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Effect of Nitrogen and Boron Fertilization on Yield and Quality of Broccoli

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ABSTRACT

Suitable broccoli nutrition has a great impact on curd yield and quality. There for two field experiments were carried out during the two successive winter seasons of 2013-2014 and 2014-2015 at the experimental station, Faculty of Agriculture, Mansoura University to study the effect of nitrogen and boron fertilization on yield and quality of broccoli. The experiment layout was split plot in a completely randomized block design arranged in three replications. Nitrogen fertilizer rates (*i.e.*; 60, 70, 80 and 90 kg per fed.) were present in the main plots, while boron treatments (0.4, 0.8 and 1.2 kg per fed.) were assigned in the sub plots. The results showed that the interaction between N and B was significant on vegetative growth parameters (*i.e.*; plant height, leaves area, leaves fresh weight, leaves dry matter percent), leaves mineral content such as N, P and K. Curds yield and its physical quality parameters (*i.e.*; curd weight, curd diameter and curd dry matter percent), curds chemical quality parameters (*i.e.*; Vit. C, T.S.S., chlorophyll a, chlorophyll b, carotenoids, N, P, K and nitrate content). On contrast the leaves number, curd length (cm) and curd compactness index were not significantly affected. The combination between nitrogen at 70 kg and boron at 0.8 kg per fed. was the most effective treatment, Since it recorded the highest values of all measured parameters and the lowest nitrate content in both seasons. On contrary, the highest level of nitrogen 80 or 90 kg with high rate of boron 1.2 kg per fed. gave the lowest values of curd yield and quality parameters.

INTRODUCTION

Broccoli (*Brassica oleracea* var. *italica*, L) is important crop belonging to the family Braassicaceae. It is a delicious vegetable and more nutritious than any other vegetables of the same genus. Also, It is one of the uncommon winter vegetables in Egypt because the lack of awareness regarding its appropriate method of production technology and nutritive value. Since, it contain 3.3 % protein and has a high content of vitamin C, A, niacin, thiamine, riboflavin, calcium and iron. Also broccoli contains high concentrations of carotenoid, which are believed to have preventative qualities with regards to human cancer (Kirsh *et al.*, 2007).

Broccoli curds compose of hundreds of immature floret arranged in whorls on a fleshy stem and each floret consists of an immature flower enclosed within chlorophyll containing sepals (Page *et al.*, 2001). Therefore, broccoli is high in chlorophyll and the plants need a large amount of nitrogen for its photosynthesis activities. Soils of Egypt are calcareous and poor in organic matter, So the application of nitrogen fertilizer is necessary to achieve the best curds yield and quality (Zaki *et al.*, 2012). Also, alkaline soils are caused micronutrient deficiency such as boron. It is essential for plant growth and development. Its application to the soil increased curds yield and its quality component (Moniruzzaman *et al.*, 2007).

The scientific researches show that application of optimum dose of nitrogen and boron decrease curd rot and hollow stem of broccoli and increase macronutrient and micronutrient concentrations such as nitrogen, phosphorus, potassium, iron and zinc in broccoli curd which are useful and necessary for human's health (Yoldas *et al.*, 2008).

In a view of the previous situation the present study was to investigate the effect of different levels of nitrogen and boron on yield and quality maximization of broccoli.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive seasons of 2013-2014 and 2014-2015 at the experimental station, Faculty of Agriculture, Mansoura University. The investigation was aimed to study effect of nitrogen rates (60, 70, 80 and 90 kg per fed.) and boron rates (0.4, 0.8 and 1.2 kg boron per fed.). Soil samples were collected at random before planting from the top layer (0-30 cm depth) for physical and chemical analysis. Soil analysis is presented in Table 1.

Table 1. Physical and chemical properties of the experimental soil during the two seasons of 2013-2014 and 2014-2015.

Soil parameters	silt	Clay	sand	Texture soil	PH	E.C	O.M %	$CaCO_3$	N ppm	P ppm	K ppm	B ppm
1st season	40.5	37.2	22.3	Loamy	8.22	1.51	1.8	3.39	51.9	5.7	2.88	0.89
2ed season	41.1	36.9	22.0	Loamy	8.1	1.78	2.o	3.45	54.1	6.2	2.94	0.92

Calcium super phosphate (12.5 % P_2O_5) as a source of phosphorus at a rate of 60 P_2O_5 units / fed. were added during preparation of the soil. Potassium sulphate (48% K_2O) as a source of potassium at rate of 50 K_2O units / fed. and boric acid (H_3BO_3, 17% B) as a source of boron were added at the first irrigation time. Nitrogen as ammonium nitrate (33.5 %) was added at two equal dose at the first and the second irrigation time. Broccoli transplants (cvs. Heraklion H) 45 days old were transplanted on 2ed and 5th of November during both seasons, at 0.5 m apart on one side of ridge that is 3.0 m long and 0.70 m wide. Each plot included five rows, experimental unit area was 10.30 m^2.

Experimental design:

A complete randomized blocks design with three replicates was carried out in a split plots experiment, nitrogen rates were located in the main plots, whereas the boron levels were assigned in the sub plots.

Measurements:

A random sample of five plants was taken from each experiment treatment 80 days after transplanting and the following data were recorded during the two seasons.

- **Vegetative growth characters:**

Plant height (cm), leaves number per plant, leaves area (cm^2) per plant, leaves fresh weight (g per plant), leaves dry matter percentage.

- **leaves mineral content:**

N, P and K were determined in the dried leaves according to A.O.A.C. (1990).

- **Curds yield and its physical quality:**

Curd weight (g), curd length (cm), curd diameter (cm), curd compactness index (curd weight / curd diameter), curd dry matter percentage, curds yield (ton / fed.).

- **Curds chemical quality:**

Vitamin C, T.S.S., chlorophyll a, chlorophyll b, carotenoids, N, P, K and NO_3. All chemical quality parameters were determined according to A.O.A.C. (1990).

Statistical analysis:

The data of the experiment was tabulated and subjected to statistical analysis according to Snedecor and Cochran (1980) and the mean differences among the treatment means were evaluated by the least significance difference (LSD) at 5 % level of probability.

RESULTS AND DISCUSSION

- **Vegetative growth characters:**

The obtained data in Table 2 reveale that the broccoli vegetative growth characters (*i.e.*; Plant height, leaves number, leaves area, leaves fresh weight and leaves dry matter percent) by the nitrogen and boron levels were significantly affected except the leaves number per plant. The highest plant height was noticed by using nitrogen 70 kg with 1.2 kg boron per fed. but the lowest value were recorded with combination of 90 kg of nitrogen and boron at 0.4 kg per fed. in the both seasons.

The highest leaves area and leaves fresh weight values were produced in both seasons by using nitrogen 70 kg and boron 0.4 kg boron per fed. in the two seasons of the study and the lowest value were recorded by 90 kg of nitrogen and boron at 0.4 kg per fed..

Also, the highest values of leaves dry matter percentage were achieved by combined effect of nitrogen at 70 kg and boron at 1.2 kg per fed., but the lowest data was obtained at 80 and 1.2 kg of nitrogen and boron per fed., respectively in the two studied seasons.

In current study, low or moderate level (60 or 70 kg) of nitrogen in combination with boron considerably improved the growth performance of broccoli. Significant values of plant height, leaves area, leaves fresh weight and leaves dry matter percentage were acquired with nitrogen application due to of quick and vigorous growth of shoot and root development. In fact, nitrogen stabilizes the carbon assimilation and mineral acquisition through source sink relationship, nutrients and water supply. Also, plants which treated with nitrogen grows quickly and retain maximum vegetative growth by means of higher canopy area development, CO_2 exchange rate and photosynthetic capacity (Tone, 2006). The positive effect of boron on the enhanced the previous characters was considered due to higher photosynthetic efficiency in plants by increased metabolic activities. Biosynthesis of cell wall, cell division, carbohydrates transport and activating some hormones (Nadian *et al.*, 2010). Also, Asad *et al.* (2003) showed that the application of B increased root growth and leaves dry weight of sunflower plants.

On the contrary, The higher doses of nitrogen more optimum do not improve growth parameters and this may be due to excessive nutrients lead to adverse effects on plant growth, increase the potential for environmental contamination due to leaching and increasing salinity (Ouda and Mahadeen, 2008). The previous results are in agreement with those found by Moniruzzaman *et al.* (2008) El-Helaly (2012), Raj *et al.* (2013), Abd El-All (2014), Singh *et al.* (2015), Islam *et al.*(2015) on broccoli.

Table 2. Effect of nitrogen and boron fertilizer on plant height, leaves number/plant, leaves area/plant, leaves fresh weight and leaves dry matter of broccoli during the two seasons of 2013-2014 and 2014-2015.

Treatments		1st season					2nd season				
N. kg. / fed.	B.kg. / fed.	Plant Height (cm).	leaves No./ plant	leaves area (cm^2) / plant	Leaves F.W. g/plant	Leaves dry matter %.	Plant Height (cm).	Leaves No./ plant	leaves area (cm^2)/ plant	Leaves F.W. g/plant	Leaves dry matter %.
60	0.4	67.5	18.0	6650	1162	6.63	68.0	18.3	6671	1165	6.52
	0.8	67.7	17.6	6395	1067	6.42	69.0	18.0	6407	1070	6.31
	1.2	67.9	18.6	7045	1121	6.01	67.6	18.3	7075	1126	5.90
70	0.4	69.8	17.3	7809	1214	6.56	70.6	17.0	7834	1218	6.50
	0.8	66.8	17.6	7473	1016	6.12	66.3	18.3	7499	1019	6.01
	1.2	75.6	17.6	6804	1095	6.85	76.3	18.3	6826	1099	6.74
80	0.4	68.6	18.3	7681	1015	6.10	70.0	18.0	7674	1014	5.99
	0.8	69.4	18.6	5744	913	5.55	69.6	19.0	5761	916	5.44
	1.2	66.6	19.3	6491	952	5.49	67.3	20.3	6502	954	5.38
90	0.4	56.5	18.3	4769	730	6.70	57.0	17.6	4771	730	6.59
	0.8	63.2	19.3	5436	835	6.60	63.6	19.0	5422	833	6.81
	1.2	68.5	18.6	7747	1069	5.58	69.3	19.3	7757	1072	5.47
LSD 5%		6.0	N.S	2036	207	0.96	6.9	N.S	2106	222	0.92

- **Leaves mineral content:**

Data presented in Table 3 show that there were significant differences in N, P and K percentage in leaves of broccoli by using different nitrogen and boron levels in the two seasons of study. However, the best values of N and P percentage were produced by nitrogen at 70 kg and boron at 0.8 kg per fed., but the highest values of K percentage in leaves was recorded with nitrogen at 80 kg and boron at 1.2 kg per fed.. On contrast the lowest amounts of N, P and K percentage in the both seasons were recorded with nitrogen at 60 kg and boron at 0.4 kg per fed., similar trend was observed by Hossein (2008).

Table 3. Effect of nitrogen and boron fertilizer on N, P and K percentage in leaves of broccoli during the two seasons of 2013-2014 and 2014-2015.

Treatments		1st season			2nd season		
N. kg. / fed.	B.kg. / fed.	N (%)	P (%)	K (%)	N (%)	P (%)	K (%)
60	0.4	1.54	0.051	1.93	1.58	0.054	1.83
	0.8	1.79	0.060	2.23	1.84	0.063	2.15
	1.2	1.68	0.054	2.66	1.71	0.062	2.56
70	0.4	2.03	0.192	2.42	2.08	0.196	2.32
	0.8	2.54	0.231	3.00	2.58	0.235	2.92
	1.2	2.24	0.226	2.90	2.28	0.227	2.82
80	0.4	1.96	0.124	3.01	1.96	0.127	2.98
	0.8	2.17	0.198	2.71	2.21	0.201	2.61
	1.2	1.92	0.126	3.44	1.96	0.173	3.36
90	0.4	1.84	0.115	2.02	1.91	0.118	1.98
	0.8	1.96	0.126	2.74	1.99	0.129	2.68
	1.2	1.91	0.117	3.48	1.97	0.120	3.40
LSD 5%		0.51	0.080	0.08	0.43	0.048	0.07

- **Curds yield and its physical quality:**

Results presented in Table 4 clearly show that there are significant differences in curd weight, curd diameter, curd dry matter percentage and curds yield. The highest values of these characters were recorded at 70 kg of nitrogen and boron at 0.8 kg boron per fed., but the lowest values of curd weight, curd diameter and curd yield were achieved with combination of 90 kg of nitrogen and boron at 0.4 kg boron per fed., the lowest curd dry matter percentage was noticed with nitrogen at 80 kg and boron at 0.8 kg per fed., Combinations of nitrogen and boron at all different rates statistically did not affect curd length and curd compactness index of broccoli (Table 4) in the two seasons.

The obtained increase in curd weight, curd diameter, curd dry matter percentage and curd yield with low or moderate level of nitrogen (60 or 70 kg) in combination with all boron levels can be attributed to the fact that the increase in level of nitrogenous fertilizers produces more vegetative growth of the plant (Table 3, 4) which in turn to higher leaf area and therefore, the photosynthetic area get increases. Also, increasing in N levels, higher rate of assimilation and ultimately more synthesis of carbohydrates and their translocation to the storage organ *i.e.* flower head occurs. These results are in conformity with the findings of Abou El-Magd (2010), Raj *et al.* (2013) and Abou El-Magd (2015) on broccoli.

The positive effect of boron on enhanced curd yield and it is component was considered due to higher photosynthetic efficiency in plants by increased metabolic activities. Its initial supply also diminishes the lignification, due to which plant cells endures to grow exclusively at tips with elongation of hypocotyl and epicotyls (Shekhawat and Shivay, 2012). Improvement in curd diameter, has also been anticipated by nitrogen and boron because of its role in chlorophyll and nucleic acid synthesis, cells differentiation and elongation turgidity and lignin biosynthesis (Hellal *et al.*, 2009). The probable reason for the decrease in curd yield and it is component after 70 kg N per fed., may be due to that excessive applied fertilizer decreased vegetative growth parameters (Table 2, 3) which in turn affected curd yield and it is component.

The previous results are in agreement with those found by Hussain *et al.* (2012), Abd El-All (2014), Abou El-Magd *et al.* (2015), Singh *et al.* (2015) and Islam *et al.* (2015) on broccoli.

Table 4. Effect of nitrogen and boron fertilizer on curds yield and its physical quality of broccoli during the two seasons of 2013-2014 and 2014-2015.

Treatments		1st season						2nd season					
N kg / fed.	B.kg. / fed.	Curd weight (g)	Curd length (cm)	Curd diameter (cm)	C.C.I.	curd dry matter %	Curds Yield (ton/ fed.)	Curd weight (g)	Curd length (cm)	Curd diameter (cm)	C.C.I.	curd dry matter %.	Curds yield (ton/ fed.)
60	0.4	726	13.9	17.4	41.0	9.79	8.70	660	14.0	17.5	38.0	9.84	7.93
	0.8	732	14.9	18.6	39.5	9.90	8.79	707	15.0	18.6	37.9	9.98	8.49
	1.2	712	14.9	18.5	38.2	9.62	8.55	715	15.0	18.6	38.2	9.75	8.58
70	0.4	732	14.2	18.3	39.8	9.71	8.79	735	14.2	18.4	39.8	9.82	8.82
	0.8	768	13.8	19.5	39.3	10.30	9.22	769	13.8	19.6	39.2	10.41	9.22
	1.2	607	13.1	17.1	35.3	9.34	7.30	609	13.2	17.2	35.3	9.42	7.31
80	0.4	607	13.2	17.5	34.8	9.00	7.29	606	13.3	17.5	34.8	9.06	7.26
	0.8	633	14.0	16.2	38.8	8.96	7.60	634	14.0	16.3	38.7	9.05	7.61
	1.2	591	13.2	16.7	35.2	9.21	7.10	592	13.2	16.8	35.2	9.26	7.10
90	0.4	509	13.2	15.9	31.5	9.28	6.11	509	13.3	15.8	31.7	9.38	6.11
	0.8	528	13.4	16.0	33.3	9.52	6.34	526	13.5	16.1	33.2	9.56	6.32
	1.2	592	13.6	17.4	34.0	9.33	7.10	592	13.7	17.5	33.9	9.43	7.10
LSD 5%		184	N.S	2.3	N.S	0.66	2.21	152	N.S	2.3	N.S	0.67	1.83

C.C.I. means curd compactness index.

- **Curds chemical quality parameters:**

Data presented in Table 5 showed that there are significant differences in Vit. C, T.S.S., chlorophyll a, chlorophyll b and carotenoids contents by using different combinations of nitrogen and boron in the two seasons of study. However, the highest Vit. C values were achieved with application nitrogen 70 kg and boron 0.8 kg per fed.. On the contrary, the lowest values of Vit. C in broccoli curd were found by the application of nitrogen at 80 kg and boron at 1.2 kg per fed.. Also, application of 70 kg of nitrogen and 0.4 kg boron per fed. gave the highest T.S.S. values but the lowest values were recorded with 90 kg of nitrogen and 1.2 kg boron per fed..

Vitamin C is one of the most important nutritional components in broccoli as well as in many other horticultural crops. The concentration of vitamin C in fruits and vegetables can be influenced by various factors such as cultural practices. The vitamin C concentration inversely correlated with the nitrogen supply in white cabbage, crisphead lettuce and potato tubers (Lee and Kader, 2000).

Our study bolsters the evidence that the concentration of ascorbic acid (the dominant form of vitamin C) in broccoli floret and stem decreased with the increased nitrogen supply above 70 kg. These results were in accordance with those reported by Chao *et al.* (2010), Abd El-All (2014) and Slosar *et al.* (2016) on broccoli.

Table 5. Effect of nitrogen and boron fertilizer on some curds chemical quality parameters of broccoli during the two seasons of 2013-2014 and 2014-2015.

Treatments		1st season					2nd season				
N. kg. / fed.	B.kg. / fed.	Vit. C mg/100g F.W	T.S.S %	Chl. a mg/100 g F.W	Chl.b mg/100 g F.W	Carotenoids mg/100g F.W	Vit. C mg /100g F.W	T.S.S %	Chl. a mg/100 F.W	Chl.b mg/100 F.W	Carotenoids mg/100g F.W
60	0.4	94.6	6.9	60.6	34.9	15.7	91.7	6.8	59.8	33.8	14.7
	0.8	84.4	7.0	58.1	33.7	13.8	80.7	6.9	57.3	31.8	12.8
	1.2	102.2	7.7	62.1	35.6	26.2	99.4	7.6	61.3	33.8	25.3
70	0.4	99.7	7.8	51.8	29.7	22.1	96.8	7.6	51.1	27.8	21.1
	0.8	158.3	5.8	44.1	24.2	20.2	155.4	5.6	43.3	22.3	19.4
	1.2	117.5	7.0	54.9	31.3	24.1	114.7	6.8	54.1	29.4	23.2
80	0.4	102.2	7.2	43.2	23.4	20.1	99.4	7.0	42.4	21.5	19.1
	0.8	66.5	7.0	40.6	22.9	22.9	63.7	6.8	39.8	21.0c	22.0
	1.2	61.4	6.8	43.7	28.4	24.1	58.6	6.7	42.8	26.4	23.2
90	0.4	64.0	6.4	50.5	30.8	26.4	61.1	6.2	49.7	28.9	25.4
	0.8	64.0	5.2	37.6	22.9	24.0	61.1	5.1	36.7	21.5	23.1
	1.2	89.5	4.9	37.3	22.0	18.0	86.6	4.8	36.6	20.6	17.1
LSD 5%		17.9	0.3	14.1	9.2	10.3	16.5	0.4	14.2	8.6	4.8

Regarding curds pigments, data presented in Table 5 illustrate that nitrogen at 60 kg and boron at 1.2 kg per fed. gave the highest values of chlorophyll a, chlorophyll b and carotenoids content. On contrast, the lowest amount of chlorophyll a, chlorophyll b and carotenoids contents in curd of broccoli were recorded by using nitrogen at 90 kg and boron at 1.2 kg per fed..

In current study, low or moderate level (60 or 70 kg) of nitrogen in combination with boron considerably improved curds chemical content performance of broccoli. The improved chlorophyll contents might be attributed to the fact that N is a constituent of chlorophyll molecule. Moreover, nitrogen is the main constituent of all amino acids in proteins that acting as a structural compounds of the chloroplast. Similar results were obtained by Ouda and Mahadeen (2008), Hossein (2008) and El-Helaly (2012) on broccoli.

As for N, P and K percentage in tissue of broccoli curds, results in Table 6 show that the maximum values of N, P and K percentage were achieved by using 70 kg of nitrogen and 0.8 kg per fed. The lowest values of N percentage was recorded at 90 kg of nitrogen and boron at 0.4 kg per fed. On the contrary, the lowest amount of P and K percentage were obtained with nitrogen at 60 kg and boron at 0.4 kg per fed.. Also, in this respect Moniruzzaman *et al.* (2007) mentioned that nitrogen conversion to nitrate in soil and nitrate absorption by roots make negative charge in root cells and the plants for equilibrium charge in cells proceed to the cation absorption. Therefore absorption of potassium and phosphorus increase. These results are in harmony with the findings of the El-Helaly (2012), Abd El-All (2014), Islam *et al.* (2015) and Slosar *et al.* (2016) on broccoli.

Concerning nitrate content in tissue of broccoli curds, data in Table 6 revealed that the maximum nitrate content was obtained from nitrogen fertilizer at 90 kg with 1.2 kg boron per fed.. On contrast, the lowest amount was recorded by using nitrogen at 60 kg and boron 0.4 kg per fed. in both seasons.

The increased nitrate accumulation in vegetable as a result of nitrogen fertilization was showed in various studies. Babik and Elkner (2002) stated that increasing level of nitrogen fertilization (100, 200, 400 and 600 kg N ha^{-1}) tended to the statistically significant increase of nitrate content in broccoli florets, Our results are in line with those obtained by Ouda And Mahadeen (2008) and Slosar *et al.* (2016) of broccoli.

Table 6. Effect of nitrogen and boron fertilizer on some curds chemical quality parameters of broccoli during the two seasons of 2013-2014 and 2014-2015.

Treatments		1st season				2nd season			
N. kg. / fed.	B.kg. / fed.	N (%)	P (%)	K (%)	NO_3 mg/ kg D.W.	N (%)	P (%)	K (%)	NO_3 mg/ kg D.W.
60	0.4	2.28	0.112	3.56	89.81	2.30	0.115	3.67	92.15
	0.8	2.84	0.255	3.81	142.97	2.86	0.258	3.94	145.89
	1.2	2.52	0.156	3.79	130.57	2.55	0.158	3.84	131.80
70	0.4	3.08	0.329	3.86	154.89	3.11	0.332	4.18	157.51
	0.8	3.40	0.397	4.17	170.68	3.42	0.400	4.23	172.62
	1.2	2.35	0.332	4.08	160.89	2.38	0.336	4.13	161.97
80	0.4	2.00	0.262	3.94	188.57	2.04	0.265	3.86	190.16
	0.8	2.19	0.311	4.15	197.39	2.27	0.314	4.21	199.07
	1.2	2.21	0.290	4.10	246.44	2.22	0.293	4.04	248.37
90	0.4	0.95	0.243	3.97	248.79	0.98	0.247	4.05	251.29
	0.8	1.09	0.288	3.83	268.62	1.13	0.291	3.91	271.38
	1.2	1.00	0.220	3.74	305.38	1.01	0.223	3.76	308.49
LSD 5%		0.76	0.067	0.38	22.70	0.64	0.064	0.12	21.29

CONCLUSION

From the above results, it can be concluded that the combination between nitrogen at 70 kg and boron at 0.8 kg per fed. was the most effective treatments, since it recorded the highest values of yield and quality parameters and the low nitrate content at save degree in both seasons. Therefore can be recommended its as the better dose of N and B fertilizer for increasing yield and quality of broccoli under similar conditions.

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تأثير التسميد بالنتروجين والبورن على المحصول والجودة فى البركولى

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التغذية المناسبة للبروكولى لها تأثير كبير على المحصول وجودة الاقراص لذلك اجريت تجربتان حقليتان متتالتين فى عامى ٢٠١٣-٢٠١٤ و ٢٠١٤-٢٠١٥ بمحطة البحوث – كلية الزراعة جامعة المنصورة. لدراسة تاثير اربعة مستويات من النتروجين (٦٠- ٧٠- ٨٠- ٩٠ وحدة ازوت للفدان) مع ثلاث مستويات من البورون (٠,٤ – ٠,٨ - ١,٢ كجم بورون للفدان) فى تصميم قطاعات كاملة العشوائية منشقة مرة واحدة فى ثلاث مكررات. اوضحت النتائج ان التفاعل بين النتروجين والبورن اثر معنويا على صفات النمو الخضرى مثل (ارتفاع النبات – المساحة الورقية للنبات - الوزن الطازج للاوراق- النسبة المئوية للمادة الجافة للاوراق-). المحتوى المعدنى للاوراق(النتروجين والفسفور والبوتاسيوم). ومحصول وجودة القرص مثل (وزن القرص- قطر القرص - النسبة المئوية للمادة الجافة للقرص- محصول الاقراص). جودة الاقراص الكيمائية مثل (فيتامين س- المواد الصلبة الذائبة الكلية - كلورفيل أ – كلورفيل ب – الكاروتينيدات - النتروجين والفسفور والبوتاسيوم - محتوى النترات). وعلى العكس عدد الاوراق للنبات وارتفاع القرص ومعامل الاندماج للقرص لم تتأثر معنويا. ولقد حقق التفاعل بين النتروجين عند معدل ٧٠ وحدة ازوت و ٠,٨ كجم بورون أعلى القيم لمعظم الصفات واقل محتوى للنترات. وعلى العكس المستويات العالية للنتروجين ٨٠ أو ٩٠ وحدة ازوت والمستوى العالى للبورون ١.٢ كجم بورون للفدان اعطت اقل القيم لمحصول وجودة الاقراص.