J. Agric. Sci. Mansoura Univ., 29(9): 5147 - 5158, 2004

EFFECT OF PLANT SPACING, NITROGEN FERTILIZER LEVELS AND ZINC FOLIAR SPRAY ON PRODUCTIVITY OF CABBAGE IN CALCAREOUS SOILS.

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ABSTRACT

Two field trials were carried out during two successive winter seasons of 2002/2003 and 2003/2004 at the farm of El-Nubaria Hort. Research Station to study the response of cabbage plants (cv. Brunswick) to nitrogen fertilizer levels, plant density and zinc foliar nutrition on growth, yield and chemical composition of cabbage plants.

The main results obtained from this investigation could be summarized as follows:-

1. Effect of nitrogen levels: Increasing nitrogen rates from 40 to 80 kg/fed caused significant increase in all studied traits, except Fe and Zn content of leaves, which was decreased by increasing N levels, P% was not affected by N levels.
2. Plant spacing: The highest values were obtained from lower density (50 cm), except yield (ton/fed) and Fe and Zn content were significantly increased with closest spacing (30 cm).
3. Zn foliar spray: Foliar application with chelated Zn (12% Zn) at 1 g/L Zn gave the highest values of outer leaves / plant, plant fresh weight, head weight, yield (ton/fed), length and diameter of heads and significantly increased leaf content of Mg and Zn (ppm). Leaf content of N, P and Fe, Mn were significantly decreased with foliar application with Zn compared with untreated treatment (without Zn).
4. Effect of Interaction: The traits under study were insignificantly affected by the interaction between N levels, plant spacing and foliar application with Zn.

The study concluded that the highest yield was obtained from:

i. Fertilization with 80 kg N/fed.
ii. The ideal spacing for cabbage plants under Nubaria location is 30 cm.
iii. Foliar application with chleated Zn at 1 g/L

INTRODUCTION

Cabbage (*Brassica oleraceae* var. *Capitata* L.) is a popular winter vegetable in Egypt. Modern intensive agriculture requires an optimum nutrient supply for the high yielding crop, plant nutrition is one of the primary factors. Fertilization with nitrogen has been reported to have great effects on cabbage yield, marketable head size and quality. Research in Egypt has demonstrated that response of cabbage plants to nitrogen may differ from one location to another, soil type and may be depend on the grown cultivar, Hassan and Abdel Ati (1993) reported that the yield of the edible heads / fed., average weight of edible head dimensions increased with increasing N fertilizer level up to 75 kg N/fed. El-Etriby (1994) pointed out that average head weight per plant and total yield per feddan were significantly increased by increasing nitrogen level up to 80 kg N/fed in comparison with the lowest N level. Hassan *et al.* (1994) reported that increasing nitrogen level from 40 to 120 kg N/fed significantly increased cabbage yield.

Data obtained were subjected to statistical analysis by the technique of analysis of variance (ANOVA) for *split split block design. The treatments* mean were compared using Duncan's Multiple Range Test (Duncan, 1965).

RESULTS AND DISCUSSION

1. Vegetative growth characters:

a. Effect of nitrogen levels:

Data in Table 2 show that the differences between the averages of all growth parameters; number of outer leaves / plant, plant fresh weight (kg) and edible head weight (kg) were significantly with addition of N fertilizer levels in both seasons. The highest values of all growth parameters were obtained from using 80 kg N/fed in comparison with the other treatments in both seasons.

Table 2: Mean effect of nitrogen levels, plant spacing and foliar nutrition with Zn on some vegetative growth characters of cabbage plants during 2002/2003 and 2003/2004 seasons.

Treatments	No. of outer leaves / plant		Plant fresh weight (kg)		Edible head weight (kg)	
	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
Nitrogen levels (kg/fed):						
40	8.68 b	9.80 b	2.76 c	3.00 c	2.00 c	2.36 c
60	9.74 a	11.70 a	3.34 b	3.68 b	2.69 b	3.09 b
80	10.62 a	12.50 a	4.27 a	4.71 a	3.50 a	3.95 a
F test	**	**	**	**	*	**
Plant spacing (cm):						
30	9.17 b	10.46 b	2.99 b	3.30 b	2.35 b	2.73 b
50	10.33 a	12.21 a	3.94 a	4.29 a	3.10 a	3.55 a
F test	**	**	**	**	**	**
Zn foliar spray:						
With	10.33 a	12.08 a	3.59 a	4.03 a	3.00 a	3.35 a
Without	9.16 b	10.46 b	3.32 b	3.56 b	2.53 b	2.90 b
F test	*	**	**	**	**	**

***, ** indicate significant differences at P< 0.05 and 0.01 according to F test.**
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

These results might be due to the fact that cabbage plants need to nitrogen for healthy especially where soils are poor in nitrogen and organic matter as this study situation (Table 1). Nitrogen is one of the most important components of cytoplasm, nucleic acid and chlorophyll (Purekar *et al.*, 1992), therefore, increasing nitrogen in plant may increase hormones production, which activate cell division and enlargement in plant tissue (Devlin, 1969). This result is in good accordance with Hassan and Abdel Ati (1993), Hassan *et al.* (1994), El-Etriby (1994), El-Shabrawy *et al.* (1999) and Ibrahim (2001).

b. Effect of plant spacing:

Data in Table 2 reveal that the highest values of No. of outer leaves, plant fresh weight (kg / plant) and edible head weight (kg) were significantly increased by increasing plant spacing from 30 to 50 cm between plants. These increments are true in both seasons. Similar results were obtained by Vlaswinkel (1997), who found that lower plant density improved crude size and quality.

c. Effect of foliar nutrition of Zn:

Data in Table 2 clear that foliar application with EDTA Zn significantly increased No. of outer leaves, plant fresh weight (kg / plant) and edible head weight (kg) were significantly increased in both seasons compared with control (without Zn). Similar results were obtained by El-Shabrawy (1991), he found that spraying cauliflower plants with 200 or 400 ppm Zn significantly increased No. of leaves and plant fresh weight compared to control. These results might be due to the fact that cabbage plants need to Zn under calcareous soil. Table 1 show that Zn DTPA extractable was very low as compared to critical value of available Zn content reported by Lindsay and Norvell (1978). Such low content may be attributed also to lime induced condition, which reduces the availability of Zn in the soil. The above-mentioned soil characteristics reveal low power of supply nutrients, especially Zn, which may lead to imbalanced nutrition of plants grown on such soil.

d. Effect of interaction:

Data in Table 3 show that the interaction between N levels, plant spacing and foliar spray with Zn had insignificant effects on all studied characters in both seasons. This shows that each of these three factors may be acting independently on these traits.

Table 3: **Effect of interaction between nitrogen levels, plant spacing and foliar nutrition with Zn on some vegetative growth characters of cabbage plants during 2002/2003 and 2003/2004 seasons.**

Treatments			No. of outer leaves / plant		Plant fresh weight (kg)		Edible head weight (kg)	
N level (kg/fed)	Plant spacing (cm)	Zn foliar Spray	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
40	30	With	8.8	10.25	2.40	2.8	1.8	2.0
		Without	7.3	7.75	2.10	2.3	1.3	1.6
	50	With	9.8	11.25	3.5	3.8	2.5	3.0
		Without	9.0	10.50	3.2	3.1	2.4	2.9
60	30	With	10.3	11.75	2.8	3.2	2.6	3.0
		Without	9.0	10.25	2.7	3.0	2.2	2.7
	50	With	11.0	13.00	4.2	4.7	3.2	3.6
		Without	9.5	12.00	3.8	3.8	2.8	3.1
80	30	With	10.3	12.25	4.1	4.5	3.4	4.0
		Without	9.5	11.00	4.0	4.1	2.9	3.2
	50	With	12.0	14.50	4.7	5.2	4.0	4.5
		Without	10.8	12.25	4.4	5.1	3.7	4.1
F test			NS	NS	NS	NS	NS	NS

NS indicate not significant between treatments according to F test.

2. Yield and head characters:

a. Effect of nitrogen level:

Table 4 shows that nitrogen fertilizer levels significantly increased head yield (ton/fed) in both seasons. Raising nitrogen rates from 40 to 80 kg N/fed led to marked increases in head yield from 26.0 to 45.5 ton/fed and from 30.68 to 51.35 ton/fed in 2002/2003 and 2003/2004 seasons, respectively.

Yield increases were due to the increases of average edible head weight with increasing nitrogen rates (Table 2). These results corresponded with those obtained by Hassan (1999) and Ibrahim (2001).

Table 4: **Mean effect of nitrogen levels, plant spacing and foliar nutrition with Zn on yield and some head characters of cabbage plants during 2002/2003 and 2003/2004 seasons.**

Treatments	Marketable yield (ton/fed)		Head diameter (cm)		Head length (cm)	
	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
Nitrogen levels (kg/fed):						
40	26.00 c	30.68 c	24.00 c	24.02 c	23.37 c	24.18 b
60	34.97 b	34.97 b	26.24 b	26.28 b	24.87 b	24.87 b
80	45.50 a	51.35 a	28.02 a	27.63 a	28.00 a	28.13 a
F test	**	**	*	**	**	*
Plant spacing (cm):						
30	37.60 a	43.68 a	25.16 b	25.42 b	14.18 b	24.25 b
50	31.00 b	35.50 b	26.25 a	26.77 a	26.83 a	27.21 a
F test	**	**	*	**	**	**
Zn foliar spray:						
With	39.00 a	43.55 a	27.12 a	27.33 a	26.16 a	26.46 a
Without	32.80 b	37.70 b	25.05 b	24.86 b	24.66 b	25.00 b
F test	**	**	*	**	**	**

*, ** indicate significant differences at $P< 0.05$ and 0.01 according to F test.
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

As shown in Table 4, data reveal that increasing nitrogen levels caused significant increases in head diameter and length in both seasons. Similar results were obtained by Ibrahim (2001).

b. Effect of plant spacing:

Data in Table 4 show that increasing plant spacing from 30 to 50 cm significantly decreased yield (ton/fed) and significantly increased head diameter and length. Similar results were obtained by Mallik and Bhattacharya (1996), who reported that highest total yield were obtained from the closest spacing.

c. Effect of foliar application of Zn:

Data in Table 4 reveal that foliar nutrition with EDTA-Zn significantly increased yield (ton/fed) and head diameter and length compared to control (without Zn). These results are in agreement with those reported by Mishra *et*

al. (1984), who found that twice foliar application of Zn at 0.25% increased cabbage yield. The improvement of cabbage yield by foliar application of Zn in El-Nubaria area may be due to the low availability of Zn soil content owing to its relatively high pH and lime (Table 1). Such relationships between soil pH and availability of different nutrients were early discussed by El-Mowelhi *et al.* (1973) and Abd El-Salam *et al.* (1979).

d. Effect of interaction:

The statistical analysis of the experimental data, Table 5 showed that the interaction between N levels, plant spacing and foliar application of chelated Zn did not exert any significant effect on yield and head diameter and length in both seasons. This shows that each of these three factors may be acting independently on these traits.

Table 5: Effect of interaction between nitrogen levels, plant spacing and foliar nutrition with Zn on yield and some head characters of cabbage plants during 2002/2003 and 2003/2004 seasons.

Treatments			Marketable yield (ton/fed)		Head diameter (cm)		Head length (cm)	
N level (kg/fed)	Plant spacing (cm)	Zn foliar Spray	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
40	30	With	28.8	32.0	24.77	25.40	23.0	24.00
		Without	20.8	25.0	22.50	22.86	22.0	20.25
	50	With	25.0	30.0	25.40	25.63	25.3	26.75
		Without	24.0	29.0	23.50	23.82	23.5	25.00
60	30	With	41.6	48.0	27.06	27.30	23.5	24.40
		Without	32.2	43.2	23.88	24.17	23.5	23.50
	50	With	32.0	36.0	29.70	29.30	27.5	28.00
		Without	28.0	31.0	27.23	27.07	25.5	26.10
80	30	With	50.24	64.0	28.18	28.60	27.0	27.60
		Without	46.4	51.2	26.27	26.50	25.5	27.30
	50	With	40.0	45.0	30.10	29.60	30.8	31.30
		Without	37.0	41.0	27.01	27.23	28.8	29.00
F test			NS	NS	NS	NS	NS	NS

NS indicate not significant between treatments according to F test.

3. Chemical composition:

a. Effect of N levels:

Data in Tables 6 and 7 shows that increase N levels from 40 to 80 kg/fed significantly increased N%, Mg% and Mn ppm and significantly decreased Zn and Fe (ppm). P% was not affected by N levels in both seasons. Similar results were obtained by El-Shabrawy *et al.* (1999) and Ibrahim (2001), who reported that increasing N levels significantly increased N% in cabbage leaves.

Table 6: Mean effect of nitrogen levels, plant spacing and foliar nutrition with Zn on some chemical composition of cabbage plants during 2002/2003 and 2003/2004 seasons.

Treatments	N (%)		P (%)		Mg (%)	
	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
Nitrogen levels (kg/fed):						
40	2.3 c	2.3 b	0.318 a	0.330 a	0.280 b	0.270 b
60	2.8 b	2.4 b	0.309 a	0.310 a	0.330 b	0.300 a
80	3.8 a	3.8 a	0.309 a	0.310 a	0.349 a	0.300 a
F test	**	**	NS	NS	*	**
Plant spacing (cm):						
30	2.8 b	2.7 b	0.318 a	0.320 a	0.310 a	0.280 a
50	3.0 a	2.9 a	0.307 a	0.310 b	0.331 a	0.300 a
F test	**	**	NS	**	NS	NS
Zn foliar spray:						
With	2.90 a	2.80 b	0.261 b	0.26 b	0.369 a	0.34 a
Without	3.01 a	2.90 a	0.263 a	0.37 a	0.272 b	0.24 b
F test	NS	**	**	**	**	*

***, ** indicate significant differences at P< 0.05 and 0.01 according to F test.**
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

b. Effect of plant spacing:

Results in Tables 6 and 7 show that increasing plant spacing from 30 to 50 cm significantly increased N% content in cabbage leaves, and decreased P%, Zn and Fe (ppm). Mg and Mn were not significantly affected by plant spacing in both seasons.

Table 7: Mean effect of nitrogen levels, plant spacing and foliar nutrition with Zn on some chemical composition of cabbage plants during 2002/2003 and 2003/2004 seasons.

Treatments	Mn (ppm)		Zn (ppm)		Fe (ppm)	
	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
Nitrogen levels (kg/fed):						
40	36.2 b	35.2 c	25.7 a	25.4 a	188.7 a	191.0 a
60	34.7 b	38.2 b	23.9 a	23.9 b	186.0 a	182.0 b
80	45.2 a	40.0 a	22.0 b	22.0 b	188.1 a	173.8 c
F test	**	**	**	*	NS	**
Plant spacing (cm):						
30	36.6 a	38.3 a	24.2 a	24.0 a	200.6 a	190.3 a
50	38.8 a	37 3 a	25.7 a	22.6 b	174.7 b	174.2 b
F test	NS	NS	NS	**	**	**
Zn foliar spray:						
With	35.0 b	33.7 b	27.1 a	25.5 a	166.8 b	168.5 b
Without	42.5 a	41.9 a	22.8 b	22.0 b	208.5 a	196.1 a
F test	**	**	**	**	**	**

***, ** indicate significant differences at P< 0.05 and 0.01 according to F test.**
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

c. Effect of foliar spray with Zn:

Data in Tables 6 and 7 reveal that foliar application of Zn significantly increased Mg% and Zn ppm in cabbage leaves and significantly decreased

N, P% and Mn, Fe (ppm). Similar results were obtained by Heng *et al.* (1997), who reported that spraying Chinese cabbage with Zn increased accumulation of Zn.

d. Effect of Interaction:

Data in Tables 8 and 9 show that chemical composition of cabbage leaves were not significantly affected by interaction between N levels, plant spacing and foliar application of Zn in both seasons.

Table 8: Effect of interaction between nitrogen levels, plant spacing and foliar nutrition with Zn on some chemical composition of cabbage plants during 2002/2003 and 2003/2004 seasons.

Treatments			N (%)		P (%)		Mg (%)	
N level (kg/fed)	Plant spacing (cm)	Zn foliar Spray	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
40	30	With	2.36	2.23	0.28	0.26	0.30	0.30
		Without	2.40	2.13	0.36	0.38	0.22	0.22
	50	With	2.43	2.60	0.27	0.29	0.40	0.33
		Without	2.36	2.35	0.38	0.38	0.20	0.24
60	30	With	2.60	2.46	0.27	0.26	0.30	0.34
		Without	2.76	2.26	0.35	0.38	0.30	0.23
	50	With	2.86	3.30	0.27	0.26	0.42	0.38
		Without	3.00	2.66	0.36	0.26	0.32	0.26
80	30	With	3.40	2.56	0.27	0.25	0.31	0.34
		Without	3.60	3.60	0.38	0.38	0.34	0.25
	50	With	3.80	3.90	0.25	0.26	0.36	0.34
		Without	3.96	4.00	0.33	0.36	0.27	0.28
F test			NS	NS	NS	NS	NS	NS

NS indicate not significant between treatments according to F test.

Table 9: Effect of interaction between nitrogen levels, plant spacing and foliar nutrition with Zn on some chemical composition of cabbage plants during 2002/2003 and 2003/2004 seasons.

Treatments			Mn (ppm)		Zn (ppm)		Fe (ppm)	
N level (kg/fed)	Plant spacing (cm)	Zn foliar Spray	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004	2002/ 2003	2003/ 2004
40	30	With	30.0	29.3	25.70	29.70	91.70	188.0
		Without	33.6	38.6	24.00	27.66	257.7	222.7
	50	With	37.6	29.3	28.00	25.33	152.6	154.0
		Without	42.0	43.6	25.00	25.70	179.3	200.0
60	30	With	31.6	35.6	24.66	24.00	167.6	183.7
		Without	37.0	42.6	20.00	21.33	220.0	194.0
	50	With	29.0	33.3	27.66	23.33	172.0	161.0
		Without	41.3	42.3	20.00	19.70	203.0	190.0
80	30	With	46.3	40.0	28.30	26.33	164.6	164.3
		Without	51.6	44.0	24.00	24.00	208.7	190.0
	50	With	35.3	36.0	28.30	24.70	152.0	160.3
		Without	47.6	40.33	24.70	20.70	189.0	181.0
F test			NS	NS	NS	NS	NS	NS

NS indicate not significant between treatments according to F test.

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تأثير مسافة الزراعة ومستويات مختلفة من التسميد النيتروجيني والرش بالزنك المخلبى على إنتاجية وجودة محصول الكرنب بالأراضي الجديدة

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[2] قسم تغذية النبات – المركز القومى للبحوث – الدقى - مصر

أجريت تجربتان حقليتان فى محطة بحوث البساتين بالنوبارية فى الموسمين الشتويين ٢٠٠٢/٢٠٠٣ و ٢٠٠٣/٢٠٠٤ وذلك بهدف دراسة إستجابة نبات الكرنب صنف برونزويك للتسميد النتروجينى والكثافة النباتية والرش بالزنك المخلبى وذلك على النمو والمحصول والتحليل الكيماوى للأوراق. إستخدم تصميم القطع المنشقة مرتين فى قطاعات كاملة العشوائية فى أربع مكررات حيث وزعت مستويات التسميد النتروجينى (٤٠ ، ٦٠ ، ٨٠ كجم ن/ف) فى القطع الرئيسية والمسافة بين النباتات (٣٠ ، ٥٠سم) فى القطع الشقية الأولى حيث أعطت ١٢ ، ١٠ آلاف نبات فى الفدان على التوالى بينما خصصت القطع الشقية الثانية لمعاملة الزنك (رش الزنك المخلبى بتركيز ١ جم/لتر وكذلك المعاملة بدون رش الزنك). وكانت أهم النتائج المتحصل عليها كما يلى:-

١- مستويات النتروجين: أدت زيادة التسميد الأزوتى من ٤٠ – ٨٠ كجم للفدان إلى زيادة عدد الأوراق الخارجية وزيادة وزن النبات الطازج ووزن الرؤوس الصالحة للتسويق وكذلك محصول الفدان بالطن وكذلك زيادة طول وقطر الرؤوس زيادة معنوية وذلك فى كلا الموسمين. كذلك أدت زيادة التسميد النتروجينى حتى ٨٠ كجم/ف لإبى زيادة محتوى الأوراق من النتروجين والمغنسيوم والمنجنيز ، بينما لم يتأثر محتوى الأوراق من الفوسفور معنويا بالتسميد النتروجينى وأدت زيادة التسميد النتروجينى إلى قلة محتوى الأوراق من الزنك والحديد.

٢- الكثافة النباتية (مسافة الزراعة): أدت مسافة الزراعة الواسعة ٥٠ سم إلى زيادة الأوراق الخارجية ووزن النبات الطازج ووزن الرؤوس بالمقارنة بالمسافة الضيقة ٣٠ سم ولكن محصول الفدان بالطن زاد زيادة معنوية عند الشتل بالمسافة الضيقة ٣٠ سم بالمقارنة بالمسافة الواسعة ٥٠ سم. كما أدت مسافة الزراعة الواسعة ٥٠ سم بين النباتات إلى زيادة محتوى الأوراق من النتروجين والفسفور ولم يتأثر المغنسيوم والمنجنيز والزنك فى الموسم الأول ، بينما أدت مسافة الزراعة الضيقة إلى زيادة محتوى الأوراق من الحديد والزنك فى الموسم الثانى.

٣- تأثير الرش بالزنك: أدى الرش بالزنك إلى زيادة معنوية فى جميع الصفات المدروسة وزيادة المحصول وطول وقطر الرأس. بينما أدى الرش بالزنك إلى قلة محتوى الأوراق من النتروجين والفسفور والمنجنيز والحديد ، بينما أدى الرش بالزنك إلى زيادة محتوى الأوراق من الماغنسيوم والزنك.

٤- تأثير التداخل: لم يكن للتداخل بين العوامل الثلاثة أى تأثير معنوى على جميع الصفات المدروسة.

ويمكن التوصية عند زراعة الكرنب (صنف برونزويك) تحت ظروف منطقة النوبارية (أراضى جيرية) بما يلى:

١- التسميد بـ ٨٠ كجم نيتروجين للفدان.

٢- شتل النباتات على ٣٠ سم.

٣- الرش الورقى بالزنك المخلبى بتركيز ١ جم/لتر.