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النمو الخضرى والمحصول للقنبيط متأثراً بمعدلات من الإشعاع الجامى والبورون والنيتروجين

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الملخص العربى

اشتملت هذه التجربة على ١٢ معاملة هى عبارة عن تداخل مستويات من النيتروجين (صفر ، ٤٥ ، ٩٠ كجم / فدان) مع الرش بأربعة تركيزات من البورون (صفر ، ٢٥ ، ٥٠ ، ١٠٠ جزء فى المليون). استخدم فى البحث صنف القنبيط سنوبول والزراعة لمدة موسمين متتاليين.

وكانت أهم النتائج كالتالى :

صفات النمو الخضرى للنبات :

١- أدت زيادة مستويات التسميد الأزوتى إلى تحسين صفات النمو الخضرى المدروسة ، وكانت أفضل النتائج من حيث ارتفاع النبات وطول الساق وعدد الأوراق عند استخدام ٤٥ كجم / فدان، بينما كانت أفضل النتائج عند استخدام ٩٠ كجم / فدان لكل من الوزن الطازج للنبات ، محتوى الأوراق من الكلوروفيل الكلى (أ ، ب) ، المحصول الكلى القابل للتسويق بالوزن وبالعدد ، وزن القرص الزهرى وقطر ودرجة اندماج القرص ، السكريات المختزلة والغير مختزلة والكلية بالأقراص ، ودرجة البياض الناصع للقرص.

٢- أدى الرش بالبورون الى تحسين صفات النمو الخضرى ، وكانت أفضل النتائج عند الرش بتركيز ٥٠ جزء فى المليون فى كلا الموسمين فيما عدا الموسم الثانى حيث استجابت النباتات للرش حتى ١٠٠ جزء فى المليون مما أدى الى زيادة معنوية فى متوسط الوزن الطازج للنبات ومحتوى الكلوروفيل الكلى والكلوروفيل أ بالأوراق وزيادة المحصول الكلى والمحصول الصالح للتسويق ومكونات المحصول والصفات الطبيعية والكيماوية والحيوية للأقراص نتيجةالمعاملة بالبورون ١٠٠ جزء فى المليون.

٣- كما كان التفاعل بين تأثير مستويات النيتروجين والبورون غير معنوى لكل من الكلوروفيل أ ، ب والكلى بالأوراق ومكونات المحصول وصفات جودة القرص. وكانت أفضل نتائج كمية المحصول عند التسميد بمعدل ٩٠ كجم / فدان مع الرش بالبورون بمعدل ٥٠ أو ١٠٠ جزء فى المليون بدون فرق معنوى بينهما.

VEGETATIVE GROWTH AND YIELD OF CAULIFLOWER AS INFLUENCED BY GAMMA RADIATION, BORON AND NITROGEN APPLICATION RATES

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ABSTRACT: *The effect of nitrogen and boron on cauliflower were studied during the two successive seasons. Different amount of nitrogen rates (0, 45 or 90 kg N/fedd.) were applied at planting broadcast and the boron application with four levels of 0, 25, 50 or 100 ppm as foliar application on the growth plants.*

The obtained results indicated that the nitrogen fertilizer significantly increased vegetative growth characters, chlorophyll in leaves, marketable and total yield and yield component of cauliflower as well as the yield quality. The same trend was also found with boron application up to 100 ppm but there was not significant difference between 50 ppm and 100 ppm application. Meanwhile, the interaction of nitrogen fertilizer and boron levels was not significant in the majority of studied characters.

Key words: *Cauliflower, Gamma Radiation, Chlorophyll, Boron, Ppm, Feddan, Snowball.*

INTRODUCTION

Cauliflower (*Brassica oleracea* var botrytis) is one of the most cook crops grown in Egypt in the fall Nili and winter seasons. The cultivated area of cauliflower reached 10.000 feddan producted 9000 tons with an average of 9.64 ton/fed increased to 10317 feddan in produced 96228 with an average 10 ton/fed. It is clear that required to increase yield of cauliflower production per feddan. The success of cauliflower production greatly depends on growing each cultivar in the good planting date. If a cauliflower cultivar is not grown at proper time no marketable yield might be obtained and most yield consists of a small curds. Which is called buttons (Tompson and Kelly, 1957) of course, the ecological factors which include weather conditions and soil properties will act with genetically factories together on cauliflower plant grown, chemical composition and consequently curd yield and its quality.

This study is an attempt to investigate the effect of planting date on growth, yield and quality of some cauliflower cultivars. Moreover, cauliflower is classified as a high sensitive plant to B deficiency (Follet *et al*., 1981). Therefore, thereponse of plant to nitrogen and boron application levels with respect to plant growth, yield and quality of curds were also studied in a separate experiment of this work. The role of nitrogen application on chlorophyll synthesis and formation have been mentioned and many investigators on most vegetable crops among Gabal (1982), Humadi *et al*. (1990), Georgieva (1986), Daufualt (1988) and Boou (1992).

MATERIALS AND METHODS

The field experiments were carried out during winter seasons of 2007/2008 and 2008/2009 at experimental farm of Nuclear Research Center (NRC), Atomic Energy Authority (AEA), Inshas, Egypt. The experiments aimed to study the effect of nitrogen fertilization and boron application levels on vegetative growth, yield and quality of cauliflower. The 3 levels of nitrogen as 0, 45 and 90 kg/fed within 4 levels of boron foliar application on growth plant are 0, 25, 50 and 100 part per million (ppm).

Cauliflower (*Brassica oleracea* L) cv. Snowball was used. The seeds had planted on 15 Sept in both seasons. The physical changes measured by curds number of leaves, weight of curds, total yield (ton/fed) and height of steams (cm), plant height (cm), curds, the number of curds and marketable yield.

Some physical and chemical properties of the soil of experimental plots before fertilizer application.

Season	Texture	pH	O.M. %	Meq 100 g^{-1}			µg g^{-1}						
				Ca	Mg	K	NH_4	P	S	B	Cu	Mn	Zn
2007/ 2008	Sandy clay loam	5.6	0.47	2.1	1.4	0.19	17	30	18	0.1	7	40	7
2008/ 2009	Sandy clay loam	5.5	0.51	2.4	1.5	0.19	16	31	17	0.2	9	42	6
Critical level	-	-	-	2.0	0.8	0,20	75	14	14	0.2	1	33	2

Chemical changes parameters :

Effect of N and B on vitamin-C, reducing, nonreducing sugars and total sugars content of curds by Smith (1956), and chlorophyll a, b and total chlorophyll content of leaves by Wintermans *et al*.,1965 and in dry matter of planting, total N and proteins, P and K % of curds in both seasons,

Total nitrogen was determined according to Black (1983) using micro-kildahel method. Phosphorus was estimated color-metrically according to method described by Murphy and Riley (1962) as modified John (1970) and potassium was determined by flam photometer according the method by Chapman and Pratt (1964).

RESULTS AND DISCUSSION

Effect of N and /or B application on vegetative growth :

The effect of N fertilization within B foliar application on vegetative growth characteristics of cauliflower, plant height, stem height, number of leaves and total fresh weight per plant are presented in Table (1). Concerning the effect of nitrogen on plant height, data show that increasing N-fertilizer level from 0 up to 45 kg N/fed. led to significant increase in plant and stem height. However, fertilizing cauliflower plants with 90 kg/fed. such increment may be due to the physiological effect of N-nutrition on vegetative growth and plant development. This result was true during the two seasons of the experiment. Such result is much similar to those obtained by Boou (1992) on cauliflower and Abo-Sedera *et al*., (1989) on cabbage. Regarding the effect of B foliar application on plant and stem height, data at Table (1) show that increasing levels of B application from 0 up to 50 or 100 ppm B significantly increased stem height as shown in both seasons. Plant height also show the same trend but only in the first season where no significant differences were detected in the second one. Data also show that spraying plants with 25 ppm B was not able to increase plant height than the control, as shown in the first season. Moreover, plants sprayed with 50 or 100 ppm B show no significant differences with respect to plant or stem height may be due to the physiological effect of B application on IAA development and formation (Duggar, 1984 and Marschner, 1986) and consequently increasing plant cell elongation.

This favorable effect of B on plant and stem height was detected in both seasons but was significant in the first season of the growth only. Such results are similar to those by Mishra and Singh (1980) and Moustafa *et al*., (1991) on cauliflower, El-

Zawily and Mashaal (1984) on lettuce and Shafshak (1987) on egg plants. Regarding the effect of nitrogen fertilization on number of leaves and total fresh weight per plant. Data presented in Table (1) show that increasing nitrogen N-level from 0, 45 up to 90 kg N/fed. gradually and significantly promoted the formation of levels which

Table 1

consequently increased the total fresh weight per plant. This result was true during the two seasons of growth and could be referred to the encourage role of N nutrition on vegetative growth parameters (Gabal, 1982). Results are increment with those obtained Reddy (1989) on cauliflower, Abo-Sedera *et al*. (1990) on cabbage. They found application of 200 kg N/ha gave significantly maximum values of all the growth parameters viz-plant height, number of leaves/plant, length and width of the biggest leaf and spread over 100 kg N/ha during both years. Haque *et al*. (1996) also found significantly higher plant height, number of leaves per plant size of the biggest leaf and the highest curd at 180 kg N/ha than 100 kg N/ha. Anwar *et al*. (2000) revealed that within certain limits the head yield of broccoli is proportional to quantities of nitrogen fertilizer applied.

Concerning the effect of boron on number of leaves and total fresh weight it is clear from Table (1) that boron foliar application significantly increased number of leaves and total fresh weight per plant as compared with the untreated plants. In this respect, the high used concentration i.e., 100 ppm B was superior in the first season, meanwhile, no significant difference were detected between 50 or 100 ppm B in the second one regarding to the number of leaves. Data also show that the highest used rate of boron (100 ppm B) significantly surpassed the other used concentrations with total fresh weight per plant. These results dealing with the favorable effect of the B application on number of leaves may be due to the seasonal changes or due to the availability of soil boron either with deficiency or sufficiency in the two seasons of the growth. Such result is much similar to those obtained by Mishra and Singh (1986), Abed *et al*. (1987b), Moustafa *et al*. (1991) and Noor *et al*. (2000) on cauliflower. According to the interaction effect of nitrogen with boron application on vegetative growth, data at Table (1) show no significant interaction effects on the total fresh weight and plant height in the two seasons. The same trend was also noticed for number of leaves and stem height in the second season. There were a significant interaction effect of N x B on stem height and number leaves only in the first season.

Effect of nitrogen and/or boron application on chlorophyll content :

Data for the effect of nitrogen and/or boron on chlorophyll content of cauliflower leaves are shown in Table (2) from such data, it is evident that the chlorophyll a, b and total chlorophyll content were significantly and gradually increased by increasing level of N-application from 0, 45 up to 90 kg N/fed. except in the second season where no significant effect between the two levels of N i.e., 45 and 90 kg N/fed. with respect to chlorophyll b could be recognized. The promotive effect of N on chlorophyll synthesis could be referred to its rate on protein synthesis, especially N is considered as a constituent part of chlorophyll molecule. Such result is much similar to those obtained Argona and Greig (1986), Daufault (1988) on broccoli and Humadi *et al*. (1990) on cabbage. Table (2) indicated that foliar application of boron at a concentration of 50 ppm led to a significant increment in chlorophyll and total chlorophyll content of leaves. However, no significant differences could be detected between the two used concentration of 50 and 100 ppm or 0 and 25 ppm with respect to chlorophyll a and/or b during the two seasons of trial. The same trend was also found for the interaction of N × B during the two seasons (Table 2). These results are in agreement with Abed *et al*. (1987b) and Moustafa *et al*. (1991).

Curd yield as affected by nitrogen and boron rates :

The effect of N-application on total yield are presented in Table (3) show the highest total yield of cauliflower at 90 kg N/fed. Results regarding with the effect of B application on total yield, data in Table (3)

show that spraying plants with boron increased production than control. In curd weight to plants sprayed with 50-100 B as compared with those received lower B-levels or the control.

Table 2

Table 3

Marketable total yield and percentage as affected by N and/or B application. Table (3) data show that increasing levels of N-fertilizer from 0, 45 up to 90 kg N/fed gradually and significantly increased number and weight marketable heads produced per feddan, as shown in both seasons. These results agree with of Daufault and Waters (1985), Csizinsky and Stanley (1984) on broccoli and cabbage with respect to marketable yield. Concerning with the effect of B application marketable yield of cauliflower, data in Table (3) show that increasing levels of B application from 0, 25 up to 50 ppm B significantly increased the marketable head yield by number and weight (ton per feddan) as shown in first season. As for the maximum marketable yield as ton / fed, it was obtained when plants sprayed with 100 ppm B in the second season. This result is completely agree with Prased and Singh (1988) and Kotur and Kumar (1989) and Moustafa *et al*. (1991) using 100 ppm B. Total yield of curds as affected by N and/or B application in data at Table (3) show increasing levels of N-fertilizer from 0 up to 90 kg N/fed.

Gradually and significantly increased number and weight of marketable heads produced per feddan, as shown in both seasons. Therefore, the highest marketable curd yield was produced by using 90 kg N/fed. These results agree with of Borna (1976) on cauliflower, Daufault and Water (1985), Csizinsky and Stanley (1984) on broccoli with respect to marketable yield. Concerning with the effect of B application on marketable yield of cauliflower, data in Table (3) show that increasing levels of B application from 0, 25 up to 50 ppm B significantly increased the marketable head yield by number and weight (ton per feddan) in the first season, However, no significant difference was detected in the second one. This result is completely agree with Prased and Singh (1988) and Kotur and Kumar (1989) working on soil application of B and Moustafa *et al*. (1991) using 100 ppm B to get the maximum improvement in the marketable yield.

Yield components as affected by nitrogen and boron applications :

Concerning of the nitrogen on total fresh weight and curd weight per plant, data in Table (4a) show that increasing N-level from 0, 45 up to 90 kg N/fed led to a gradual significant increase in both plant fresh weight could be referred to its role for increasing plant growth. According to main effect of B show that increasing levels of B foliar application from 0 up to 100 ppm increased total fresh weight and average curd weight per plant. This results is in boron with those of Abed *et al*. (1987b) on cauliflower. It could be mentioned that the interaction between nitrogen levels and boron levels for yield components was not significant during the two successive seasons (Tables 4 a and b).

Chemical constituent of cauliflower curd as affected by nitrogen and/or boron applications :

Data on the chemical constituents of curds, dry matter, total-N, NO_3-N, P, K and B content as affected by N and/or B application are given in Table (5). Results show that increasing N level from 0 up to 45 kg N/fed. significantly increased dry matter, total N %, NO_3-N % and B content (ppm) of curds as shown in both season of the growth. The same trend was also noticed for P % and K % of curd only in the second season since variances failed to reach the level of significance in the first one. Results also show that increasing level of N-application from 45 up to 90 kg N/fed. did not considerably increase any of the studied chemical constituents of cauliflower. These results are agreement with those obtained by Sharma and Arora (1984), Boou (1992) on cauliflower, Daufault (1988) and Farghaly (1990) on cabbage.

Regarding the effect of boron foliar application on nitrogen, phosphorus and potassium content, data in Table (5) show that no significant effect on total N, P and K

% with increasing boron concentration or the control. This result was true during the two seasons. However, NO_3-N were significantly increased by increasing levels of boron application up to 50 or 100 ppm B. These results are in agreement with those reported by Moustafa *et al*., (1991) on cauliflower.

Table 4 a

Table 4 b

Table 5

Referring with vitamin-C, reducing, non reducing and total sugars content of curds, data are presented in Table (6) such data show that increasing N level from 0 up to 45 kg N/fed. led to a significant increment in vitamin-C content of curds. It is worth to notice that vitamin-C was significantly increased in the first season only, meanwhile, such increments was not significant in the second one. Markovic and Djurovka (1990) on cauliflower reported that, no considerable variances in vitamin-C content were detected when plant supplied with 45 or 90 kg N/fed.

Regarding the effect of nitrogen of the reducing, non-reducing and total sugars, data in Table (6) that increasing N-level from 0, 45 up to 90 kg N/fed. led to a gradual significant increase in reducing, non-reducing and total sugars content of cauliflower curd tissues. This result was true during both seasons of growth. Such results are in agreement with those reported by Abo-Sedera *et al*. (1989) on cabbage.

According to the effect of boron foliar application on vitamin-C content, data presented in Table (6) show a little increase in vitamin-C content of curd in plants sprayed with 50 or 100 ppm B as compared with 25 ppm B in the first season only, whereas, no significant effect could be detected between the two used concentrations of boron i.e., 50 or 100 ppm during the first season. Such favorable effect of B application on vitamin-C was statistically significant in the second of growth. These results in agreement with those reported by Moustafa *et al*., (1991) on cauliflower.

Table (6) : Chemical constituents of cauliflower plant (cv. Snowball) as affected by levels of nitrogen, boron application and their interactions in 2007/2008 and 2008/2009 seasons.

Treatments	First season 2007/2008				Second season 2008/2009			
	Vit. C Mg/100 g F.wt.)	Sugar (mg/100 g dry wt.)			Vit. C Mg/100 g F.wt.	Sugar (mg/100 g dry wt.)		
		Reducing	Non-reducing	Total sugars		Reducing	Non-reducing	Total sugars
Nitrogen levels (kg N/fed)								
0 (N0)	37.6	6812	2167	8988	47.2	6979	2184	9164
45 (N1)	51.8	10848	3689	14537	50.3	11746	4026	15773
90 (N2)	53.3	12100	4215	16360	50.4	12547	4511	17083
L.S.D. at 0.05	2.9	335	358	310	N.S.	651	312	795
Boron levels (ppm)								
0 (B0)	43.6	9227	2987	12215	43.8	9755	3108	12897
25 (B1)	46.6	9768	3208	12979	48.3	10344	3445	13789
50 (B2)	50.6	10138	3427	13576	55.0	10598	3760	14361
100 (B3)	49.5	10562	3805	14412	49.6	10996	3982	14978
L.S.D. at 0.05	3.6	439	244	459	N.S.	292	290	450
N-levels × B-levels								
N0 × B0	36.9	7665	1660	7665	39.8	6459	1822	8281
N0 × B1	36.1	8900	1958	8900	46.7	6861	2050	8911
N0 × B2	38.1	9440	2432	9440	54.9	7081	2363	9451
N0 × B3	40.3	9950	2619	9950	47.4	7509	2504	10013
N1 × B0	45.4	13545	3444	13545	44.6	10801	3601	14402
N1 × B1	52.6	14182	3545	14182	51.1	11662	3888	15550
N1 × B2	56.6	14804	3705	14804	55.6	12084	4246	16330
N1 × B3	52.7	15620	4062	15620	49.9	12440	4371	16811
N2 × B0	49.5	15435	3859	15435	47.3	12007	3903	16010

N2 × B1	51.0	15825	4123	15855	47.2	12511	4397	16908
N2 × B2	57.2	16485	4145	16485	55.6	12631	4673	17304
N2 × B3	55.6	17668	4735	17668	51.6	13040	5072	18112
L.S.D. at 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

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النمو الخضرى والمحصول للقنبيط متأثراً بمعدلات من الإشعاع الجامى والبورون والنيتروجين

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الملخص العربى

اشتملت هذه التجربة على ١٢ معاملة هى عبارة عن تداخل مستويات من النيتروجين (صفر ، ٤٥ ، ٩٠ كجم / فدان) مع الرش بأربعة تركيزات من البورون (صفر ، ٢٥ ، ٥٠ ، ١٠٠ جزء فى المليون). استخدم فى البحث صنف القنبيط سنوبول والزراعة لمدة موسمين متتاليين.

وكانت أهم النتائج كالتالى :

صفات النمو الخضرى للنبات :

٤- أدت زيادة مستويات التسميد الأزوتى إلى تحسين صفات النمو الخضرى المدروسة ، وكانت أفضل النتائج من حيث ارتفاع النبات وطول الساق وعدد الأوراق عند استخدام ٤٥ كجم / فدان، بينما كانت أفضل النتائج عند استخدام ٩٠ كجم / فدان لكل من الوزن الطازج للنبات ، محتوى الأوراق من الكلوروفيل الكلى (أ ، ب) ، المحصول الكلى القابل للتسويق بالوزن وبالعدد ، وزن القرص الزهرى وقطر ودرجة اندماج القرص ، السكريات المختزلة والغير مختزلة والكلية بالأقراص ، ودرجة البياض الناصع للقرص.

٥- أدى الرش بالبورون الى تحسين صفات النمو الخضرى ، وكانت أفضل النتائج عند الرش بتركيز ٥٠ جزء فى المليون فى كلا الموسمين فيما عدا الموسم الثانى حيث استجابت النباتات للرش حتى ١٠٠ جزء فى المليون مما أدى الى زيادة معنوية فى متوسط الوزن الطازج للنبات ومحتوى الكلوروفيل الكلى والكلوروفيل أ بالأوراق وزيادة المحصول الكلى والمحصول الصالح للتسويق ومكونات المحصول والصفات الطبيعية والكيماوية والحيوية للأقراص نتيجةالمعاملة بالبورون ١٠٠ جزء فى المليون.

٦- كما كان التفاعل بين تأثير مستويات النيتروجين والبورون غير معنوى لكل من الكلوروفيل أ ، ب والكلى بالأوراق ومكونات المحصول وصفات جودة القرص. وكانت أفضل نتائج كمية المحصول عند التسميد بمعدل ٩٠ كجم / فدان مع الرش بالبورون بمعدل ٥٠ أو ١٠٠ جزء فى المليون بدون فرق معنوى بينهما.

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النمو الخضرى والمحصول للقنبيط متأثراً بمعدلات من الإشعاع الجامى والبورون والنيتروجين

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الملخص العربى

اشتملت هذه التجربة على ١٢ معاملة هى عبارة عن تداخل مستويات من النيتروجين (صفر ، ٤٥ ، ٩٠ كجم / فدان) مع الرش بأربعة تركيزات من البورون (صفر ، ٢٥ ، ٥٠ ، ١٠٠ جزء فى المليون). استخدم فى البحث صنف القنبيط سنوبول والزراعة لمدة موسمين متتاليين.

وكانت أهم النتائج كالتالى :

أولاً : صفات النمو الخضرى للنبات :

٧- أدت زيادة مستويات التسميد الأزوتى إلى تحسين صفات النمو الخضرى المدروسة ، وكانت أفضل النتائج من حيث ارتفاع النبات وطول الساق وعدد الأوراق عند استخدام ٤٥ كجم / فدان، بينما كانت أفضل النتائج عند استخدام ٩٠ كجم / فدان لكل من الوزن الطازج للنبات ، محتوى الأوراق من الكلوروفيل الكلى (أ ، ب) ، المحصول الكلى القابل للتسويق بالوزن وبالعدد ، وزن القرص الزهرى وقطر ودرجة اندماج القرص ، السكريات المختزلة والغير مختزلة والكلية بالأقراص ، ودرجة البياض الناصع للقرص.

٨- أدى الرش بالبورون الى تحسين صفات النمو الخضرى ، وكانت أفضل النتائج عند الرش بتركيز ٥٠ جزء فى المليون فى كلا الموسمين فيما عدا الموسم الثانى حيث استجابت النباتات للرش حتى ١٠٠ جزء فى المليون مما أدى الى زيادة معنوية فى متوسط الوزن الطازج للنبات ومحتوى الكلوروفيل الكلى والكلوروفيل أ بالأوراق وزيادة المحصول الكلى والمحصول الصالح للتسويق ومكونات المحصول والصفات الطبيعية والكيماوية والحيوية للأقراص نتيجةالمعاملة بالبورون ١٠٠ جزء فى المليون.

٩- كما كان التفاعل بين تأثير مستويات النيتروجين والبورون غير معنوى لكل من الكلوروفيل أ ، ب والكلى بالأوراق ومكونات المحصول وصفات جودة القرص. وكانت أفضل نتائج كمية المحصول عند التسميد بمعدل ٩٠ كجم / فدان مع الرش بالبورون بمعدل ٥٠ أو ١٠٠ جزء فى المليون بدون فرق معنوى بينهما.

Table (1) : Vegetative growth characteristics of cauliflower plant (cv. Snowball) as affected by levels of nitrogen, boron application and their interactions in 2007/2008 and 2008/2009 seasons.

Treatments	First season 2007/2008				Second season 2008/2009			
	Plant height (cm)	Stem height (cm)	Number of leaves (No./plant)	Total fresh weight (kg/plant)	Plant height (cm)	Stem height (cm)	Number of leaves (No./plant)	Total plant fresh weight (kg/plant)
Nitrogen levels (kg N/fed)								
0 (N0)	46.7	10.4	19.7	1.202	51.8	8.6	16.2	1.230
45 (N1)	55.6	13.6	22.0	2.261	59.1	9.4	18.6	2.460
90 (N2)	56.4	14.2	25.1	2.553	60.9	9.8	19.0	2.685
L.S.D. at 0.05	3.7	0.8	0.7	0.299	5.4	0.7	0.6	0.109
Boron levels (ppm)								
0 (B0)	50.9	11.7	21.1	1.781	53.7	8.8	17.0	1.977
25 (B1)	52.6	12.6	22.4	1.917	57.8	9.0	17.9	2.084
50 (B2)	54.1	13.4	22.9	2.139	58.3	9.5	18.5	2.170
100 (B3)	53.9	13.4	24.0	2.184	59.2	9.9	18.6	2.264
L.S.D. at 0.05	2.1	0.7	0.9	0.374	N.S.	0.6	0.8	0.091
N-levels × B-levels								
N0 × B0	45.6	10.2	19.0	1.035	44.5	8.0	14.7	1.100
N0 × B1	46.7	10.6	20.2	1.160	54.0	8.5	16.2	1.250
N0 × B2	47.5	10.7	19.0	1.287	53.8	9.0	17.0	1.270
N0 × B3	47.2	10.3	20.7	1.327	56.2	9.0	16.7	1.300
N1 × B0	53.7	11.8	21.5	2.097	59.1	9.2	17.0	2.250
N1 × B1	54.9	13.7	22.0	2.130	60.0	9.2	17.0	2.250
N1 × B2	56.0	14.3	23.2	2.370	61.1	9.0	19.5	2.512
N1 × B3	57.5	14.7	25.2	2.445	60.5	10.0	19.5	2.675
N2 × B0	53.5	13.0	23.0	2.210	60.5	9.2	19.5	2.580
N2 × B1	56.4	13.3	24.0	2.460	50.5	9.2	19.5	2.615
N2 × B2	58.9	15.3	26.5	2.760	61.2	10.2	19.0	2.727
N2 × B3	56.9	15.2	26.0	2.780	61.3	10.7	19.8	2.817
L.S.D. at 0.05	N.S.	1.2	1.6	N.S.	N.S.	N.S.	N.S.	N.S.

Table (2) : Chlorophyll a, b and total chlorophyll content of cauliflower leaves (cv. Snowball) as affected by levels of nitrogen, boron application and their interactions in 2007/2008 and 2008/2009 seasons.

Treatments	First season 2007/2008			Second season 2008/2009		
	Chlorophyll (mg/100 g fresh wt.)			Chlorophyll (mg/100 g fresh wt.)		
	a	b	Total	a	b	Total
Nitrogen levels (kg N/fed)						
0 (N0)	165.8	74.1	240.7	158.7	72.7	231.7
45 (N1)	180.8	83.2	263.3	172.1	83.3	255.3
90 (N2)	194.1	91.4	285.4	183.1	88.7	271.9
L.S.D. at 0.05	8.0	7.9	12.8	7.8	10.0	9.1
Boron levels (ppm)						
0 (B0)	175.2	78.5	253.5	163.3	78.1	241.6
25 (B1)	175.4	82.5	258.2	168.8	80.3	249.2
50 (B2)	183.5	86.2	269.8	174.8	85.2	260.1
100 (B3)	187.0	84.3	271.0	178.3	82.6	261.0
L.S.D. at 0.05	7.6	N.S.	10.6	7.3	N.S.	12.7
N-levels × B-levels						
N0 × B0	159.7	67.7	227.1	148.2	68.6	216.9
N0 × B1	161.1	73.2	238.2	153.6	73.3	226.9
N0 × B2	169.0	78.0	247.1	164.6	76.6	241.2
N0 × B3	173.0	77.6	250.0	168.7	73.2	241.9
N1 × B0	181.2	81.8	263.1	167.1	81.9	249.1
N1 × B1	177.5	83.1	257.3	169.5	82.5	252.0
N1 × B2	180.7	85.5	266.4	174.1	85.6	259.7
N1 × B3	184.3	82.2	266.6	177.8	83.2	261.1
N2 × B0	184.8	86.0	270.1	175.1	84.6	259.8
N2 × B1	187.6	91.3	279.0	183.3	85.3	268.5
N2 × B2	200.9	95.1	269.0	185.7	93.6	279.3
N2 × B3	203.4	93.2	269.4	188.4	91.4	279.9
L.S.D. at 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table (3) : Marketable and total yield of cauliflower plant (cv. Snowball) as affected by levels of nitrogen, boron application and their interactions in 2007/2008 and 2008/2009 seasons.

Treatments	First season 2007/2008					Second season 2008/2009				
	Marketable yield		Total yield		Market. wt.	Marketable yield		Total yield		Market. wt.
	No./fed.	Ton/fed.	No./fed.	Ton/fed.	Total wt. %	No./fed.	Ton/fed.	No./fed.	Ton/fed.	Total wt. %
Nitrogen levels (kg N/fed)										
0 (N0)	5726	4.953	9113	10.568	46.9	5706	4.471	9035	10.974	40.7
45 (N1)	8177	14.638	9331	20.953	69.9	8242	15.596	9193	22.591	69.0
90 (N2)	8638	16.615	9272	23.607	70.4	8638	17.462	9351	25.116	69.4
L.S.D. at 0.05	439	0.879	163	0.329	4.5	680	1.595	209	0.343	4.1
Boron levels (ppm)										
0 (B0)	7211	10.411	9112	16.062	64.8	7080	11.281	9008	17.611	64.0
25 (B1)	7502	11.758	9166	17.425	67.4	7502	12.342	9377	19.553	63.1
50 (B2)	7605	12.748	9377	19.812	64.3	7710	13.035	9193	20.322	64.1
100 (B3)	7736	13.355	9298	20.207	66.0	7819	13.781	9193	20.754	66.4
L.S.D. at 0.05	391	0.758	N.S.	0.467	N.S.	N.S.	0.725	N.S.	0.781	N.S.
N-levels × B-levels										
N0 × B0	5468	3.991	8951	9.138	43.6	5072	3.650	8876	8.876	41.1
N0 × B1	5706	4.733	9193	10.249	46.1	5706	4.828	9193	11.490	42.0
N0 × B2	5706	5.306	9113	10.936	48.6	6023	5.171	8876	11.597	44.5
N0 × B3	6025	5.782	9193	11.950	48.3	6023	5.436	9193	11.932	45.6
N1 × B0	7925	13.313	9510	19.433	68.5	7925	13.876	8876	19.969	69.4
N1 × B1	8242	14.054	9113	19.411	72.4	8242	15.082	9510	22.633	66.7
N1 × B2	8235	15.000	9510	22.538	66.6	8242	16.071	9193	23.217	69.2
N1 × B3	8309	16.176	9113	22.430	73.5	8559	17.357	9193	24.544	70.7
N2 × B0	8242	13.928	8876	19.615	71.0	8242	16.318	9272	23.991	68.0
N2 × B1	8559	16.488	9193	22.614	72.9	8559	17.117	9430	24.538	69.7
N2 × B2	8876	17.939	9510	25.961	69.0	8876	17.865	9510	26.151	68.3
N2 × B3	8876	18.107	9510	26.240	69.0	8876	18.550	9193	25.786	71.9
L.S.D. at 0.05	N.S.	1.313	N.S.	0.810	N.S.	N.S.	1.256	N.S.	N.S.	N.S.

Table (4a) : Yield components of cauliflower plant (cv. Snowball) as affected by levels of nitrogen, boron application and their interactions in 2007/2008 and 2008/2009 seasons.

Treatments	First season 2007/2008				Second season 2008/2009			
	Total fresh wt. kg/plant	Curd wt. Kg/plant	Curd wt. Total wt. %	Curd height (H) (cm)	Total fresh wt. kg/plant	Curd wt. Kg/plant	Curd wt. Total wt. %	Curd height (H) (cm)
Nitrogen levels (kg N/fed)								
0 (N0)	1.202	0.668	55.5	10.0	1.230	0.608	49.3	10.9
45 (N1)	2.261	1.427	63.1	11.0	2.456	1.580	64.3	11.7
90 (N2)	2.553	1.635	54.0	11.7	2.685	1.743	64.9	12.0
L.S.D. at 0.05	0.290	0.067	2.7	N.S.	0.109	0.119	4.0	0.6
Boron level (ppm)								
0 (B0)	1.781	1.074	60.3	9.7	1.977	1.195	60.4	10.7
25 (B1)	1.917	1.179	61.5	10.9	2.084	1.265	60.7	11.2
50 (B2)	2.139	1.346	62.8	11.4	2.170	1.345	61.9	11.9
100 (B3)	2.184	1.376	63.0	11.7	2.264	1.434	63.3	12.2
L.S.D. at 0.05	0.374	0.07	N.S.	1.4	0.091	0.087	N.S.	0.4
N-level × B-level								
N0 × B0	1.035	0.561	54.2	9.4	1.100	0.524	47.6	10.2
N0 × B1	1.160	0.636	54.8	9.7	1.250	0.614	49.1	10.6
N0 × B2	1.287	0.717	55.7	10.2	1.270	0.635	50.0	11.2
N0 × B3	1.327	0.760	57.3	10.6	1.300	0.660	50.8	11.5
N1 × B0	2.097	1.260	60.0	8.8	2.250	1.400	62.2	10.5
N1 × B1	2.130	1.330	62.4	11.7	2.387	1.500	62.8	11.5
N1 × B2	2.370	1.540	64.9	11.9	2.512	1.608	64.0	12.2
N1 × B3	2.445	1.580	64.6	12.1	2.625	1.750	65.4	12.6
N2 × B0	2.210	1.400	63.3	10.9	2.580	1.660	64.3	11.5
N2 × B1	2.460	1.570	63.8	11.3	2.615	1.680	64.2	11.7
N2 × B2	2.760	1.780	64.4	12.1	2.727	1.800	66.0	12.2
N2 × B3	2.780	1.790	64.3	12.4	2.817	1.830	65.0	12.7
L.S.D. at 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table (4b) : Yield components of cauliflower plant (cv. Snowball) as affected by levels of nitrogen, boron application and their interactions in 2007/2008 and 2008/2009 seasons.

Treatments	First season 2007/2008				Second season 2008/2009			
	Curd diameter (D) (cm)	Curd index (H/D)	Curd compactness (1 to 3)	Curd colourness (1 to 3)	Curd diameter (D) (cm)	Curd index (H/D)	Curd compactness (1 to 3)	Curd colourness (1 to 3)
Nitrogen levels (kg N/fed)								
0 (N0)	22.7	0.44	1.5	1.5	22.9	0.47	1.4	1.8
45 (N1)	27.3	0.43	1.2	1.2	27.6	0.42	1.1	1.3
90 (N2)	28.2	0.42	1.1	1.2	28.3	0.42	1.1	1.2
L.S.D. at 0.05	1.6	N.S.	0.3	0.2	1.4	0.4	0.2	0.3
Boron levels (ppm)								
0 (B0)	24.6	0.43	1.3	1.4	24.8	0.43	1.3	1.6
25 (B1)	25.6	0.43	1.3	1.3	26.2	0.43	1.3	1.5
50 (B2)	26.4	0.44	1.2	1.2	27.0	0.45	1.2	1.3
100 (B3)	27.7	0.43	1.2	1.3	27.0	0.45	1.1	1.3
L.S.D. at 0.05	1.5	N.S.	0.1	N.S.	1.0	N.S.	N.S.	0.2
N-levels × B-levels								
N0 × B0	21.4	0.44	1.6	1.5	22.5	0.45	1.5	1.9
N0 × B1	22.6	0.43	1.6	1.5	23.0	0.46	1.4	1.9
N0 × B2	22.6	0.46	1.5	1.6	23.0	0.49	1.4	1.8
N0 × B3	24.1	0.44	1.5	1.5	23.0	0.50	1.3	1.8
N1 × B0	26.4	0.43	1.3	1.4	25.2	0.42	1.1	1.3
N1 × B1	27.3	0.43	1.2	1.3	27.6	0.42	1.4	1.6
N1 × B2	27.1	0.44	1.2	1.1	29.0	0.43	1.1	1.2
N1 × B3	28.4	0.43	1.2	1.2	28.6	0.44	1.1	1.0
N2 × B0	26.1	0.42	1.2	1.3	26.8	0.43	1.2	1.5
N2 × B1	26.7	0.42	1.3	1.2	28.1	0.41	1.2	1.2
N2 × B2	29.5	0.41	1.0	1.0	29.1	0.42	1.1	1.1
N2 × B3	30.5	0.41	1.1	1.1	29.2	0.41	1.0	1.2
L.S.D. at 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table (5) : Chemical constituents of cauliflower plant (cv. Snowball) as affected by levels of nitrogen, boron application and their interactions in 2007/2008 and 2008/2009 seasons.

Treatments	First season 2007/2008						Second season 2008/2009					
	Dry matter (%)	Total-N (%)	NO_3-N (%)	P (%)	K (%)	B (%)	Dry matter (%)	Total-N (%)	NO_3-N (%)	P (%)	K (%)	B (%)
Nitrogen levels (kg N/fed)												
0 (N0)	9.6	2.52	0.378	0.439	1.33	83.9	9.5	2.32	0.453	0.456	1.45	96.4
45 (N1)	10.1	3.04	0.643	0.460	1.40	121.3	10.3	3.26	0.929	0.515	1.64	139.4
90 (N2)	10.4	3.13	0.791	0.464	1.48	127.3	10.4	3.41	0.996	0.552	1.71	146.0
L.S.D. at 0.05	0.6	0.18	0.990	N.S.	N.S.	8.0	0.9	0.21	0.189	0.072	0.20	9.2
Boron levels (ppm)												
0 (B0)	9.7	2.80	0.535	0.446	1.36	92.3	9.7	2.87	0.734	0.451	1.54	105.8
25 (B1)	9.9	2.88	0.570	0.451	1.43	105.9	9.9	2.97	0.774	0.534	1.59	121.7
50 (B2)	10.2	2.93	0.634	0.463	1.41	115.5	10.1	3.02	0.834	0.508	1.61	132.2
100 (B3)	10.4	2.95	0.678	0.457	1.43	129.6	10.5	3.13	0.813	0.506	1.65	148.3
L.S.D. at 0.05	N.S.	N.S.	0.106	N.S.	N.S.	10.0	0.3	N.S.	N.S.	N.S.	N.S.	11.5
N-levels × B-levels												
N0 × B0	9.2	2.43	0.265	0.425	1.32	72.5	9.0	2.24	0.412	0.398	1.40	83.3
N0 × B1	9.5	2.53	0.404	0.427	1.32	73.9	9.4	2.28	0.455	0.494	1.40	84.0
N0 × B2	9.7	2.60	0.430	0.453	1.32	80.4	9.9	2.35	0.472	0.498	1.50	92.4
N0 × B3	9.9	2.54	0.413	0.453	1.36	108.8	9.9	2.43	0.775	0.436	1.49	124.2
N1 × B0	9.9	2.93	0.535	0.450	1.36	98.5	9.9	3.03	0.880	0.440	1.63	113.2
N1 × B1	9.9	3.01	0.552	0.459	1.41	124.7	10.1	3.24	0.825	0.540	1.63	143.4
N1 × B2	10.1	3.08	0.558	0.469	1.42	128.5	10.1	3.32	0.992	0.541	1.64	147.7
N1 × B3	10.7	3.13	0.812	0.464	1.42	133.8	10.9	3.45	0.992	0.538	1.65	153.8
N2 × B0	10.0	3.05	0.786	0.465	1.41	105.9	10.2	3.35	0.935	0.516	1.59	121.7
N2 × B1	10.3	3.13	0.755	0.467	1.55	119.3	10.3	3.40	1.017	0.570	1.74	137.1
N2 × B2	10.6	3.13	0.815	0.469	1.47	137.8	10.3	3.39	0.990	0.576	1.72	158.4
N2 × B3	10.7	3.20	0.810	0.456	1.49	146.2	10.8	3.50	1.045	0.545	1.82	167.9
L.S.D. at 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.