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Influence of Foliar Application with Nitrogen and Boron on Growth and Yield of Cauliflower

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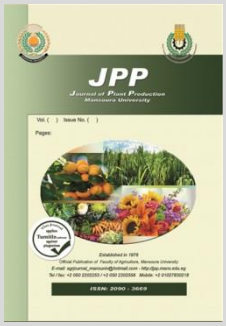

ABSTRACT

Appropriate nutrition in early autumn season under high temperature conditions has a major effect on cauliflower yield and quality. Thus two field experiments were conducted during autumn 2018 and 2019 seasons at a private farm in Demiana village, Belqas district, Dakahlia governorate to investigate the influence of foliar application with nitrogen micro carbon (NMC) at 0, 300, 600 and 900 ppm) and boron (B) at 0, 10 and 20 ppm and their interaction on vegetative growth characters, leaves chemical contents, curds yield and quality. This study contains 12 treatments with three replicates arranged in split plots in a complete randomized block design. Nitrogen micro carbon was assigned in the main plots, whereas the boron was randomly located in sub plots. Obtained results cleared that interaction impact between NMC and B significantly affected on vegetative growth (plant height, foliage fresh weight, No. of leaves, leaves fresh weight, leaves area and leaves dry matter), chemical contents of leaves (N, P, K, chlorophyll a, chlorophyll b and carotenoids), curds yield and physical characters (curd weight, diameter compactness rate, yield and hollow stem) and curds quality (dry matter, Vit. C, acidity and TSS). In this concern, combination between nitrogen micro carbon at 600 ppm and Boron at 20 ppm gave the highest values of previous parameters except hollow stem percentage where between NMC at 0 ppm and B at 20 ppm gave the lowest percentage of hollow stem.

Keywords: Cauliflower, nitrogen micro carbon, boron, curd quality, hollow stem.

INTRODUCTION

Cauliflower (*Brassica oleracea* var. botrytis, L) is one of popular vegetable in Egypt belongs to Brassicaceae. It contain variable amount of thiamine, riboflavin, niacin vitamin C and proteins. Cultivated area in Egypt from cauliflower was 9171 fed. produced 108660 ton/fed. (According to Ministry of Egyptian Agriculture statistics, 2018).

Nitrogen is a fundamental element of amino acids that are building proteins which affect plant structures that helps to enhance biomass production (Dhakal *et al.*, 2019). It is a major component of nucleic acid and chlorophyll. Nitrogen micro carbon is new technology that provides superior transportation for nutrients to achieve great benefit in plant growth and production without more effort to absorb elements.

Boron (B) is important micro element for ingredient of cell membrane by enhancing cell division. Insufficiency amount of boron in cauliflower give rise to browning and hollow stem by causing disorder in cell division (Meena *et al.*, 2018). Singh *et al.* (2011) mentioned that enhancing levels of B has linear increased significantly in vegetative characters and cauliflower yield compared to control.

Many studies showed that increasing nitrogen fertilizers increased hollow stem, while there were negative correlation between hollow stem and addition with boron (Sartori *et al.*, 2009 and Hussain *et al.*, 2012). Thus this study aimed to increased vegetative growth, yield, chemical contents and quality on cauliflower by using foliar application with nitrogen micro carbon and boron.

MATERIALS AND METHODS

Two field experiments were conducted in a private farm located in Demiana village, Belqas District, Dakahlia Governorate, Egypt in autumn seasons of 2018 and 2019, to investigate the influence of foliar application with nitrogen micro carbon and boron on growth and yield of cauliflower grown under clay loamy soil conditions using drip irrigation system. Samples from the top layer of soil (0-30 cm depth) were randomly collected before planting for physical and chemical analysis (Table 1).

Table 1. Physical and chemical parameters during the two seasons of 2018 and 2019.

Seasons	Silt %	Clay %	Sand %	Texture soil	PH	E.C (dSm-1)	Organic matter%	$CaCO_3$ %	N ppm	P ppm	K ppm	B ppm
2018	40.5	37.2	22.3	Clay loamy	8.22	1.51	1.8	3.39	51.9	5.7	288	1.5
2019	41.1	36.9	22.0	Clay loamy	8.13	1.78	2.o	3.45	54.1	6.2	294	1.6

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Cauliflower seeds (cv. Kasber) were sown in nursery for 40 days old and transplanted on 22nd and 24th of August in the 1st and 2nd seasons respectively. Seedlings were transplanted on one side of each ridge in 100 cm width and 50 cm apart. Each plot consists of five ridges, each ones 3.0 m long, plot area was 15.0 m^2.

Nitrogen micro carbon 0.0, 300, 600 and 900 ppm (from the commercial product named super-nitro consist of 30 % N which introduced by Mafco for agriculture company) and boron (0.0, 10 and 20 ppm) from the commercial product named keep (11.5% boron and 0.13% molybdenum) were added as foliar application. Its volume was 150 and 250 litter per fed. in the 1st and 2nd foliar application, respectively but 350 litter per fed in the other times. The first application began after one month after planting and repeated every ten days until two weeks before the end of the season.

All treatments received 70 kg N, 45 kg P_2O_5 and 65 kg K_2O kg/ fed. as ammonium nitrate (33.5 %), phosphoric acid (50 % P_2O_5) and potassium sulfate (50 % K_2O), respectively. as fertigation at 2 days interval beginning one week after transplanting. Also, Farmyard manure (FYM) at 20 m^3/ fed. was applied during soil preparation

Experimental design:

A split plots experiment in a complete randomized blocks design with three replicates was conducted. Nitrogen micro carbon was assigned in the main plots, whereas the boron was randomly located in the sub plots.

Measurements:

After 105 days from transplanting, five plants were taken randomly from each plot and data were recorded in both seasons as follow:

1- Vegetative growth characters:

Plant height, foliage FW, leaves number, leaves fresh weight, leaves area and leaves dry matter.

2- Chemical contents of leaves:

N, P, K, chlorophyll a, chlorophyll b and carotenoids were determined in leaves according to AOAC (1990).

3- Curds yield and its physical characters:

Curd weight, curd diameter, curd compactness rate (according to Riad *et al*., 2009), hollow stem and curds yield (ton/fed.)

Curds chemical quality:

Curd dry matter, vitamin C, acidity, TSS were measured according to AOAC (1990).

Statistical analysis:

All the obtained data were subjected to standard analysis of variance procedure. The values of LSD were calculated at 5% according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Results

1- Vegetative growth characters:

Results presented in Table 2 show that application of nitrogen micro carbon (NMC) significantly enhanced vegetative growth characters of cauliflower (plant height, foliage fresh weight, leaves number, leaves fresh weight, leaves area and leaves dry matter). The highest values of vegetative growth obtained from NMC at 600 ppm followed by NMC at 900 ppm.

As regard to boron application, data in the same table clear that increasing boron rates increased vegetative growth. The highest vegetative growth obtained from 20 ppm of B in the 1st and 2nd seasons.

Concerning the interaction effect between foliar application with NMC and B on vegetative growth characters, results indicate that spraying with NMC at 600 ppm combined with B at 20 ppm gave the maximum values of vegetative growth.

Table 2. Influence of nitrogen micro carbon and boron vegetative growth characters of cauliflower in 2018 and 2019 seasons.

Treatments		Plant height (cm)		Foliage FW Kg / plant		Leaves No. / plant		Leaves FW Kg / plant		Leaves area (m^2) / plant		Leaves DM %	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Nitrogen micro carbon (ppm)													
zero		49.5	50.6	4.95	5.06	34.6	35.4	2.31	2.37	8363	8562	9.05	9.27
300		52.7	54.0	5.27	5.40	37.0	37.7	2.47	2.52	8968	9181	9.85	10.09
600		54.8	56.1	5.48	5.16	38.4	39.3	2.56	2.63	9363	9586	10.25	10.49
900		52.9	54.2	5.29	5.41	37.2	37.8	2.47	2.53	8995	9209	9.88	10.12
LSD 5%		1.12	1.16	0.11	0.12	0.71	0.59	0.05	0.05	141	145	0.34	0.35
Boron (ppm)													
zero		50.5	51.4	5.05	5.14	35.4	36.0	2.27	2.31	8550	9704	9.33	9.50
10		53.0	54.3	5.30	5.43	37.1	37.9	2.49	2.55	9011	9237	9.86	10.10
20		54.0	55.5	5.40	5.55	37.9	38.9	2.60	2.68	9206	9564	10.08	10.37
LSD 5%		0.89	0.93	0.09	0.09	0.73	0.79	0.04	0.04	123	125	0.16	0.17
NMC	Boron	Interaction											
	zero	48.9	49.8	4.89	4.98	34.0	35.0	2.20	2.24	8159	8305	8.73	8.88
zero	10	49.1	50.3	4.91	5.03	34.6	35.0	2.31	2.36	8351	8559	9.00	9.23
	20	50.4	51.9	5.04	5.18	35.3	36.3	2.43	2.50	8581	8822	9.43	9.69
	zero	49.5	50.4	4.95	5.05	34.6	35.3	2.23	2.27	8424	8576	9.25	9.42
300	10	53.7	55.0	5.36	5.50	37.6	38.3	2.52	2.58	9126	9354	10.03	10.28
	20	55.0	56.6	5.50	5.65	38.6	39.6	2.65	2.73	9353	9615	10.27	10.56
	zero	52.3	53.2	5.23	5.32	36.6	37.3	2.35	2.39	8894	9054	9.77	9.95
600	10	55.8	57.3	5.58	5.72	39.0	40.0	2.62	2.69	9500	9738	10.44	10.70
	20	56.4	58.0	5.64	5.80	39.6	40.6	2.72	2.80	9695	9967	10.54	10.83
	zero	51.3	52.2	5.13	5.22	36.3	36.3	2.30	2.35	8723	8880	9.58	9.76
900	10	53.3	54.7	5.33	5.46	37.3	38.3	2.50	2.57	9069	9296	9.96	10.21
	20	54.1	55.6	5.40	5.55	38.0	39.0	2.61	2.68	9194	9451	10.10	10.38
LSD 5%		1.84	1.91	0.18	0.19	1.39	1.42	0.08	0.09	245	251	0.44	0.45

2- Chemical contents of Leaves:

Illustrated results in Table 3 clarify that N, P, K, chlorophyll a, chlorophyll b and carotenoids significantly increased with increasing rates of nitrogen micro carbon up to 600 ppm then decreased at 900 ppm. These results are true in two seasons.

As well as for boron effects on leaves chemical contents, results in the same table clear that all chemical components in leaves enhanced with increasing boron rates. The highest values obtained from 20 ppm of B in 2018 and 2019 seasons.

Interaction effect between foliar spraying with nitrogen micro carbon and boron had significant impact on N, P, K, chlorophyll a, chlorophyll b and carotenoids. The highest values came from combination between NMC at 600 ppm with B at 20 ppm in the first and second seasons.

Table 3. Influence of nitrogen micro carbon and boron as foliar application on leaves chemical content of cauliflower in 2018 and 2019 seasons.

Treatments		N %		P %		K %		Chl. a mg/100 FW		Chl.b mg/100 FW		Carotenoids mg/100g FW	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Nitrogen micro carbon (ppm)													
zero		1.88	1.93	0.253	0.259	2.40	2.45	50.41	51.61	22.14	22.67	12.42	12.72
300		2.01	2.05	0.270	0.276	2.55	2.61	54.77	56.08	25.39	26.00	13.73	14.06
600		2.08	2.13	0.281	0.288	2.66	2.72	57.57	58.94	27.64	28.30	14.60	14.95
900		2.02	2.06	0.271	0.277	2.56	2.62	54.94	56.25	25.39	26.00	13.76	14.09
LSD 5%		0.04	0.04	0.005	0.006	0.05	0.05	0.81	0.83	0.37	0.38	0.20	0.21
Boron (ppm)													
zero		1.92	1.95	0.259	0.263	2.44	2.49	51.89	52.83	23.13	23.54	12.84	13.08
10		2.01	2.06	0.272	0.278	2.57	2.63	54.86	56.24	25.59	26.23	13.78	14.13
20		2.05	2.11	0.276	0.284	2.61	2.69	56.51	58.09	26.70	27.45	14.25	14.69
LSD 5%		0.03	0.03	0.004	0.004	0.04	0.04	0.78	0.80	0.35	0.36	0.19	0.20
NMC	Boron	Interaction											
	zero	1.86	1.89	0.251	0.255	2.37	2.41	48.52	49.40	20.84	21.21	11.87	12.09
zero	10	1.87	1.91	0.252	0.258	2.38	2.44	50.29	51.55	22.08	22.63	12.39	12.70
	20	1.92	1.97	0.258	0.266	2.44	2.51	52.42	53.88	23.51	24.17	13.00	13.37
	zero	1.88	1.92	0.254	0.258	2.40	2.45	51.45	52.38	22.84	23.25	12.72	12.95
300	10	2.04	2.09	0.257	0.282	2.60	2.66	55.74	57.13	26.07	26.72	14.02	14.36
	20	2.09	2.15	0.282	0.290	2.67	2.74	57.13	58.73	27.26	28.03	14.46	14.87
	zero	1.99	2.02	0.268	0.273	2.53	2.58	54.32	55.31	24.73	25.18	13.54	13.78
600	10	2.12	2.18	0.286	0.294	2.71	2.77	58.03	59.48	28.80	29.52	14.88	15.26
	20	2.14	2.20	0.289	0.297	2.73	2.81	60.35	62.04	29.38	30.20	15.38	15.81
	zero	1.95	1.99	0.263	0.268	2.48	2.53	53.28	54.24	24.10	24.54	13.25	13.49
900	10	2.03	2.08	0.273	0.280	2.58	2.65	55.40	56.78	25.43	26.07	13.84	14.19
	20	2.06	2.11	0.277	0.285	2.62	2.69	56.16	57.73	26.64	27.39	14.19	14.58
LSD 5%		0.07	0.07	0.009	0.010	0.08	0.09	1.51	1.54	0.68	0.72	0.18	0.38

3- Curds yield and its physical characters:

Recorded results in Table 4 demonstrate foliar application with nitrogen micro carbon at 600 ppm gave the highest values of cauliflower yield, curd weight, diameter and compactness rate in the first and second seasons, also increasing hollow stem percentage associated with increasing NMC rates.

Regarding the effect of boron on curds yield, results in the same table show that increasing B from 0 to 20 ppm of B increased curd weight, diameter, curd compactness and curds yield/fed., on contrast hollow stem percentage decreased with increasing boron rates.

Concerning the effect of nitrogen micro carbon and boron on curd weight, diameter, curd compactness and curds yield/fed., results clear that using NMC at 600 ppm combined with B at 20 ppm gave the maximum values of aforementioned parameters, on the other hand using NMC at zero ppm combined with B at 20 ppm gave the lowest hollow stem percentage followed with NMC at zero ppm combined with B at 10 ppm.

4- Curds quality:

Obtained results in Table 5 clear that curds quality i.e., curds dry matter, vitamin C, acidity and TSS significantly affected by nitrogen micro carbon foliar application. The highest values curds quality came from using NMC at 600 ppm followed by NMC at 900 ppm in the 1st and 2nd seasons.

As for the effect of boron on curds quality, results in the same table illustrate that boron at 20 ppm of gave maximum values of curds quality.

As regard to the interaction between foliar application of NMC combined with B, results show that NMC at 600 ppm and B at 20 ppm gave the highest values of dry matter, vitamin C, acidity and TSS o curds in both seasons.

Table 4. Influence of nitrogen micro carbon and boron as foliar application on curds yield and its physical quality of cauliflower in 2018 and 2019 seasons.

Treatments		Curd weight (Kg)		Curd diameter (cm)		Curd compactness rate		Hollow stem %		Curds Yield (ton/ fed.)	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Nitrogen micro carbon (ppm)											
zero		2.28	2.33	23.3	23.8	1.64	1.72	4.24	4.33	19.16	19.62
300		2.43	2.48	24.8	25.5	1.86	1.95	5.04	5.15	20.42	20.90
600		2.52	2.58	25.9	26.4	2.01	2.11	6.32	6.45	21.24	21.74
900		2.43	2.49	24.9	25,5	1.87	1.97	6.92	7.08	20.48	20.97
LSD 5%		0.05	0.05	0.53	0.54	0.07	0.08	0.04	0.03	0.44	0.45
Boron (ppm)											
zero		2.32	2.37	23.8	24.2	1.71	1.77	6.21	6.32	19.56	19.91
10		2.44	2.50	24.9	25.6	1.88	1.98	5.65	5.80	20.52	21.03
20		2.48	2.55	25.4	26.1	1.95	2.06	5.03	5.15	20.90	21.49
LSD 5%		0.04	0.04	0.42	0.43	0.06	0.07	0.15	0.15	0.34	0.36
NMC	Boron	Interaction									
	zero	2.25	2.29	23.0	23.4	1.60	1.66	4.83	4.90	18.94	19.29
zero	10	2.26	2.32	23.2	23.7	1.61	1.69	4.26	4.36	19.07	19.49
	20	2.32	2.39	23.7	24.4	1.70	1.80	3.63	3.73	19.54	20.08
	zero	2.28	2.32	23.4	23.7	1.64	1.70	5.63	5.73	19.18	19.52
300	10	2.47	2.53	25.3	25.9	1.92	2.02	5.06	5.20	20.78	21.30
	20	2.53	2.60	25.9	26.6	2.02	2.14	4.43	4.53	21.29	21.89
	zero	2.41	2.45	24.6	25.2	1.83	1.89	6.90	7.03	20.25	20.61
600	10	2.57	2.63	26.3	27.0	2.09	2.19	5.33	6.50	21.63	22.17
	20	2.60	2.67	26.6	27.3	2.13	2.25	5.73	5.83	21.84	22.45
	zero	2.36	2.40	24.1	24.6	1.76	1.82	7.50	7.63	19.86	20.22
900	10	2.45	2.52	25.2	25.7	1.90	2.00	6.93	7.13	20.65	21.16
	20	2.49	2.56	25.4	26.2	1.95	2.06	6.33	6.50	20.93	21.52
LSD 5%		0.08	0.09	0.87	0.89	0.13	0.14	0.26	0.25	0.71	0.73

Table 5. Influence of nitrogen micro carbon and boron as foliar application on curds chemical quality characters of cauliflower in 2018 and 2019 seasons.

Treatments		Curd dry matter %		Vitamin C mg/100gF.W		Acidity %		TSS %	
		S1	S2	S1	S2	S1	S2	S1	S2
Nitrogen micro carbon (ppm)									
zero		6.70	6.86	125	128	0.259	0.265	5.37	5.50
300		7.30	7.47	136	139	0.276	0.282	5.83	5.96
600		8.09	8.28	143	146	0.287	0.294	6.06	6.23
900		7.32	7.49	137	140	0.277	0.284	5.86	5.97
LSD 5%		0.25	0.26	2.03	2.07	0.005	0.006	0.19	0.20
Boron (ppm)									
zero		6.91	7.04	128	131	0.264	0.269	5.53	5.62
10		7.41	7.60	136	139	0.277	0.284	5.85	5.98
20		7.73	7.94	140	144	0.282	0.290	5.97	6.15
LSD 5%		0.19	0.20	1.94	1.99	0.004	0.005	0.09	0.11
NMC	Boron	Interaction							
	zero	6.47	6.58	120	122	0.256	0.261	5.16	5.26
zero	10	6.67	6.83	124	128	0.257	0.264	5.36	5.46
	20	6.98	7.18	130	133	0.264	0.271	5.60	5.76
	zero	6.85	6.98	127	130	0.259	0.264	5.50	5.56
300	10	7.43	7.61	138	141	0.281	0.288	5.93	6.06
	20	7.61	7.82	142	145	0.288	0.296	6.06	6.26
	zero	7.24	7.37	135	137	0.274	0.279	5.80	5.90
600	10	8.19	8.39	144	147	0.293	0.300	6.16	6.36
	20	8.85	9.09	149	154	0.295	0.303	6.23	6.43
	zero	7.10	7.23	132	134	0.269	0.273	5.66	5.76
900	10	7.38	7.56	137	141	0.279	0.286	5.93	6.03
	20	7.48	7.69	139	143	0.283	0.291	6.00	6.13
LSD 5%		0.40	0.41	3.76	3.85	0.009	0.010	0.25	0.26

DISCUSSION

Results in this research clear that increasing nitrogen micro carbon increased al aforementioned parameters this may be due to increase photosynthetic pigments (Ali *et al.*, 2019) protein and nucleic acids then increase physiological processes and metabolism this lead to increase leaves area and large vegetative growth (as shown in Table 2) that improve carbohydrate synthesis to accumulate extra dry matter in curds (reproductive tissues) this reflect to curds growth and yield (Laghari *et al.*, 2016) and improve curds quality. These results are conformity with those obtained by Hussain *et al.* (2012), Metwaly (2016) on broccoli, Abdrabbo *et al.* (2019) on sweet fennel and Ali *et al.* (2019).

The positive effect of boron on vegetative growth parameters, curds yield, quality and decreased hollow stem may be attribute to increased cell multiplication and elongation as well vegetative growth because of useful

effect on metabolic photosynthetic activity, translocation of carbohydrates and physiological activity (Meena *et al.*, 2019). Boron enhanced availability of nutrients thereby enhancing manufacturing carbohydrates and proteins and more translocation to storage site thus increasing yield and quality of cauliflower.

Hussain *et al.* (2012) revealed that using higher rate of N and moderate amount of B increased growth and quality of broccoli and decreased hollow stem disorder. This findings are agree with those obtained by Meena *et al.* (2018) on cauliflower and Farooq *et al.* (2018) on broccoli.

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تأثير الرش بالنتروجين والبورون على نمو ومحصول القنبيط

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التغذية المناسبة فى العروة الخريفية المبكرة تحت ظروف درجات الحرارة المرتفعة لها تأثير كبير على محصول وجودة القنبيط؛ لذلك تم إجراء تجربتان حقليتان فى العروة الخريفية لعامى 2018- 2019 بمزرعة خاصة بقرية دميانة بمركز بلقاس - محافظة الدقهلية لدراسة تأثيرالرش الورقى بالنتروجين ميكروكربون بمعدل (صفر، 300،600،900 جزء فى المليون) والبورون بمعدل (صفر، 10،20 جزء فى المليون) والتفاعل بينهم على صفات النمو الخضرى ومحتوى الأوراق الكيماوى ومحصول الأقراص وجودته. إشتملت هذه التجربة على 12 معاملة فى 3 مكررات تم ترتيبها فى تصميم قطع منشقة فى قطاعات كاملة العشوائية. وتم وضع النتروجين ميكروكربون فى القطع الرئيسية والبورون فى القطع الشقية. أوضحت النتائج التى تم الحصول عليها أن التفاعل بين النتروجين ميكروكربون والبورون أثر معنويا على صفات النمو الخضرى (طول النبات، الوزن الغض للنبات، عدد الأوراق، الوزن الغض للأوراق، المساحة الورقية و المادة الجافة للأوراق) والمحتوى الكيماوى للأوراق (النتروجين، الفوسفور، البوتاسيوم، كلوروفيل أ،كلوروفيل ب والكاروتينات) ومحصول القرص (وزن القرص، قطره، معدل اندماج القرص، محصول الأقراص ونسبة الساق الجوفاء) وجودة الأقراص (المادة الجافة، فيتامين سى، الحموضة و المواد الصلبة الذائبة). وفى هذا الصدد أعطى التفاعل بين النتروجين ميكروكربون بمعدل 600 جزء فى المليون والبورون بمعدل 20 جزء فى المليون أعلى القيم للصفات السابقة ما عدا نسبة الساق الجوفاء حيث أعطى التفاعل بين النتروجين ميكروكربون بمعدل صفر والبورون بمعدل 20 جزء فى المليون أقل نسبة مئوية للساق الجوفاء.