EFFECT OF BIOFERTILIZATION AND CHEMICAL NITROGEN FERTILIZER LEVELS AND SOURCES ON CAULIFLOWER PLANTS

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ABSTRACT

Two experiments were carried out during the two successive growing seasons of 2005/06 and 2006/07 in the Experimental Farm of Sakha Agricultural Research Station, Kafr elsheikh Governorate, Egypt. This work aimed to study the effect of biofertilizer (Halex – 2), different N levels (13.7, 27.4, 41 kg N/fed) and two nitrogen sources (urea, 46% N and ammonium nitrate, 33.5% N) on growth, head yield and quality of cauliflower plants (cv. Amshery)

The results of this study indicated that the combination of biofertilizer (Halex-2) and the highest level of nitrogen (41kg N) with both sources (urea and ammonium nitrate) produced, in the most cases, the highest vegetative growth parameters, head quality, average head weight, total head yield, total chlorophyll and total nitrogen compared with using either of Halex-2 urea or ammonium nitrate alone. Urea as a nitrogen source was more suitable for cauliflower than ammonium nitrate. It can be recommended, that the use of biofertilizer (Halex-2) with chemical fertilizer at rate (27.4 kg N/fed) gave the same head yield compared with the recommended nitrogen level (41 kg N/fed) without biofertilizer, hence reduce N-fertilizer rate about 13.7kg N/fed and consequently reduce the cost of cauliflower production.

Key words:biofertilizer, N fertilizer, N-sources, cauliflower.

INTRODUCTION

Cauliflower (*Brassica oleracea* L. var. *botrytis)* is a very popular vegetable crop around the world, especially in USA and Europe. Besides, its appreciable contents of thiamin, riboflavin, niacin, potassium, magnesium, iron and protein. Also, it has fairly high vitamins A and C and folic acid contents (Yamaguchi, 1983).

Cauliflower is grown for clusters of unopened flowers. The total cultivated area in Egypt was about 10533 feddans, which yielded 117944 tons (according to the statistics data of Ministry of Agriculture, 2007).

Nitrogen is considered one of the major essential elements for plant growth. Plants require large quantities of Nitrogen; since it is the basic constituent of proteins and nucleic acids (Chandrasekar *et al.*, 2005). The continuous rising of the costs N fertilizers and the possibility of subsequent environmental pollution imposed some restrictions on their extensive usage.

Biofertilizers are microbial inoculants which are used for application to seed or soil to increase soil fertility, with the objective of increasing number of such micro – organisms and to accelerate certain microbial processes in the rhizosphere of the inoculated plants. Goredaria *et al.*, (1997) concluded that the use of biofertilizers can substitute for a certain amount of mineral N particularly in the production of organic food. The application of biofertilization had positive effects on both plant growth and enhancement of N uptake (Galal *et al*, 2000). In this concern, El-Haddad *et al.* (1993) concluded that utilization of biofertilizers is considered a promising alternative instead of chemical fertilizers for improving productivity and quality of vegetables.

Recent attention has been a trend of producing nitrogen fertilizer having high nitrogen concentration, with eliminating some industrial processes to reduce the cost of nitrogen unit. So, the nitrogen sources can play an effective role in this concern. Urea has positive effects on many vegetable crops compared with ammonium nitrate (Farag and Abdel Aal, 1989 on spinach; Moustafa *et al.*, 1992 on cabbage and Saif 1991 on sugar beet). Meanwhile, Richardson and Hardgrave (1992) found that ammonium nitrate had the higher yield of head lettuce than urea. On the other hand, Mazrouh (1994), Agwah *et al.* (1989) and Osman *et al.* (1987) found that N sources had no effect on vegetative growth of some vegetables.

This study aimed to investigate the effect of Halex – 2 as a biofertilizer with two mineral N fertilization sources in the form of urea or ammonium nitrate at three levels on growth, head yield and quality of cauliflower.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station Farm during the successive winter seasons of 2005/06 and 2006/07. The soil used was loamy clay with the following characteristics: clay%(49.17),silt% (26.1), sand% (24.7), organic matter%(1.6), available N mg^{-1}(28), available P mg^{-1}(5.8) available K mg^{-1}(214),pH (8.2) and EC (2.4) dSm^{-1}.Cauliflower (cv. Amshery) transplants were planted on 16th and 22nd October in the first and second seasons, respectively. The experimental plot contained 5 rows, 1.25 m in length and 0.80 m in width, making an area of 5 m^2.

The biofertilizer (Halex – 2) contained a mixture of growth promoting N – fixing bacteria of the genera *Azotobacter*, *Azospirillum* and *Klebsiella* which was provided from the Biofertilization Unit, Plant Pathology Dept., Fac. Agric. Alex. Univ.

Two N sources were tested: ammonium nitrate (NH_4NO_3, 33% N) and urea (CO $(NH_2)_2$, 46% N) were applied at three nitrogen levels of 13.7, 27.4 and 41 kg N/fed.

The experiments included 9 treatments as follows:

1- Halex-2 alone
2- Urea alone (41 kg N/fed.)
3- Ammonium nitrate alone (41 kg N/fed.)
4- Halex-2 + urea (13.7 kg N/fed.)
5- Halex-2 + urea (27.4 kg N/fed.)
6- Halex-2 + urea (41 kg N/fed.)
7- Halex-2 + ammonium nitrate (13.7 kg N/fed.)
8- Halex-2 + ammonium nitrate (27.4 kg N/fed.)
9- Halex-2 + ammonium nitrate (41.0 kg N/fed.).

Just before transplanting, transplant seedling roots were dipped in a suspension of Halex–2 for 30 minutes, while seedlings of the uninoculated control were dipped in distilled water.

Nitrogen fertilizer of the two sources was directly applied as a soil application in two equal portions at 21 days after transplanting and 30 days later.

The amounts of mineral P and K fertilizers were used as recommended by Ministry of Agriculture (75 kg potassium sulphate 48% K_2o and 150 kg calcium superphosphate 15.5 P_2o_5). All cultural

practices such as irrigation, cultivation, pests and diseases control and others were carried out whenever necessary.

Data recorded:

1- Vegetative growth: Number of leaves plant, leaves weight (g) / plant and stem length (cm).

2- Head yield:

Average head weight (kg.), total head yield per plot (kg) and feddan (ton).

3-Head quality characteristics: Head diameter, head height (cm) and head perimeter.

Data of vegetative growth and head quality were determined for three plants in each plot that were randomly taken at the first of harvesting season

4- Chemical constituents:

Chlorophyll content with SPAD – 501 (a portable leaf chlorophyll meter, Minolta) (Marquard and Timpton, 1987) on the recently fully mature expanded leaf.

Both leaves dry matter and head dry matter %, were determined by drying samples to leaves and heads at 70 °C until a constant weight.

Total nitrogen was determined with microkjeldahl method according to Chapman and Pratt (1961).

The experimental design was a randomized complete blocks design with 4 replicates in both seasons. Data were tested by analysis of variance (Little and Hills, 1972). Duncan's multiple range test was used for the comparison among the treatment means (Duncan, 1965).

RESULTS AND DISCUSSION

1-Vegetative growth:

Data presented in Table (1) show that all the studied vegetative growth parameters were significantly influenced by the different fertilizer treatments, Halex+urea 3 had the highest mean values of number and weight of leaves in both seasons followed by Halex+ammonium nitrate, while either Halex or ammonium nitrate alone had the lowest values in both seasons.

Concerning stem length, Halex+ ammonium nitrate 3 had the highest values followed by Halex+urea 3 and Halex+urea2, while the lowest values were obtained from Halex alone treatment.

Data in Table (1) show also that the combination of biofertilizer (Halex) and chemical fertilizer at different levels and sources produced better results than using either Halex, urea or ammonium nitrate alone. In addition, urea improved all the parameters previously mentioned compared with ammonium nitrate.

The favorable effect of the combination between Halex-2 and chemical N-fertilizer on vegetative growth parameters might be attributed to the fact that Halex-2 contains a mixture of growth promoting N- fixing bacteria of genera *Azospirillum*, *Azotobacter* and *Klebsiella* which may induce growth directly by production of phytohormones (Noel *et al.*, 1996). In this concern, Jagnow *et al.*, (1991) reported that *Azospirillum* and *Azotobacter* strains produced adequate amounts of IAA and cytokinins. The present data are in agreement with those of Abd El Fattah and Sorial(2000)on squash, Midan and Sorial(2006) on lettuce and Abd El Fattah *et al.*,(2003) on spinach.

The favourable results of urea compared with ammonium nitrate are in agreement with Moustafa *et al.*, (1992) on cabbage.

2-Head yield and its compounds:

The present results in Table (2) show that, average head weight significantly affected by the different fertilizer treatments, Halex + urea 3 had the highest mean values in both seasons, followed by Halex + ammonium nitrate 3. In contrast, the lowest values were obtained from Halex alone treatment. Also, data in the same table show that urea as N source increased the tested physical characters compared with ammonium nitrate.

Data shown in Table (2) and Fig. (1) reveal that, total yield was significantly affected by the different fertilizer treatments; Halex + urea 3 had the highest yield followed by Halex and ammonium nitrate 3, while the lowest total yield was obtained from Halex-2 alone without N mineral fertilizer, in both seasons. Data in Table (2) show, also, that the combination between Halex and ammonium nitrate in the different levels significantly increased total cauliflower yield more

than ammonium nitrate. On the other hand, urea as N source increased total head yield more than the other source, (ammonium nitrate).

Table (1): Effect of Halex biofertilizer and chemical nitrogen fertilizer levels and sources on vegetative growth parameters of cauliflower plants in 2005/06 and 2006/07 seasons.

Treatments	No. of leaves /plant		Leaves weight /plant (g)		Stem length (cm)	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
Halex	17.9 gh*	17.80 g	720.00 h	700.00 i	11.50 d	12.23 e
Urea	18.27 g	19.00 f	940.00 e	995.00 e	13.50 b	13.57 c
Ammonium nitrate	17.77 h	18.23 g	790.00 g	765.00 g	13.00 bc	12.77 d
Halex +urea1	21.00 e	19.00 f	800.00 g	830.00 g	12.33 c	13.40 c
Halex +urea2	24.00 c	23.30 c	1020.0 c	1210.00 c	13.50 b	13.60 c
Halex + urea3	25.93 a	25.00 a	1300.0 a	1350.0 a	13.60 b	14.03 b
Halex +ammonium nitrate1	20.00 f	20.17 e	830.00 f	895.00 f	13.00 bc	12.83 d
Halex +ammonium nitrate2	22.90 d	22.00 d	990.00 d	1120.0 d	13.00 bc	12.97 d
Halex +ammonium nitrate3	24.97 b	24.03 b	1200.0 b	1270.0 b	14.90 a	14.73 a
F test	**	**	**	**	**	**

Urea1, Ammonium nitrate 1 = 13.7 kg N/fed. Urca2, Ammonium nitrate 2 = 27.4 kg N/fed. Urea3, Ammonium nitrate 3 = 41.0 kg N/fed.

*values marked with the same alphabetical letter (s) are not significantly different, using Duncan's test at 0.05 level.

Table (2): Effect of Halex biofertilizer and chemical nitrogen fertilizer levels and sources on head yield of cauliflower plants in 2005/06 and 2006/07 seasons.

Treatments	Average head weight (kg)		Total yield (Ton / fed.)	
	2005/06	2006/07	2005/06	2006/07
Halex	0.60 e*	0.70 h	5.943 g	6.323 i
Urea	0.93 c	0.97 c	8.596 c	9.766 c
Ammonium nitrate	0.67 de	0.83 f	6.065 f	7.957 h
Halex +urea1	0.68 de	0.90 e	6.095 f	8.147 g
Halex +urea2	0.90 c	0.95 cd	8.276 d	9.143 e
Halex + urea3	1.40 a	1.33 a	12.578 a	13.178 a
Halex +ammonium nitrate1	0.69 d	0.77 g	6.908 e	8.383 f
Halex +ammonium nitrate2	0.88 c	0.91 de	8.307 d	9.348 d
Halex +ammonium nitrate3	1.15 b	1.20 b	10.838 b	11.712 b
F test	**	**	**	**

Urea1, Ammonium nitrate 1 = 13.7 kg N/fed. Urea2, Ammonium nitrate 2 = 27.4 kg N/fed. Urea3, Ammonium nitrate 3 = 41.0 kg N/fed.

*values marked with the same alphabetical letter (s) are not significantly different, using Duncan's test at 0.05 level.

The favorable effect of the combination between Halex-2 and chemical fertilizer on head yield could be due to enhancing vegetative growth (Table, 1), N% and total chlorophyll content (Table, 4). These results are in the same line with those obtained by Barakat and Gabr(1998), Chandrasekar *et al.*, (2005), El-waraky and Kasem (2007).

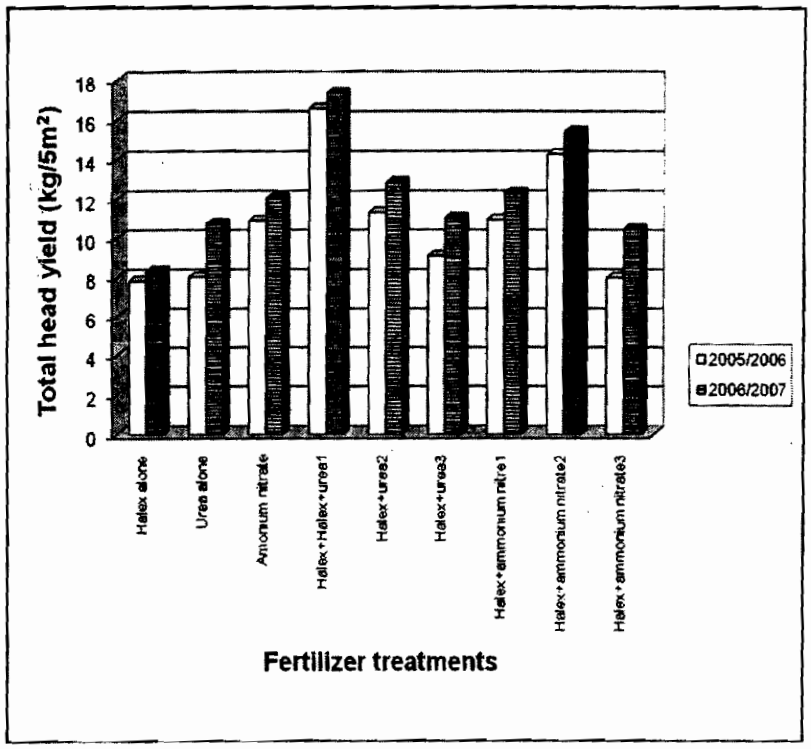

Fig.(1): Total head yield of cauliflower plants as affected by of Halex-2 biofertilizer and chemical nitrogen fertilizer levels and sources in 2005/06 and 2006/07 seasons.

Table (3): Effect of Halex biofertilizer and chemical nitrogen fertilizer levels and sources on head quality of cauliflower plants in 2005/06 and 2006/07 seasons.

Treatments	Head diameter (cm)		Head height (cm)		Head perimeter (cm)	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
Halex	23.30 bc*	22.97 b	12.50 bc	12.40 de	55.10 e	56.70 c
Urea	24.00 b	23.10 b	13.00 b	13.10 c	56.00 d	57.7 bc
Ammonium nitrate	20.33 de	19.33 e	12.00 c	12.20 e	57.00 c	59.17 ab
Halex +urea1	22.17 d	21.50 d	13.00 b	12.70 cd	60.17 ab	60.70 a
Halex +urea2	22.27 d	22.43 bc	13.13 b	13.53 b	60.27 a	60.80 a
Halex + urea3	26.10 a	25.20 a	14.17 a	14.33 a	60.00 ab	60.00 a
Halex +ammonium nitrate1	18.00 f	17.5 f	11.00 d	11.5 f	59.5 ab	60.30 a
Halex +ammonium nitrate2	22.40 cd	22.00 cd	11.00 d	11.70 f	59.30 b	59.70 a
Halex +ammonium nitrate3	25.93 a	24.80 a	14.30 a	13.97 a	59.83 ab	61.00 a
F test	**	**	**	**	*	**

Urea1, Ammonium nitrate 1 = 13.7 kg N/fed. Urea2, Ammonium nitrate 2 = 27.4 kg N/fed. Urea3, Ammonium nitrate 3 = 41.0 kg N/fed.

*values marked with the same alphabetical letter (s) are not significantly different, using Duncan's test at 0.05 level.

Concerning head perimeter, the combination between biofertilizer (Halex-2) and chemical fertilizer with different levels and sources produced better results than using either Halex-2, urea or ammonium nitrate alone, while using of Halex-2 alone.

The increase in head quality could be due to increasing vegetative growth parameters, which increased photosynthetic capacity of the plant. These results are in agreement with those obtained by Vavrina *et al.*, (1993) on Chinese cabbage, El-Afifi *et al.*, (2002) on cabbage, El-Shal *et al.*,(2002) on lettuce and Saad (2002) on squash.

4-Chemical constituents:

The present results in Table (4) indicate that leaves dry matter was significantly affected by fertilizer treatments, the highest values were obtained from Halex+ urea 3 in both seasons. However, no significant differences were observed with using either urea alone or Halex +

ammonium nitrate 3 in the first season. On the other hand, Halex alone gave the lowest leaves dry matter.

Table (4): Effect of Halex biofertilizer and chemical nitrogen fertilizer levels and Sources on chemical characters of cauliflower plants in 2005/06 and 2006/07 seasons.

Treatments	Leaves dry matter %		Head dry matter %		chlorophyll content (SPAD)		Nitrogen %	
	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07	2005/06	2006/07
Halex	7.83 e*	8.90 g	51.93 a	52.10 a	51.93 a	52.10 a	4.20 e	4.30 e
Urea	10.77 a	11.13 c	51.00 b	50.87 bcd	51.00 b	50.87 bcd	4.50 bcde	4.40 e
Ammonium nitrate	8.89 d	10.00 f	50.73 bc	50.50 cd	50.73 bc	50.50 cd	4.80 b	4 70 d
Halex +urea1	10.15 c	10.60 e	50.20 c	50.40 cd	50.20 c	50.40 cd	4.33 de	4.37 e
Halex +urea2	10.25 c	10.79 cde	50.83 bc	51.40 abc	50.83 bc	51.40 abc	4.63 bcd	4.67 d
Halex + urea3	10.73 a	13.00 a	52.03 a	52.5 a	52.03 a	52.5 a	5.30 a	5.20 b
Halex +ammonium nitrate1	10.06 c	10.73 de	50.00 bc	49.83 d	50.00 bc	49.83 d	4.43 cde	4 47 e
Halex +ammonium nitrate2	10.47 b	11.07 cd	50.83 bc	50.37 cd	50.83 bc	50.37 cd	4.73 bc	4.93 c
Halex +ammonium nitrate3	10.74 a	12.27 b	52.10 a	51.83 ab	52.10 a	51.83 ab	5.53 a	5.50 a
F test	**	**	**	**	**	**	**	**

Urea1, Ammonium nitrate 1 = 13.7 kg N/fed. Urea2, Ammonium nitrate 2 = 27.4 kg N/fed.
Urea3, Ammonium nitrate 3 = 41.0 kg N/fed.
*values marked with the same alphabetical letter (s) are not significantly different, using Duncan's test at 0.05 level.

Regarding head dry matter, data in Table (4) show that, both Halex + urea 1 and Halex + ammonium nitrate 2 gave a significant increase in head dry matter in both seasons, while the lowest values were obtained from Halex + ammonium nitrate 3. This result is in agreement with that of El-Gamal, (1996) and Midan and Sorial, (2006).

As for total chl., it was significantly affected by the different fertilizer treatments. Generally, Halex + urea 3, Halex + ammonium

nitrate 3 or Halex alone increased total chl. while no significant differences were observed among the other treatments in both seasons.

Concerning total nitrogen, either Halex + urea 3 or Halex + ammonium nitrate 3 treatments gave the highest values, while the lowest values were obtained from Halex and Halex with low nitrogen level for each nitrogen source. The present results agree with those reported by Abd Alla and El-Knany, (2009) who reported that the combination between biofertilizer and chemical fertilizer gave the highest values of total chl. and mineral uptake of cucumber plants.

This result could be related to increasing N% since chlorophyll particle is a prophyrin of Mg which contains 4 atoms of N, subsequently more chlorophyll was formed (El- Gamal, 1996 and Aroiee and Omidbaigi, 2004).

It can be concluded that using the highest N level (41.0 kg N/fed.) combined with biofertilizer (Halex-2) produced the highest growth and head yield. In the same time, cauliflower plants were preferred urea application for production. Additionally, the use of halex-2 combined with chemical N-fertilizer at (27.4 kg N/fed) produced in most cases equally head yield production with the recommended N fertilizer (41.0 kg/fed).

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الملخص العربى

تأثير السماد الحيوى وصور و مصادر التسميد النيتروجينى على نباتات القنبيط .

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**قسم البساتين – كلية الزراعه جامعة كفر الشيخ – مصر.

أجريت هذه التجربة فى موسمى ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ بالمزرعة البحثية بمحطة البحوث الزراعية بسخا محافظة كفر الشيخ لدراسة تأثير استخدام السماد الحيوى (هالكس – ٢) ومستويات مختلفة من التسميد الأزوتى (١٣،٧ – ٢٧،٤ – ٤١ كجم N / فدان) ومصدرين للسماد النيتروجينى على النمو الخضرى و المحصول و الجودة لنباتات القنبيط (صنف أمشيرى)

و لقد أظهرت النتائج ما يلى : استخدام السماد الحيوى (هالكس-٢) مع المستوى المرتفع من النيتروجين (٤١ كجم ن) من أى من المصدرين(اليوريا أو نترات الامونيوم) ادى فى اغلب الاحيان لزيادة صفات النمو الخضرى و جودة الرأس و متوسط وزن الرأس و المحصول الكلى للرؤوس و كذلك محتوى الاوراق من الكلوروفيل و النيتروجين (%) مقارنة باستخدام اى من الهالكس-٢ او اليوريا او نترات الامونيوم كل منهم منفردا.

كما يعتبر استخدام سماد اليوريا منفردا اكثر ملائمة لانتاج القنبيط عن استخدام نترات الامونيوم منفردا.

ويمكن التوصيه باستخدام السماد الحيوى (الهالكس-٢)مع تقليل معدل السماد الكيماوى (٢٧,٤ كجم ن/ فدان) حيث ينتج نفس محصول الرؤوس مقارنة بمعدل النيتروجين الموصى به (٤١ كجم ن/ فدان) بدون إستخدام سماد حيوى و بالتالى تقليل معدل بنحو ١٣,٧كجم N /فدان وبالتالى تقليل التكاليف التسميد النيتروجينى لانتاج القنبيط .