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ORIGINAL ARTICLES

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. Results revealed that foliar application with boron and yeast extract either individually or in 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.

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

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; Wanas, 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 (Mahmoued, 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

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metabolism, pollen germination and pollen tube growth and increase yield (Gerendas and Sattelmatcher, 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.

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 by 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 Mahmoued (2001) is presented in Table (A).

Table A: Chemical analysis of yeast extract.

Amino acid mg⁄100g dry weight		Vitamins and Carbohydrates 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	Insitol	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^2 (3x 3.5m) with five rows. Broad bean seeds were sown in hills spaced 15 cm on ridges on the 1st of November in the two seasons.

A total of 200 kg/fed. calcium super phosphate (15.5% P_2O_5), 100 kg/fed. ammonium nitrate (33% N) and 50 kg/fed. potassium sulphate (48% K_2O) 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).

$AGR = w_2 - w_1 / t_2 - t_1$.

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

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).

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).

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^2)/ 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^2)/ plant	Stem dry weight (g)/ plant	Leaf dry weight (g)/ plant	Shoot dry weight (g/ plant	Dry matter distribution %	
								stem	Leaves							stem	Leaves
		Main effects															
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
Interactions																	
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^2)/ 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^2)/ plant	Stem dry weight (g)/ plant	Leaf dry weight (g)/ plant	Shoot dry weight (g/ plant	Dry matter distribution %	
								stem	Leaves							stem	Leaves
		Main effects															
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
Interactions																	
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

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 hydrolisates (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).

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 in 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
		Main effects					
Boron (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%	0.072	0.076	0.031	0.038	0.107	0.103
Yeast extract (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%	0.073	0.051	0.037	0.033	0.103	0.117
		Interactions					
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%		0.096	0.074	0.038	0.046	0.114	0.135

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 caroteinods 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).

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).

Treatments		Days after sowing											
		70 days						85 days					
		Chlorophylls			Carotenoids	Chl a+ b / Carotenoids	Total pigments	Chlorophylls			Carotenoids	Chl a+ b / Carotenoids	Total pigments
		a	b	a+b				a	b	a+b			
		Main effects											
Boron (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%	0.081	0.019	0.091	0.045	NS	0.089	0.031	0.063	0.030	NS	NS	0.074
Yeast extract (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%	0.067	0.023	0.083	0.034	NS	0.68	0.056	0.061	0.034	0.055	NS	0.093
Interactions													
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 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 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%		0.088	0.051	0.115	0.064	0.164	0.136	0.098	0.084	0.141	0.036	0.193	0.177

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).

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

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 bioconestituents (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).

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 mg/g D.W	P mg/g D.W	K mg/g D.W	B µg/g D.W	Total sugar mg/g F.W	Total free amino acid mg/ g F.W	Crude protein mg/g D.W	N mg/g D.W	P mg/g D.W	K mg/g D.W	B µg/g D.W	Total sugar mg/g F.W	Total free amino acid mg/ g F.W	Crude protein mg/g D.W
		Main effects													
Boron (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%	0.89	0.35	0.43	1.28	2.58	0.81	11.2	1.06	0.28	0.55	3.54	3.84	0.66	8.9
Yeast extract (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%	0.72	0.48	0.41	1.77	3.14	0.85	17.7	1.28	0.25	0.89	4.54	3.23	0.52	13.8
Interactions															
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%		1.15	0.44	1.09	2.54	4.32	1.05	19.1	1.35	0.32	1.12	5.48	4.43	1.04	14.3

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 mg/g D.W	P mg/g D.W	K mg/g D.W	B µg/g D.W	Total sugar mg/g F.W	Total free amino acid mg/ g F.W	Crude protein mg/g D.W	N mg/g D.W	P mg/g D.W	K mg/g D.W	B µg/g D.W	Total sugar mg/g F.W	Total free amino acid mg/ g F.W	Crude protein mg/g D.W
		Main effects													
Boron (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%	0.46	0.17	0.81	2.20	1.26	0.74	7.2	0.70	0.15	NS	1.63	2.78	0.48	11.2
Yeast extract (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%	0.72	0.25	0.82	1.97	1.81	0.73	5.7	0.83	0.18	0.91	1.85	2.63	0.65	10.4
Interactions															
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%		1.18	0.20	1.11	2.58	2.98	1.03	16.7	1.07	0.27	1.05	2.56	3.56	1.09	15.5

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.

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

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 ; Mahmoued, 2001).

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)
		Main effects							
Boron (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%	4.32	0.62	0.48	1.76	NS	NS	24.5	0.87
Yeast extract (YE)	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%	5.84	0.95	0.71	2.07	1.12	NS	21.4	0.83
		Interactions							
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%		6.32	1.02	1.32	3.11	1.13	1.51	47.6	1.18

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.

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

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.

Table 11: Effect of boron and yeast extract foliar application on seed yield and its components of broad bean plants in the first season (2009/2010).

Treatments		N mg/g D.W	P mg/g D.W	K mg/g D.W	Crude protein mg/g D.W	Total carbohydrates mg/g D.W	Number of seeds per pod	Weight of 100 seeds (g)	Seed yield per plant (g)	Seed yield per fed. (ton)
Main effects										
Boron (B)	0 ppm	32.44	3.41	42.91	202.7	445.6	3.845	74.81	44.00	1.592
	25 ppm	34.76	3.50	45.69	217.3	458.6	4.126	78.45	50.92	1.843
	50 ppm	35.77	3.59	46.61	223.6	467.9	4.305	80.07	53.40	1.933
	LSD at 5%	0.66	NS	0.28	13.8	14.1	NS	1.74	2.32	0.058
Yeast extract (YE)	0 ml/L	32.06	3.19	43.39	200.4	425.8	3.743	73.40	40.26	1.457
	2.5 ml/L	34.63	3.60	44.77	216.5	467.6	4.151	78.59	51.52	1.865
	5 ml/L	36.28	3.71	47.06	226.8	478.7	4.382	81.34	56.55	2.047
	LSD at 5%	0.87	0.21	0.23	13.2	13.4	NS	1.55	3.47	0.107
Interactions										
0 ppm B + 0 ml/L YE		30.65	3.14	41.43	191.6	413.9	3.617	71.32	34.21	1.238
0 ppm B + 2.5 ml/L YE		33.11	3.54	42.56	206.9	453.7	3.914	76.12	46.12	1.669
0 ppm B + 5 ml/L YE		33.55	3.55	44.74	209.7	469.3	4.005	76.98	51.67	1.870
25 ppm B + 0 ml/L YE		32.63	3.18	43.76	203.9	424.0	3.615	73.65	41.67	1.508
25 ppm B + 2.5 ml/L YE		35.23	3.58	45.43	220.2	471.7	4.245	79.11	53.78	1.946
25 ppm B + 5 ml/L YE		36.43	3.73	47.89	227.7	480.3	4.518	82.60	57.32	2.074
50 ppm B + 0 ml/L YE		32.89	3.24	44.98	205.6	439.7	3.996	75.23	44.89	1.625
50 ppm B + 2.5 ml/L YE		35.56	3.68	46.32	222.3	477.4	4.294	80.54	54.67	1.979
50 ppm B + 5 ml/L YE		38.87	3.84	48.54	242.9	486.7	4.623	84.45	60.65	2.195
LSD at 5%		1.12	0.22	0.52	16.9	17.7	0.47	3.15	6.65	0.263

Table 12: Effect of boron and yeast extract foliar application on seed yield and its components of broad bean plants in the second season (2010/2011).

Treatments		N mg/g D.W	P mg/g D.W	K mg/g D.W	Crude protein mg/g D.W	Total carbohydrates mg/g D.W	Number of seeds per pod	Weight of 100 seeds (g)	Seed yield per plant (g)	Seed yield per fed. (ton)
Main effects										
Boron (B)	0 ppm	33.55	3.39	43.27	209.7	451.2	4.056	75.30	44.49	1.610
	25 ppm	34.52	3.52	45.69	215.7	462.4	4.168	80.59	51.98	1.881
	50 ppm	35.27	3.64	46.93	220.5	471.1	4.100	81.72	54.34	1.967
	LSD at 5%	0.66	NS	0.44	5.1	9.3	NS	2.14	2.84	0.191
Yeast extract (YE)	0 ml/L	32.32	3.19	42.95	202.0	426.4	3.825	73.62	41.56	1.504
	2.5 ml/L	34.83	3.60	45.63	217.7	473.8	4.211	80.85	52.54	1.901
	5 ml/L	36.18	3.76	47.32	226.1	484.4	4.289	83.14	56.70	2.052
	LSD at 5%	0.74	0.17	0.94	6.5	8.7	NS	2.38	3.17	0.214
Interactions										
0 ppm B + 0 ml/L YE		31.21	3.12	40.65	195.1	418.5	3.690	70.43	35.54	1.286
0 ppm B + 2.5 ml/L YE		34.67	3.45	43.95	216.7	461.7	4.238	77.56	47.27	1.711
0 ppm B + 5 ml/L YE		34.76	3.59	45.21	217.3	473.5	4.241	77.90	50.67	1.834
25 ppm B + 0 ml/L YE		32.80	3.17	42.87	205.0	426.4	3.940	74.55	43.34	1.568
25 ppm B + 2.5 ml/L YE		34.87	3.64	45.88	217.9	476.5	4.352	81.67	54.38	1.968
25 ppm B + 5 ml/L YE		35.88	3.76	48.32	224.3	484.1	4.212	85.54	58.21	2.107
50 ppm B + 0 ml/L YE		32.96	3.28	45.32	206.0	434.3	3.845	75.87	45.80	1.658
50 ppm B + 2.5 ml/L YE		34.95	3.71	47.05	218.4	483.3	4.042	83.32	55.98	2.026
50 ppm B + 5 ml/L YE		37.91	3.93	48.43	236.9	495.6	4.414	85.98	61.23	2.216
LSD at 5%		1.34	0.04	0.86	19.3	19.21	0.58	3.65	8.13	0.332

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.

Conclusion:

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

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