
| 25 ppm B + 2.5 ml/L YE |           | 0.557                            | 0.511        | 0.481        | 0.470        | 1.038        | 0.981        |
| 25 ppm B + 5 ml/L YE   |           | 0.588                            | 0.596        | 0.479        | 0.495        | 1.067        | 1.091        |
| 50 ppm B + 0 ml/L YE   |           | 0.471                            | 0.466        | 0.392        | 0.420        | 0.863        | 0.886        |
| 50 ppm B + 2.5 ml/L YE |           | 0.569                            | 0.523        | 0.489        | 0.512        | 1.057        | 1.035        |
| 50 ppm B + 5 ml/L YE   |           | 0.591                            | 0.632        | 0.516        | 0.552        | 1.107        | 1.184        |
| LSD at 5%              |           | <b>0.096</b>                     | <b>0.074</b> | <b>0.038</b> | <b>0.046</b> | <b>0.114</b> | <b>0.135</b> |



**Table 4.** Effect of boron and yeast extract foliar application on photosynthetic pigments (mg/g F.W.) of broad bean leaves from 70 to 85 days after sowing in the first season (2009/2010).

| Treatment s               |           | Days after sowing |              |              |              |                           |                   |              |              |              |              |                           |                   |
|---------------------------|-----------|-------------------|--------------|--------------|--------------|---------------------------|-------------------|--------------|--------------|--------------|--------------|---------------------------|-------------------|
|                           |           | 70 days           |              |              |              |                           |                   | 85 days      |              |              |              |                           |                   |
|                           |           | Chlorophylls      |              |              | Carotenoids  | Chl a+ b /<br>Carotenoids | Total<br>pigments | Chlorophylls |              |              | Carotenoids  | Chl a+ b /<br>Carotenoids | Total<br>pigments |
|                           |           | a                 | b            | a+b          |              |                           |                   | a            | b            | a+b          |              |                           |                   |
| <b>Main effects</b>       |           |                   |              |              |              |                           |                   |              |              |              |              |                           |                   |
| Boron<br>(B)              | 0 ppm     | 0.593             | 0.400        | 0.994        | 0.477        | 2.080                     | 1.470             | 0.578        | 0.366        | 0.944        | 0.445        | 2.119                     | 1.390             |
|                           | 25 ppm    | 0.663             | 0.424        | 1.087        | 0.519        | 2.090                     | 1.606             | 0.615        | 0.402        | 1.017        | 0.456        | 2.230                     | 1.473             |
|                           | 50 ppm    | 0.692             | 0.445        | 1.137        | 0.526        | 2.158                     | 1.663             | 0.631        | 0.426        | 1.057        | 0.469        | 2.251                     | 1.526             |
|                           | LSD at 5% | <b>0.081</b>      | <b>0.019</b> | <b>0.091</b> | <b>0.045</b> | NS                        | <b>0.089</b>      | <b>0.031</b> | <b>0.063</b> | <b>0.030</b> | NS           | NS                        | <b>0.074</b>      |
| Yeast extract<br>(YE)     | 0 ml/L    | 0.552             | 0.354        | 0.906        | 0.449        | 2.017                     | 1.354             | 0.536        | 0.335        | 0.871        | 0.401        | 2.169                     | 1.272             |
|                           | 2.5 ml/L  | 0.673             | 0.449        | 1.122        | 0.517        | 2.173                     | 1.639             | 0.635        | 0.415        | 1.050        | 0.481        | 2.184                     | 1.531             |
|                           | 5 ml/L    | 0.723             | 0.467        | 1.190        | 0.556        | 2.138                     | 1.746             | 0.654        | 0.444        | 1.097        | 0.488        | 2.248                     | 1.585             |
|                           | LSD at 5% | <b>0.067</b>      | <b>0.023</b> | <b>0.083</b> | <b>0.034</b> | NS                        | <b>0.68</b>       | <b>0.056</b> | <b>0.061</b> | <b>0.034</b> | <b>0.055</b> | NS                        | <b>0.093</b>      |
| <b>Interactions</b>       |           |                   |              |              |              |                           |                   |              |              |              |              |                           |                   |
| 0 ppm B + 0 ml/L YE       |           | 0.512             | 0.326        | 0.838        | 0.436        | 1.922                     | 1.274             | 0.502        | 0.311        | 0.813        | 0.387        | 2.101                     | 1.200             |
| 0 ppm B + 2.5 ml/L YE     |           | 0.623             | 0.432        | 1.055        | 0.473        | 2.23                      | 1.528             | 0.610        | 0.383        | 0.993        | 0.471        | 2.108                     | 1.464             |
| 0 ppm B + 5 ml/L YE       |           | 0.645             | 0.443        | 1.088        | 0.521        | 2.088                     | 1.609             | 0.622        | 0.405        | 1.027        | 0.478        | 2.149                     | 1.505             |
| 25 ppm B + 0 ml/L YE      |           | 0.564             | 0.35         | 0.914        | 0.452        | 2.022                     | 1.366             | 0.538        | 0.328        | 0.866        | 0.394        | 2.198                     | 1.260             |
| 25 ppm B + 2.5 ml/L<br>YE |           | 0.684             | 0.452        | 1.136        | 0.536        | 2.119                     | 1.672             | 0.643        | 0.423        | 1.066        | 0.483        | 2.207                     | 1.549             |
| 25 ppm B + 5 ml/L YE      |           | 0.741             | 0.471        | 1.212        | 0.569        | 2.13                      | 1.781             | 0.665        | 0.455        | 1.120        | 0.490        | 2.286                     | 1.610             |
| 50 ppm B + 0 ml/L YE      |           | 0.580             | 0.385        | 0.965        | 0.458        | 2.107                     | 1.423             | 0.567        | 0.367        | 0.934        | 0.423        | 2.208                     | 1.357             |
| 50 ppm B + 2.5 ml/L<br>YE |           | 0.712             | 0.464        | 1.176        | 0.542        | 2.17                      | 1.718             | 0.652        | 0.439        | 1.091        | 0.488        | 2.236                     | 1.579             |
| 50 ppm B + 5 ml/L YE      |           | 0.783             | 0.486        | 1.269        | 0.578        | 2.196                     | 1.847             | 0.674        | 0.471        | 1.145        | 0.496        | 2.308                     | 1.641             |
| LSD at 5%                 |           | <b>0.088</b>      | <b>0.051</b> | <b>0.115</b> | <b>0.064</b> | <b>0.164</b>              | <b>0.136</b>      | <b>0.098</b> | <b>0.084</b> | <b>0.141</b> | <b>0.036</b> | <b>0.193</b>              | <b>0.177</b>      |

**Table 5. Effect of boron and yeast extract foliar application on photosynthetic pigments (mg/g F.W.) of broad bean leaves at 70 and 85 days after sowing in the second season (2010/2011).**

| Treatment s                   |                  | Days after sowing |              |              |              |                           |                   |              |              |              |              |                           |                   |
|-------------------------------|------------------|-------------------|--------------|--------------|--------------|---------------------------|-------------------|--------------|--------------|--------------|--------------|---------------------------|-------------------|
|                               |                  | 70 days           |              |              |              |                           |                   | 85 days      |              |              |              |                           |                   |
|                               |                  | Chlorophylls      |              |              | Carotenoids  | Chl a+ b /<br>Carotenoids | Total<br>pigments | Chlorophylls |              |              | Carotenoids  | Chl a+ b /<br>Carotenoids | Total<br>pigments |
|                               |                  | a                 | b            | a+b          |              |                           |                   | a            | b            | a+b          |              |                           |                   |
| <b>Main effects</b>           |                  |                   |              |              |              |                           |                   |              |              |              |              |                           |                   |
| <b>Boron<br/>(B)</b>          | <b>0 ppm</b>     | 0.588             | 0.378        | 0.966        | 0.472        | 2.043                     | 1.438             | 0.571        | 0.358        | 0.929        | 0.416        | 2.237                     | 1.345             |
|                               | <b>25 ppm</b>    | 0.645             | 0.435        | 1.080        | 0.519        | 2.078                     | 1.599             | 0.616        | 0.403        | 1.019        | 0.442        | 2.307                     | 1.461             |
|                               | <b>50 ppm</b>    | 0.679             | 0.448        | 1.127        | 0.531        | 2.119                     | 1.658             | 0.637        | 0.425        | 1.062        | 0.444        | 2.396                     | 1.505             |
|                               | <b>LSD at 5%</b> | <b>0.041</b>      | <b>0.021</b> | <b>0.057</b> | <b>0.058</b> | <b>0.069</b>              | <b>0.087</b>      | <b>NS</b>    | <b>0.032</b> | <b>0.054</b> | <b>NS</b>    | <b>NS</b>                 | <b>0.088</b>      |
| <b>Yeast extract<br/>(YE)</b> | <b>0 ml/L</b>    | 0.562             | 0.353        | 0.915        | 0.456        | 2.006                     | 1.310             | 0.550        | 0.338        | 0.889        | 0.377        | 2.354                     | 1.266             |
|                               | <b>2.5 ml/L</b>  | 0.658             | 0.443        | 1.101        | 0.524        | 2.103                     | 1.625             | 0.626        | 0.410        | 1.037        | 0.453        | 2.289                     | 1.489             |
|                               | <b>5 ml/L</b>    | 0.692             | 0.466        | 1.157        | 0.543        | 2.131                     | 1.700             | 0.648        | 0.437        | 1.084        | 0.472        | 2.296                     | 1.556             |
|                               | <b>LSD at 5%</b> | <b>0.046</b>      | <b>0.023</b> | <b>0.085</b> | <b>0.051</b> | <b>NS</b>                 | <b>0.070</b>      | <b>0.068</b> | <b>0.054</b> | <b>0.052</b> | <b>0.048</b> | <b>NS</b>                 | <b>0.062</b>      |
| <b>Interactions</b>           |                  |                   |              |              |              |                           |                   |              |              |              |              |                           |                   |
| <b>0 ppm B + 0 ml/L YE</b>    |                  | 0.528             | 0.315        | 0.843        | 0.442        | 1.907                     | 1.285             | 0.532        | 0.318        | 0.850        | 0.368        | 2.310                     | 1.218             |
| <b>0 ppm B + 2.5 ml/L YE</b>  |                  | 0.613             | 0.397        | 1.010        | 0.481        | 2.099                     | 1.491             | 0.588        | 0.374        | 0.962        | 0.428        | 2.248                     | 1.390             |
| <b>0 ppm B + 5 ml/L YE</b>    |                  | 0.624             | 0.422        | 1.046        | 0.493        | 2.122                     | 1.539             | 0.594        | 0.381        | 0.975        | 0.453        | 2.152                     | 1.428             |
| <b>25 ppm B + 0 ml/L YE</b>   |                  | 0.566             | 0.365        | 0.931        | 0.456        | 2.042                     | 1.387             | 0.547        | 0.332        | 0.879        | 0.379        | 2.319                     | 1.258             |
| <b>25 ppm B + 2.5 ml/L YE</b> |                  | 0.673             | 0.458        | 1.131        | 0.538        | 2.102                     | 1.669             | 0.632        | 0.415        | 1.047        | 0.468        | 2.237                     | 1.515             |
| <b>25 ppm B + 5 ml/L YE</b>   |                  | 0.696             | 0.482        | 1.178        | 0.564        | 2.089                     | 1.742             | 0.670        | 0.461        | 1.131        | 0.478        | 2.366                     | 1.609             |
| <b>50 ppm B + 0 ml/L YE</b>   |                  | 0.592             | 0.378        | 0.970        | 0.469        | 2.068                     | 1.259             | 0.572        | 0.365        | 0.937        | 0.385        | 2.434                     | 1.322             |
| <b>50 ppm B + 2.5 ml/L YE</b> |                  | 0.689             | 0.474        | 1.163        | 0.552        | 2.107                     | 1.715             | 0.659        | 0.442        | 1.101        | 0.462        | 2.383                     | 1.563             |
| <b>50 ppm B + 5 ml/L YE</b>   |                  | 0.755             | 0.493        | 1.248        | 0.572        | 2.182                     | 1.820             | 0.679        | 0.468        | 1.147        | 0.484        | 2.370                     | 1.631             |
| <b>LSD at 5%</b>              |                  | <b>0.094</b>      | <b>0.063</b> | <b>0.128</b> | <b>0.060</b> | <b>0.146</b>              | <b>0.158</b>      | <b>0.105</b> | <b>0.074</b> | <b>0.112</b> | <b>0.054</b> | <b>NS</b>                 | <b>0.175</b>      |

**Table 6.** Effect of boron and yeast extract foliar application on minerals and bioconstituents in leaves of broad bean at 70 and 85 days after sowing in the first season (2009/2010).

| Treatments             |           | Days after sowing   |                  |                  |                  |                               |   |                                 |                  |                  |                  |                  |                               |   |                                 |
|------------------------|-----------|---------------------|------------------|------------------|------------------|-------------------------------|---|---------------------------------|------------------|------------------|------------------|------------------|-------------------------------|---|---------------------------------|
|                        |           | 70 days             |                  |                  |                  |                               |   | 85 days                         |                  |                  |                  |                  |                               |   |                                 |
|                        |           | N<br>mg/g<br>D.W    | P<br>mg/g<br>D.W | K<br>mg/g<br>D.W | B<br>µg/g<br>D.W | Total<br>sugar<br>mg/g<br>F.W | Total<br>free<br>amino<br>acid<br>mg/<br>g<br>F.W | Crude<br>protein<br>mg/g<br>D.W | N<br>mg/g<br>D.W | P<br>mg/g<br>D.W | K<br>mg/g<br>D.W | B<br>µg/g<br>D.W | Total<br>sugar<br>mg/g<br>F.W | Total<br>free<br>amino<br>acid<br>mg/<br>g<br>F.W | Crude<br>protein<br>mg/g<br>D.W |
| Boron<br>(B)           | 0 ppm     | 28.98               | 2.75             | 23.99            | 48.61            | 58.71                         | 12.55   | 180.7                           | 27.58            | 3.13             | 23.00            | 48.72            | 53.64                         | 12.94   | 172.4                           |
|                        | 25 ppm    | 30.89               | 3.13             | 24.77            | 60.07            | 63.76                         | 14.71   | 193.0                           | 29.98            | 3.52             | 23.78            | 60.77            | 62.95                         | 13.67   | 187.4                           |
|                        | 50 ppm    | 31.40               | 3.27             | 25.05            | 64.40            | 68.50                         | 15.07   | 196.2                           | 30.56            | 3.59             | 24.29            | 62.80            | 67.77                         | 14.23   | 191.0                           |
|                        | LSD at 5% | <b>0.89</b>         | <b>0.35</b>      | <b>0.43</b>      | <b>1.28</b>      | <b>2.58</b>                   | <b>0.81</b>                                       | <b>11.2</b>                     | <b>1.06</b>      | <b>0.28</b>      | <b>0.55</b>      | <b>3.54</b>      | <b>3.84</b>                   | <b>0.66</b>                                       | <b>8.9</b>                      |
| Yeast extract<br>(YE)  | 0 ml/L    | 27.44               | 2.63             | 23.26            | 52.21            | 52.64                         | 12.18   | 171.5                           | 26.53            | 2.94             | 22.75            | 51.72            | 49.24                         | 12.49   | 165.8                           |
|                        | 2.5 ml/L  | 31.76               | 3.13             | 25.12            | 60.52            | 65.81                         | 14.85   | 198.1                           | 30.59            | 3.54             | 23.93            | 58.91            | 63.73                         | 13.78   | 191.2                           |
|                        | 5 ml/L    | 32.06               | 3.39             | 25.44            | 60.34            | 72.51                         | 15.29   | 200.4                           | 30.99            | 3.76             | 24.39            | 61.67            | 71.40                         | 14.57   | 193.7                           |
|                        | LSD at 5% | <b>0.72</b>         | <b>0.48</b>      | <b>0.41</b>      | <b>1.77</b>      | <b>3.14</b>                   | <b>0.85</b>                                       | <b>17.7</b>                     | <b>1.28</b>      | <b>0.25</b>      | <b>0.89</b>      | <b>4.54</b>      | <b>3.23</b>                   | <b>0.52</b>                                       | <b>13.8</b>                     |
|                        |           | <b>Interactions</b> |                  |                  |                  |                               |   |                                 |                  |                  |                  |                  |                               |   |                                 |
| 0 ppm B + 0 ml/L YE    |           | 25.53               | 2.46             | 22.65            | 42.63            | 48.98                         | 11.28   | 159.6                           | 24.17            | 2.52             | 21.85            | 43.66            | 45.64                         | 12.21   | 151.1                           |
| 0 ppm B + 2.5 ml/L YE  |           | 30.65               | 2.88             | 24.45            | 52.33            | 62.45                         | 12.92   | 190.3                           | 28.87            | 3.25             | 23.56            | 51.64            | 54.75                         | 13.16   | 180.4                           |
| 0 ppm B + 5 ml/L YE    |           | 30.75               | 2.90             | 24.87            | 50.86            | 64.70                         | 13.44   | 192.2                           | 29.69            | 3.63             | 23.60            | 50.87            | 60.54                         | 13.44   | 185.6                           |
| 25 ppm B + 0 ml/L YE   |           | 27.94               | 2.68             | 23.34            | 55.67            | 50.53                         | 12.46   | 174.6                           | 26.96            | 3.12             | 22.96            | 54.28            | 49.76                         | 12.57   | 168.5                           |
| 25 ppm B + 2.5 ml/L YE |           | 32.16               | 3.18             | 25.32            | 62.70            | 66.55                         | 15.79   | 201.0                           | 31.24            | 3.66             | 23.69            | 61.32            | 63.21                         | 13.85   | 195.3                           |
| 25 ppm B + 5 ml/L YE   |           | 32.56               | 3.54             | 25.66            | 61.85            | 74.19                         | 15.88   | 203.5                           | 31.73            | 3.78             | 24.70            | 66.71            | 75.89                         | 14.60   | 198.3                           |
| 50 ppm B + 0 ml/L YE   |           | 28.85               | 2.76             | 23.78            | 58.34            | 58.42                         | 12.80   | 180.3                           | 28.45            | 3.19             | 23.44            | 57.21            | 52.32                         | 12.69   | 177.8                           |
| 50 ppm B + 2.5 ml/L YE |           | 32.48               | 3.32             | 25.58            | 66.54            | 68.43                         | 15.84   | 203.0                           | 31.67            | 3.71             | 24.55            | 63.76            | 73.23                         | 14.34   | 197.9                           |
| 50 ppm B + 5 ml/L YE   |           | 32.86               | 3.72             | 25.80            | 68.32            | 78.64                         | 16.56   | 205.4                           | 31.55            | 3.86             | 24.87            | 67.42            | 77.76                         | 15.66   | 197.2                           |
| LSD at 5%              |           | <b>1.15</b>         | <b>0.44</b>      | <b>1.09</b>      | <b>2.54</b>      | <b>4.32</b>                   | <b>1.05</b>                                       | <b>19.1</b>                     | <b>1.35</b>      | <b>0.32</b>      | <b>1.12</b>      | <b>5.48</b>      | <b>4.43</b>                   | <b>1.04</b>                                       | <b>14.3</b>                     |

**Table 7.** Effect of boron and yeast extract foliar application on minerals and bioconstituents in leaves of broad bean at 70 and 85 days after sowing in the second season (2010/2011).

| Treatments            |                        | Days after sowing |               |               |             |                               |  |                              |                  |                  |                  |             |                               |  |                              |
|-----------------------|------------------------|-------------------|---------------|---------------|-------------|-------------------------------|--|------------------------------|------------------|------------------|------------------|-------------|-------------------------------|--|------------------------------|
|                       |                        | 70 days           |               |               |             |                               |  | 85 days                      |                  |                  |                  |             |                               |  |                              |
|                       |                        | N<br>mg/g D.W     | P<br>mg/g D.W | K<br>mg/g D.W | B           | Total<br>sugar<br>mg/g<br>F.W | Total<br>free<br>amino<br>acid<br>mg/ g<br>F.W | Crude<br>protein<br>mg/g D.W | N<br>mg/g<br>D.W | P<br>mg/g<br>D.W | K<br>mg/g<br>D.W | B           | Total<br>sugar<br>mg/g<br>F.W | Total<br>free<br>amino<br>acid<br>mg/ g<br>F.W | Crude<br>protein<br>mg/g D.W |
| µg/g<br>D.W           | µg/g<br>D.W            |                   |               |               |             |                               |  |                              |                  |                  |                  |             |                               |  |                              |
| <b>Main effects</b>   |                        |                   |               |               |             |                               |  |                              |                  |                  |                  |             |                               |  |                              |
| Boron<br>(B)          | 0 ppm                  | 27.97             | 2.80          | 24.08         | 49.32       | 58.20                         | 12.98  | 174.8                        | 27.91            | 3.14             | 22.58            | 60.00       | 54.17                         | 12.67  | 174.4                        |
|                       | 25 ppm                 | 30.24             | 3.31          | 25.02         | 62.03       | 66.12                         | 13.92  | 189.0                        | 30.03            | 3.49             | 23.65            | 61.92       | 63.03                         | 13.55  | 187.7                        |
|                       | 50 ppm                 | 30.62             | 3.43          | 25.35         | 65.84       | 68.97                         | 14.47  | 191.4                        | 31.13            | 3.61             | 23.79            | 64.09       | 66.74                         | 14.12  | 194.8                        |
|                       | LSD at 5%              | <b>0.46</b>       | <b>0.17</b>   | <b>0.81</b>   | <b>2.20</b> | <b>1.26</b>                   | <b>0.74</b>                                    | <b>7.2</b>                   | <b>0.70</b>      | <b>0.15</b>      | <b>NS</b>        | <b>1.63</b> | <b>2.78</b>                   | <b>0.48</b>                                    | <b>11.2</b>                  |
| Yeast extract<br>(YE) | 0 ml/L                 | 26.86             | 2.67          | 23.55         | 52.30       | 50.90                         | 12.53  | 167.9                        | 27.64            | 3.02             | 22.36            | 54.58       | 51.83                         | 12.51  | 172.7                        |
|                       | 2.5 ml/L               | 30.39             | 3.37          | 25.30         | 61.53       | 68.26                         | 13.82  | 189.9                        | 30.33            | 3.50             | 23.40            | 64.55       | 62.58                         | 13.34  | 189.6                        |
|                       | 5 ml/L                 | 31.58             | 3.50          | 25.60         | 63.35       | 74.14                         | 15.02  | 197.4                        | 31.11            | 3.73             | 24.26            | 66.88       | 69.53                         | 14.49  | 194.6                        |
|                       | LSD at 5%              | <b>0.72</b>       | <b>0.25</b>   | <b>0.82</b>   | <b>1.97</b> | <b>1.81</b>                   | <b>0.73</b>                                    | <b>5.7</b>                   | <b>0.83</b>      | <b>0.18</b>      | <b>0.91</b>      | <b>1.85</b> | <b>2.63</b>                   | <b>0.65</b>                                    | <b>10.4</b>                  |
| <b>Interactions</b>   |                        |                   |               |               |             |                               |  |                              |                  |                  |                  |             |                               |  |                              |
|                       | 0 ppm B + 0 ml/L YE    | 26.36             | 2.51          | 22.11         | 41.15       | 46.23                         | 12.17  | 164.8                        | 25.98            | 2.60             | 21.34            | 44.65       | 47.75                         | 12.28  | 162.4                        |
|                       | 0 ppm B + 2.5 ml/L YE  | 27.94             | 2.92          | 24.79         | 54.19       | 61.62                         | 12.94  | 174.6                        | 28.77            | 3.35             | 22.98            | 66.80       | 56.55                         | 12.75  | 179.8                        |
|                       | 0 ppm B + 5 ml/L YE    | 29.62             | 2.96          | 25.34         | 52.63       | 66.76                         | 13.83  | 185.1                        | 28.98            | 3.48             | 23.41            | 68.54       | 58.21                         | 12.98  | 181.1                        |
|                       | 25 ppm B + 0 ml/L YE   | 26.88             | 2.70          | 23.89         | 56.32       | 51.70                         | 12.55  | 168.0                        | 27.97            | 3.20             | 22.80            | 58.44       | 52.32                         | 12.59  | 174.8                        |
|                       | 25 ppm B + 2.5 ml/L YE | 31.45             | 3.52          | 25.48         | 62.98       | 70.43                         | 13.88  | 196.6                        | 30.43            | 3.50             | 23.59            | 61.87       | 63.34                         | 13.49  | 190.2                        |
|                       | 25 ppm B + 5 ml/L YE   | 32.40             | 3.71          | 25.69         | 66.78       | 76.24                         | 15.32  | 202.5                        | 31.70            | 3.77             | 24.56            | 65.45       | 73.43                         | 14.56  | 198.1                        |
|                       | 50 ppm B + 0 ml/L YE   | 27.35             | 2.79          | 24.65         | 59.44       | 54.76                         | 12.86  | 170.9                        | 28.96            | 3.26             | 22.94            | 60.64       | 55.42                         | 12.65  | 181.0                        |
|                       | 50 ppm B + 2.5 ml/L YE | 31.78             | 3.67          | 25.64         | 67.42       | 72.74                         | 14.65  | 198.6                        | 31.79            | 3.64             | 23.62            | 64.98       | 67.85                         | 13.78  | 198.7                        |
|                       | 50 ppm B + 5 ml/L YE   | 32.73             | 3.84          | 25.77         | 70.65       | 79.41                         | 15.90  | 204.6                        | 32.65            | 3.93             | 24.80            | 66.64       | 76.94                         | 15.92  | 204.6                        |
|                       | LSD at 5%              | <b>1.18</b>       | <b>0.20</b>   | <b>1.11</b>   | <b>2.58</b> | <b>2.98</b>                   | <b>1.03</b>                                    | <b>16.7</b>                  | <b>1.07</b>      | <b>0.27</b>      | <b>1.05</b>      | <b>2.56</b> | <b>3.56</b>                   | <b>1.09</b>                                    | <b>15.5</b>                  |

**Table 8.** Effect of boron and yeast extract foliar application on endogenous phytohormones of broad bean leaves at 75 days after sowing in the second season (2010/2011).

| Treatments                        |                 | Auxins ( $\mu\text{g/g F.W}$ ) | Cytokinins ( $\mu\text{g/g F.W}$ ) | Abscisic acid ( $\mu\text{g/g F.W}$ ) |
|-----------------------------------|-----------------|--------------------------------|------------------------------------|---------------------------------------|
|                                   |                 | <b>Main effects</b>            |                                    |                                       |
| <b>Boron<br/>(B)</b>              | <b>0 ppm</b>    | 74.22                          | 20.19                              | 0.73                                  |
|                                   | <b>25 ppm</b>   | 83.98                          | 21.58                              | 0.63                                  |
|                                   | <b>50 ppm</b>   | 88.18                          | 22.30                              | 0.60                                  |
| <b>Yeast<br/>extract<br/>(YE)</b> | <b>0 ml/L</b>   | 71.17                          | 17.80                              | 0.88                                  |
|                                   | <b>2.5 ml/L</b> | 83.64                          | 22.55                              | 0.58                                  |
|                                   | <b>5 ml/L</b>   | 91.56                          | 23.72                              | 0.50                                  |
|                                   |                 | <b>Interactions</b>            |                                    |                                       |
| <b>0 ppm B + 0 ml/L YE</b>        |                 | 63.34                          | 16.77                              | 0.98                                  |
| <b>0 ppm B + 2.5 ml/L YE</b>      |                 | 77.54                          | 21.26                              | 0.62                                  |
| <b>0 ppm B + 5 ml/L YE</b>        |                 | 81.78                          | 22.53                              | 0.60                                  |
| <b>25 ppm B + 0 ml/L YE</b>       |                 | 71.86                          | 17.97                              | 0.84                                  |
| <b>25 ppm B + 2.5 ml/L YE</b>     |                 | 85.40                          | 22.94                              | 0.58                                  |
| <b>25 ppm B + 5 ml/L YE</b>       |                 | 94.67                          | 23.82                              | 0.47                                  |
| <b>50 ppm B + 0 ml/L YE</b>       |                 | 78.32                          | 18.65                              | 0.83                                  |
| <b>50 ppm B + 2.5 ml/L YE</b>     |                 | 87.98                          | 23.45                              | 0.55                                  |
| <b>50 ppm B + 5 ml/L YE</b>       |                 | 98.23                          | 24.81                              | 0.42                                  |

Table 9. Effect of boron and yeast extract foliar application on flowering, pod setting, green pod yield and its components of broad bean plants in the first season (2009/2010).

| Treatments                | Number of flowers per plant | Pod setting percentage | Shedding percentage | Number of green pods/plant | Average pod length (cm) | Average green pod weight (g) | Weight of green pod per plant (g) | Estimated green pod yield per fed. (ton) |             |
|---------------------------|-----------------------------|------------------------|---------------------|----------------------------|-------------------------|------------------------------|-----------------------------------|--|-------------|
| <b>Main effects</b>       |                             |                        |                     |                            |                         |                              |                                   |  |             |
| <b>Boron (B)</b>          | 0 ppm                       | 89.35                  | 31.29               | 68.71                      | 21.44                   | 12.92                        | 12.16                             | 260.7                                    | 9.435       |
|                           | 25 ppm                      | 99.06                  | 32.22               | 67.78                      | 23.77                   | 13.97                        | 12.82                             | 304.7                                    | 11.028      |
|                           | 50 ppm                      | 104.07                 | 32.41               | 67.59                      | 24.84                   | 13.66                        | 12.99                             | 322.7                                    | 11.678      |
|                           | LSD at 5%                   | <b>4.32</b>            | <b>0.62</b>         | <b>0.48</b>                | <b>1.76</b>             | NS                           | NS                                | <b>24.5</b>                              | <b>0.87</b> |
| <b>Yeast extract (YE)</b> | 0 ml/L                      | 84.97                  | 31.09               | 68.91                      | 18.20                   | 13.01                        | 11.92                             | 216.9                                    | 7.851       |
|                           | 2.5 ml/L                    | 99.36                  | 32.38               | 67.62                      | 25.19                   | 13.30                        | 12.89                             | 324.7                                    | 11.751      |
|                           | 5 ml/L                      | 108.15                 | 32.45               | 67.55                      | 26.66                   | 14.25                        | 13.17                             | 351.1                                    | 12.707      |
|                           | LSD at 5%                   | <b>5.84</b>            | <b>0.95</b>         | <b>0.71</b>                | <b>2.07</b>             | <b>1.12</b>                  | NS                                | <b>21.4</b>                              | <b>0.83</b> |
| <b>Interactions</b>       |                             |                        |                     |                            |                         |                              |                                   |  |             |
| 0 ppm B + 0 ml/L YE       | 79.74                       | 29.93                  | 70.07               | 16.13                      | 12.51                   | 11.24                        | 181.3                             | 6.561                                    |             |
| 0 ppm B + 2.5 ml/L YE     | 92.68                       | 32.34                  | 67.66               | 23.32                      | 13.30                   | 12.56                        | 292.9                             | 10.600                                   |             |
| 0 ppm B + 5 ml/L YE       | 95.64                       | 31.59                  | 68.41               | 24.86                      | 13.21                   | 12.68                        | 315.2                             | 11.408                                   |             |
| 25 ppm B + 0 ml/L YE      | 85.53                       | 31.15                  | 68.85               | 18.56                      | 12.41                   | 12.14                        | 225.3                             | 8.154                                    |             |
| 25 ppm B + 2.5 ml/L YE    | 98.78                       | 32.94                  | 67.06               | 25.59                      | 13.83                   | 12.95                        | 331.4                             | 11.993                                   |             |
| 25 ppm B + 5 ml/L YE      | 112.87                      | 32.56                  | 67.44               | 27.15                      | 14.31                   | 13.38                        | 363.3                             | 13.147                                   |             |
| 50 ppm B + 0 ml/L YE      | 89.64                       | 32.18                  | 67.82               | 19.91                      | 13.17                   | 12.37                        | 246.3                             | 8.913                                    |             |
| 50 ppm B + 2.5 ml/L YE    | 106.63                      | 31.87                  | 68.13               | 26.65                      | 14.30                   | 13.15                        | 350.4                             | 12.683                                   |             |
| 50 ppm B + 5 ml/L YE      | 115.94                      | 33.19                  | 66.81               | 27.96                      | 14.61                   | 13.46                        | 376.3                             | 13.620                                   |             |
| LSD at 5%                 | <b>6.32</b>                 | <b>1.02</b>            | <b>1.32</b>         | <b>3.11</b>                | <b>1.13</b>             | <b>1.51</b>                  | <b>47.6</b>                       | <b>1.18</b>                              |             |

**Table 10. Effect of boron and yeast extract foliar application on flowering, pod setting, green pod yield and its components of broad bean plants in the second season (2010/2011).**

| Treatments                    |                  | Number of flowers per plant | Pod setting percentage | Shedding percentage | Number of green pods/plant | Average pod length (cm) | Average green pod weight (g) | Weight of green pod per plant (g) | Estimated green pod yield per fed. (ton) |
|-------------------------------|------------------|-----------------------------|------------------------|---------------------|----------------------------|-------------------------|------------------------------|-----------------------------------|--|
| <b>Main effects</b>           |                  |                             |                        |                     |                            |                         |                              |                                   |  |
| <b>Boron (B)</b>              | <b>0 ppm</b>     | 91.34                       | 30.29                  | 69.71               | 20.95                      | 13.25                   | 12.24                        | 256.4                             | 9.280                                    |
|                               | <b>25 ppm</b>    | 101.58                      | 32.88                  | 67.12               | 23.39                      | 14.10                   | 12.77                        | 298.7                             | 10.810                                   |
|                               | <b>50 ppm</b>    | 104.71                      | 33.08                  | 66.92               | 25.15                      | 13.98                   | 12.94                        | 325.4                             | 11.778                                   |
|                               | <b>LSD at 5%</b> | <b>2.61</b>                 | <b>0.43</b>            | <b>0.58</b>         | <b>1.61</b>                | <b>NS</b>               | <b>NS</b>                    | <b>32.1</b>                       | <b>0.889</b>                             |
| <b>Yeast extract (YE)</b>     | <b>0 ml/L</b>    | 83.88                       | 30.75                  | 69.25               | 18.12                      | 13.31                   | 11.99                        | 217.3                             | 7.863                                    |
|                               | <b>2.5 ml/L</b>  | 103.58                      | 32.38                  | 67.62               | 24.85                      | 13.65                   | 12.82                        | 318.6                             | 11.529                                   |
|                               | <b>5 ml/L</b>    | 110.17                      | 33.11                  | 66.89               | 26.52                      | 14.37                   | 13.14                        | 348.5                             | 12.611                                   |
|                               | <b>LSD at 5%</b> | <b>5.32</b>                 | <b>0.56</b>            | <b>0.62</b>         | <b>1.69</b>                | <b>0.63</b>             | <b>NS</b>                    | <b>44.8</b>                       | <b>1.05</b>                              |
| <b>Interactions</b>           |                  |                             |                        |                     |                            |                         |                              |                                   |  |
| <b>0 ppm B + 0 ml/L YE</b>    |                  | 77.78                       | 28.93                  | 71.07               | 15.65                      | 12.69                   | 11.44                        | 179.0                             | 6.479                                    |
| <b>0 ppm B + 2.5 ml/L YE</b>  |                  | 96.56                       | 30.34                  | 69.66               | 22.98                      | 13.38                   | 12.53                        | 287.9                             | 10.421                                   |
| <b>0 ppm B + 5 ml/L YE</b>    |                  | 99.67                       | 31.59                  | 68.41               | 24.23                      | 13.85                   | 12.76                        | 309.2                             | 11.189                                   |
| <b>25 ppm B + 0 ml/L YE</b>   |                  | 86.44                       | 31.15                  | 68.85               | 17.96                      | 12.90                   | 12.21                        | 219.3                             | 7.936                                    |
| <b>25 ppm B + 2.5 ml/L YE</b> |                  | 104.45                      | 32.94                  | 67.06               | 25.31                      | 14.15                   | 12.88                        | 326.0                             | 11.798                                   |
| <b>25 ppm B + 5 ml/L YE</b>   |                  | 113.86                      | 34.56                  | 65.44               | 26.89                      | 14.42                   | 13.23                        | 355.8                             | 12.875                                   |
| <b>50 ppm B + 0 ml/L YE</b>   |                  | 87.43                       | 32.18                  | 67.82               | 20.76                      | 13.63                   | 12.33                        | 256.0                             | 9.264                                    |
| <b>50 ppm B + 2.5 ml/L YE</b> |                  | 109.73                      | 33.87                  | 66.13               | 26.27                      | 14.50                   | 13.07                        | 343.3                             | 12.426                                   |
| <b>50 ppm B + 5 ml/L YE</b>   |                  | 116.98                      | 33.19                  | 66.81               | 28.43                      | 14.45                   | 13.42                        | 381.5                             | 13.808                                   |
| <b>LSD at 5%</b>              |                  | <b>7.54</b>                 | <b>0.81</b>            | <b>1.12</b>         | <b>3.06</b>                | <b>0.88</b>             | <b>0.74</b>                  | <b>87.0</b>                       | <b>2.86</b>                              |

**Conclusion:**

It could be concluded that foliar spraying with boron at 50 ppm and yeast extract at 5 ml/L can be used to increase the final green pods and seed yield as well as seed quality of broad bean plants

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