Efficiency of Inorganic and Organic Nitrogen Fertilization on Cauliflower (*Brassica oleraceae* var. *botrytis*, L.) Curds Quality

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ABSTRACT

Two experiments were established at the Experimental Station Farm, Faculty of Agriculture, Alexandria University in two winter seasons of 2006/2007 and 2007/2008 to evaluate the effects of application three levels of inorganic N fertilizer (40, 80 and 120 kg N fad.$^{-1}$ as ammonium nitrate) and control treatment (without addition, soil N), three rates of chicken manure (5, 10 and 15 m^3 fad.$^{-1}$) in addition to control treatment (without application chicken manure) as well as their interactions effect on curd quality of cauliflower "Amshiry" cultivar.

The results showed positive effects of using either inorganic or organic N fertilizers on cauliflower curds quality characters. The inorganic N form was more effective in the presence than in absence of organic fertilizer concerning curds quality. The application of high level of inorganic N fertilizer (120 kg N fad.$^{-1}$), significantly, increased curd weight, phenolic compounds, concentrations of Ca and Mg of curds, and significantly decreased inflorescence stalks length of cauliflower curds. However, both medium and high levels of inorganic N form (80 and 120 kg N fad.$^{-1}$) augmented curd diameter, dry matter content, protein nitrogen, true protein, non protein nitrogen as well as concentrations of some macro and micro-nutrient (N, P, K, Na and Zn) of curds compared with other treatments. Chicken manure at the highest rate (15 m^3 fad.$^{-1}$) reflected clear superior in all curds quality characters under consideration. Positive changes in all studied parameters *viz.* curd quality characteristics and nutritional value were obtained in response to the collaborative effect of both inorganic and organic N fertilization. The results of the current study indicated that combination of inorganic N level (80 kg N fad.$^{-1}$ as NH_4NO_3) with chicken manure rate (15 m^3 fad.$^{-1}$; i.e., 72 kg N fad.$^{-1}$) gave the superior curd quality characteristics with high nutritional values for cauliflower "Amshiry" cultivar under the study region conditions.

Key words: Cauliflower, chicken manure, curd quality, N fertilizer, nitrate content, phenolic compounds.

INTRODUCTION

Vegetable crops produced by using organic manures are gaining increasing popularity and importance because of the public perception that they may be of higher quality, less chemical residues and increases of health concern (Rani and Mallareddy, 2007).

In Egypt, there are several governmental initiatives to reduce the use of chemical fertilizers and compensate that by using organic fertilizers (Hasanin, 2007). Several researches are advocating the integrated nutrient management with organic and inorganic fertilizers to conserve the soil health as well as to obtain good quality product (Rani and Mallareddy, 2007). The importance of using organic fertilizer and decrease using inorganic fertilizer in plant production is one of the most important ways in health protection (Badawy *et al*., 2007).

Cauliflower (*Brassica oleraceae* var. *botrytis*, L.) is the second most important inflorescence vegetables after globe artichoke and before broccoli in many places of the world. It is an inexpensive winter crop and can be consumed as a fresh or frozen vegetable. In Egypt, cauliflower's curds are consumed cooked, fried, boiled and pickled. It is well known that, cauliflower have enormous nutritional and medicinal values due to its high contents of vitamins; i.e., C, K, B5 and B6, dietary fibers, folic acid, and minerals such as K, Mg, P, Zn and Fe (Nonnecke, 1989).

Concerning of health aspect has been raised the attention towards phytochemicals from different plant sources. Among phytochemicals, phenolic compounds may exert a protective role against various diseases, and can prevent the formation of cancer causing agents due to their antibacterial and antioxidant properties (Ramarathnam *et al*., 1997, Silva *et al*., 2004, and Sousa *et al*., 2008). Cauliflower represents one of the vegetables that contain polyphenolic compounds with good antioxidant activity (Ramarathnam *et al*., 1997).

Proper use of organic manures and inorganic N fertilizers is very essential not only for obtaining high yield and great quality but also to maintain soil health and sustainability for longer period (Rani and Mallareddy, 2007). Nitrogen is the most difficult element to manage in a fertilization system in order to ensure an adequate, but not excessive, amount of available N within the rhizosphere from planting to harvest (Sorensen *et al*., 1995) as high doses of N may

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cause excessive accumulation of nitrates or non protein nitrogen in different plant parts of some vegetables including cauliflower (Pimpini *et al*., 1973; Greenwood and Hunt, 1986; Lisiewska and Kmiecik, 1996 and Elia *et al*., 1998).

Little information is available on the integrated use of organic and inorganic N fertilization on cauliflower curds quality, macro- and micro-nutrient concentrations as well as nutritional value including phenolic compounds and nitrate content. Therefore, the current investigation was undertaken to evaluate the effect of applied inorganic N (NH_4NO_3) and organic N (chicken manure) fertilizers on curds quality characteristics. Also, to find out the best combination level of both inorganic and organic N forms used on nutritional value and chemical constituents of "Amshiry" cultivar cauliflower curds.

MATERIALS AND METHODS

Curds quality characters of cauliflower plants "Amshiry" cultivar were studied using two field experiments conducted at the Agricultural Experimental Station Farm, Faculty of Agriculture, Alexandria University through two successive growing winter seasons of 2006/2007 and 2007/2008.

Representative soil samples were collected from 0-30 cm soil depth, at random, to represent the experimental field after soil preparation and before adding chicken manure in both seasons. Samples of chicken manure used were also taken for analysis. The samples were air dried, crushed by wooden hammer, sieved through 2 mm sieve, thoroughly mixed and used to determine several physical and chemical characters. The pH and electric conductivity (E.C.) were determined in soil/water extract (1:2.5 w:v) and chicken manure/water extract (1:10 w:v). Calcium carbonate ($CaCO_3$) content of the soil was determined using Calcimeter method. Potassium dichromate method was used to determine organic matter (O.M.) content. Total nitrogen (N) was determined using Bauschi digestion and distillation apparatus. Available phosphorus (P) content of soil was extracted using sodium bicarbonate method. Available potassium (K) and magnesium (Mg) were extracted using ammonium acetate. The amounts of available Fe, Mn, Zn and Cu were extracted using DTPA method. All the previous methods were carried out according to Chapman and Pratt (1978) procedures.

Some physical and chemical characteristics of both soil and chicken manure samples are shown in Tables 1 and 2, respectively.

Organic fertilizer source and rates:

Chicken manure used was obtained from the Experimental Poultry Station, (Abies region), Faculty of Agriculture, Alexandria University. The quantity of chicken manure used is divided into three rates; 05, 10 and 15 m^3 $fad.^{-1}$ in addition to control treatment (without chicken manure addition). These three rates represent 24, 48 and 72 kg N $fad.^{-1}$. The organic manure rates were incorporated and mixed thoroughly with the surface soil layer (0-20 cm) one week before transplanting (Table 3).

Inorganic N fertilizer source and levels:

Ammonium nitrate (NH_4NO_3, 33.5% N) was used as inorganic N fertilizer based on the results of previous study obtained by Abdel-Razzak *et al*., (2008) which concluded that ammonium nitrate fertilizer gave the best curds quality of the same cauliflower cultivar "Amshiry" comparing with other commercial inorganic N fertilizers as ammonium sulphate and urea. Inorganic N levels were planned to be 0, 40, 80 and 120 kg N $fad.^{-1}$. These N levels were performed by combining three equal divided side dressings and added at approximately 3-4 weeks intervals. The actual inorganic N levels used and the dates of N fertilization application are shown in Table (3). All levels of N fertilizer were applied to the soil surface by hand immediately after labor weed control and followed by irrigation. Phosphorus and potassium fertilizers were broadcast-applied to the all experimental plots at 100 kg $fad.^{-1}$ as calcium supper phosphate (15.5% P_2O_5) and potassium sulphate (48.0% K_2O). Phosphate fertilizer was applied as a basal dose during soil preparation; whereas, potassium fertilizer was applied twice, half was applied as a basal dose and the other half quantity was added one month after planting.

Table 1. Some physical and chemical soil properties of the experimental sites during 2006/2007and 2007/2008 seasons

Season	Particle size distribution (%)			Texture class	O.M. (%)	$CaCO_3$ (%)	pH	E.C. ($dSm.^{-1}$)
	Sand	Silt	Clay					
2006/2007	17	24	59	Clay loam	1.7	6.9	7.9	1.86
2007/2008	13	36	51	Clay loam	2.0	7.3	7.4	1.90

	Available nutrients								
	Macro-nutrients (mg/100gm)					Micro-nutrients (ppm)			
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
2006/2007	60	9.0	76	58	58	10.0	48.5	1.12	7.10
2007/2008	70	6.7	45	70	60	12.3	30.0	1.50	7.90

Table 2. Some physical and chemical characteristics of chicken manure used during 2006/2007 and 2007/2008 seasons

Characteristics	Season	
	2006/2007	2007/2008
Moisture content (%)	47	45
Weight 1m^3 of manure (Kg)	374	400
Organic matter (%)	33.9	31.5
Organic Carbon (%)	19.7	18.3
Nitrogen (%)	1.3	1.2
C/N ratio	15:1	15:1
[x] pH	7.6	8.0
[x] Total dissolved salts (%)	0.47	0.38
[x] Macro-nutrients (%)		
[y] P	0.12	0.17
K	1.80	1.50
Ca	0.44	0.80
Mg	0.14	0.17
[x] Micro-nutrients (ppm)		
Fe	60.70	40.90
Mn	6.10	9.00
Zn	18.50	20.00
Cu	36.50	30.50

[x] (1:10 w : v) chicken manure : water extract.
[y] Total P content determined based on chicken manure digestion (Isamu, 1972).

Table 3. Dates of chicken manure application, transplanting, levels of mineral N application, first and last harvest of "Amshiry" cv. cauliflower in two winter seasons of 2006/2007 and 2007/2008

Planting seasons	Date and rate of chicken manure fad.$^{-1}$		Transplanting date	Levels of mineral N NH_4NO_3 (kg N fad.$^{-1}$)	Dates of mineral N applications			First harvest	Last harvest
					First	Second	Third		
	17 Nov.				10 Dec.	11 Jan.	2 Feb.		
	(m^3)	(kg N)							
2006/2007	00	00.00	22 Nov.	00	00	00	00	26 Feb.	29 Mar.
	05	24.31		40	13.33	13.33	13.33		
	10	48.62		80	26.67	26.67	26.67		
	15	72.93		120	40.00	40.00	40.00		
	20 Nov.				19 Dec.	18 Jan.	10 Feb.		
	(m^3)	(kg N)							
2007/2008	00	00.00	26 Nov.	00	00	00	00	5 Mar.	3 Apr.
	05	24.00		40	13.33	13.33	13.33		
	10	48.00		80	26.67	26.67	26.67		
	15	72.00		120	40.00	40.00	40.00		

Healthy cauliflower seedlings of "Amshiry" cultivar (three- to four-leaves stage) were transplanted on one side of the ridge at a distance of 50 cm on November 22nd and 26th in 2006 and 2007 seasons, respectively (Table 3).

The normal cultural practices used for the cauliflower production, i.e. irrigation, weed and pest control were accomplished according to the common cultivation in cauliflower field production.

Experimental design

Three replications of field experiment were carried out in a split-plot system with a randomized complete blocks design (R.C.B.D.). Each replicate consisted of 16 treatments representing all combinations among the four levels of inorganic N fertilizer (0, 40, 80 and 120 Kg N fad.$^{-1}$, NH4NO3) and four rates of organic fertilizer (0, 5, 10 and 15 m^3 fad.$^{-1}$, chicken manure).

The main plots were assigned to the levels of inorganic N fertilizer, while chicken manure rates occupied as sub-plot treatments and they were placed randomly in each main plot. Each sub-plot consisted of four rows 4.0 m length and 0.7 m width and the plot area was 12 m^2. A guard row was left without planting to separate each two adjacent sub-plots.

Data recorded:

Cauliflower curd is a mass of abortive florets attached to thick, hypertrophied branches at the top of a short thick stem; as a peculiar inflorescence consisting of thick, fleshy, strongly ramified flower stalk; as edible malformed and condensed flowers and flower stems (Nonnecke, 1989).

During plants maturity period (90-130 days after transplanting), five randomly selected cauliflower plants of each plot were cut at ground level at harvestable size, then separated into wrapper leaves, rest of leaves, curds and stems. The five curds were graded to determine the following characters:

(a) Curd weight (g); cauliflower curds were cut, trimmed to marketable form, and used to determine the average weight of five net curds.

(b) Curd diameter (cm); it was measured across the widest part of the curd.

(c) Inflorescence stalks length (cm); it was measured from three different sides from starting of branch up to the top of the curd.

(d) Curds dry matter (%); the content of curd's dry matter was determined according to the Association of Official Analytical Chemists (AOAC, 1995) by drying 5 ± 0.5 g curd samples at 110°C in a drying oven until a constant weight.

Nutritional value of cauliflower curds:

(a) Protein nitrogen and non protein nitrogen of cauliflower curds were determined using the micro-Kjeldahl method (AOAC, 1995). The non protein nitrogen was determined after precipitation of protein by using Trichloro acetic acid 30%.

(b) The true proteins contents were calculated using a conversion factor (6.25) as following; the true protein = protein N × 6.25.

(c) Nitrate content of curds was determined using magnesium oxide-Devarda Alloy stem distillation method (Cottenei *et al*., 1982).

(d) Polyphenol compounds of curds as tannic acid were determined according to the colorimetric method proposed by Gutfinger, (1981). Five g of fresh curds was extracted with 100 ml of (methanol/water solution 3/1). After filtration into 100-ml volumetric flask, the total volume of extract was complete to mark. One ml from the final extract was transferred into a 25 ml volumetric flask and a Folin-Ciocalteau reagent (0.5 ml) was added. Three min later 1.0 ml of a saturated sodium carbonate solution was added and the flask was filled up to volume with distilled water and stored in the dark for one hour. A blue color formation indicated the presence of phenols. The absorbance of the solution was measured at 725 nm by spectrophotometer against blank.

(e) Determination of macro-nutrients; N, P, K, Ca and Mg and micro-nutrients; Na, Fe, Mn, Zn, and Cu concentrations (Chapman and Pratt, 1978).

Cauliflower curds sample preparation for minerals analysis:

Small portions of cauliflower curds were washed carefully by diluted HCL (0.001 N), followed by a tap water and finally two successive distilled water. The crud pieces were dried at 70°C for constant weight, and grounded in stainless steel mill to pass through 0.5 mm sieve. Based on Jones *et al*., (1991) method, the curd sample (1.0 g) was subjected to ashing in a muffle furnace at 500°C for 6 hrs. After cooling in disscator, ash was dissolved by adding 5ml concentrated mineral acids mixture (3:1 HCl: HNO_3 conc.), transferred quantitatively into 100ml volumetric flask and completed to mark with de-ionized water. The ash solution was homogenized and filtered through ashless filter paper in a polythene container with sealed cover and kept refrigerated for the minerals analysis.

Nitrogen (N) concentration; was determined using the micro-Kjeldahl method (AOAC, 1995). Phosphorus (P)concentration; was estimated using Spectrophotometer (Zaies).

Potassium (K), Sodium (Na) and Calcium (Ca) concentrations; were determined, using Flame photometer (Jenway, PFP7).

Concentrations of Mg, Fe, Mn, Zn, and Cu were determined by using Atomic Absorption Spectrophotometer (GBC 932 AA).

Statistical Analysis:

The obtained data were subjected to statistical analysis using the analysis of variance procedure as outlined by Co-Stat Software computer program for statistics (2004). Means for the two factors under consideration and their interactions were compared according to Duncan's multiple range test at a probability error of 5% level (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

I. Curd growth characteristics

(A) Effect of inorganic nitrogen fertilizer levels:

Table (4) showed that either curd weight or curd diameter was, significantly, increased by increasing the inorganic N levels in both seasons. In this direction, the highest level of inorganic N fertilizer; 120 kg N fad.$^{-1}$ was more effective for increasing curds weight and diameter progressively than those of other lower treatments levels. Addition of 120 kg N fad.$^{-1}$ increased both curd weight and diameter by 7.96%, 11.47% and 9.06%, 13.18% in the first and second seasons, in succession compared with control treatment (zero level; soil N). These results are in the same line of the recent findings of Abdel-Razzak *et al*., (2008) who reported that both curd weight and diameter of cauliflower, significantly, increased linearly with increasing levels of applied mineral N fertilizer up to 120 kg N fad.$^{-1}$. Also, Bjelic (1996) and Thompson *et al*., (2000) reported that curd weight and diameter, were generally responsive to mineral N application compared with control treatment. On the other hand, the medium and high N levels (80 and 120 kg N fad.$^{-1}$), significantly, decreased inflorescence stalks length than control treatment in both seasons. That might be related to a limiting N supply (40 kg N fad.$^{-1}$ or zero N, soil N) is associated with curd looseness. Such looseness of the curd can be regarded as the onset of bolting. Then the peduncles start to separate and elongate with the lowest level of inorganic N fertilization (Rather *et al*., 1999). A significant increase was observed in the curds dry matter content as a result of application of any level of inorganic N fertilizer comparing with control treatment, in both seasons. A similar trend was obtained by Rather *et al*., (1999) and Farrag *et al*., (2000), who found that increasing mineral N rates, significantly, increased dry matter content of cauliflower curds. This could be explained by the fact that N is one of the most important constituents of all proteins and nucleic acids and hence of all protoplasm and chlorophyll. This would supply the more rapidly the synthesized carbohydrates that necessary for more dry matter accumulation in plant organs (Russel, 1973).

(B) Effect of organic nitrogen fertilizer (chicken manure) rates:

Table (4) showed significant linear increment of chicken manure rates up to 15m^3 fad.$^{-1}$ in curds weight, diameter and dry matter content during both seasons of experiments. The highest organic N rate; 15 m^3 fad.$^{-1}$ recorded maximum curd weight (1.827, 1.879 kg), curd diameter (38.06, 33.92 cm) and curd dry matter content (10.34, 10.29 %) in both seasons, respectively. These values are corresponding for (28.12%, 34.32%), (33.59%, 22.68%) and (14.63%, 12.83%) increases in curds weight, diameter, and dry matter content compared with control treatment (without chicken manure addition; soil organic matter) in the first and second seasons, in succession. The enhancement effect of chicken manure application could be related to the fact that, chicken manure is considered as a rich source of N and providing slow release of nutrients during the growth season (Hasanin, 2007). Therefore, it creates better nutrients absorption and favors the growth and development of good root system which in turn reflects better vegetative growth, photosynthetic activity and dry matter accumulation (Abou El-Magd *et al*., 2006). On the other hand, the same organic N rate; 15m^3 fad.$^{-1}$ recorded the minimum inflorescence stalks length (10.74, 9.31 cm) than other chicken manure rates in the first and second seasons, respectively. This result may attributed to the fact that chicken manure can offer quantity of N for soil micro-organisms activation, which are effective in nutrients availability through convert the nutrients from unavailable to available form for growing plants (El-Leboudi *et al*., 1984 and Solieman *et al*., 2006), which in turn, can give vigorous growth of cauliflower plants accordingly, decrease curds looseness.

(C) Effect of interaction (inorganic N levels x organic N rates):

Cauliflower curds characteristics were, significantly, improved by the collaborative addition of both inorganic N fertilizer and organic manure (Table 4). The highest values of curd weight (1.942 and 2.000 kg) and curd diameter (39.42 and 34.83 cm) were obtained by using the highest level of inorganic N (120 kg N fad.$^{-1}$) and the highest rate of chicken manure (15 m^3 fad.$^{-1}$) treatment followed by application the medium level of inorganic N (80 kg N fad.$^{-1}$) and the highest rate of chicken manure (15 m^3 fad.$^{-1}$) in both seasons, respectively. However, the later treatment (80 kg N fad.$^{-1}$) and the highest rate of chicken manure (15 m^3 fad.$^{-1}$) increased the percentage of curd dry matter (10.75% and 10.65%) followed by interaction treatment of the highest levels of inorganic N (120 kg N fad.$^-$1) and the highest rate of chicken manure (15 m^3 fad.$^{-1}$), particularly, in the first season. But, the differences between both later treatments were not high enough to be significant in the second one. These results may show the positive effect of inorganic N source used *viz*. ammonium nitrate which could increase decomposition rate of organic matter i.e., chicken manure and thereby release more nutrients in available form for growing cauliflower plants. On the other side, the lowest values of inflorescence stalks length (9.24, 8.92 cm) were recorded by using the highest level of inorganic N (120 kg N fad.$^-$1) and the highest rate of organic N (15 m^3 fad.$^{-1}$) in both seasons. The relatively short cauliflower inflorescence stalks length with higher applications of both inorganic and organic N fertilization could be explained perhaps by the curd tissue being softer at a high N availability, thereby having less physical resistance to inflorescence stalk elongation. Therefore, the inflorescence stalks increased in thickness and tended to become short and thick, which in turn can increase from curds quality; i.e., compactness. This finding is in agreement with Nonnecke, (1989), who clarified that the flower stem with branchlets of

Table 4. The characteristics of "Amshiry" cultivar cauliflower curds, at harvest, as influenced by different inorganic N fertilizer levels and chicken manure rates, during two seasons of experiments

Season		2006/2007				2007/2008			
Characters		Curd weight (kg)	Curd diameter (cm)	Inflorescence stalks length (cm)	Curd dry matter (%)	Curd weight (kg)	Curd diameter (cm)	Inflorescence stalks length (cm)	Curd dry matter (%)
(A) Inorganic N levels (NH_4NO_3, Kg N. fad.$^{-1}$)									
0		1.583 c	31.91 c	14.52 a	9.30 b	1.561 d	28.60 c	12.75 a	9.37 c
40		1.608 c	32.92 b	13.87 ab	9.75 a	1.618 c	31.15 b	11.87 ab	9.70 b
80		1.647 b	34.83 a	12.59 b	10.03 a	1.702 b	31.96 ab	11.42 b	9.97 a
120		1.709 a	34.80 a	12.52 b	9.88 a	1.740 a	32.37 a	11.12 b	9.92 a
(B) Organic N rates (Chicken manure, m^3 fad.$^{-1}$)									
0		1.426 d	28.49 d	16.35 a	9.02 d	1.399 d	27.65 d	15.08 a	9.12 d
5		1.567 c	32.50 c	13.89 b	9.60 c	1.601 c	30.33 c	12.35 b	9.57 c
10		1.727 b	35.42 b	12.52 c	10.02 b	1.741 b	32.19 b	10.42 c	9.98 b
15		1.827 a	38.06 a	10.74 d	10.34 a	1.879 a	33.92 a	9.31 d	10.29 a
(C) Inorganic N levels (NH_4NO_3, Kg N. fad.$^{-1}$) x Organic N rates (Chicken manure, m^3 fad.$^{-1}$)									
0	0	1.383 j	27.26 h	17.36 a	8.58 i	1.355 i	25.00 i	16.58 a	8.93 g
	5	1.525 hi	30.90 f	15.45 bc	9.22 gh	1.487 g	27.67 gh	13.42 cd	9.22 e-g
	10	1.674 e-g	33.11 e	13.56 d	9.41 f-h	1.612 ef	29.50 e-g	11.00 f-h	9.59 de
	15	1.750 b-e	36.37 bc	11.70 e	10.01 cd	1.792 c	32.25 cd	10.00 h-k	9.74 cd
40	0	1.424 j	28.11 gh	16.59 ab	9.21 gh	1.391 hi	27.17 h	15.25 b	9.11 fg
	5	1.533 hi	31.45 f	14.07 cd	9.57 e-g	1.560 f	31.00 d-f	12.50 de	9.69 cd
	10	1.695 d-f	34.89 cd	12.89 de	9.94 c-e	1.704 d	32.33 b-d	10.42 g-i	9.87 cd
	15	1.780 b-d	37.22 b	11.93 e	10.28 bc	1.816 c	34.08 a-c	9.33 i-k	10.12 bc
80	0	1.444 ij	29.37 g	15.57 b	9.07 h	1.429 gh	29.08 f-h	14.25 bc	8.99 g
	5	1.580 gh	34.04 de	12.82 de	9.69 d-f	1.667 de	31.17 d-f	12.17 ef	9.84 cd
	10	1.727 c-f	36.71 b	11.89 e	10.62 ab	1.802 c	33.08 a-d	10.25 g-j	10.41 ab
	15	1.838 b	39.21 a	10.09 f	10.75 a	1.910 b	34.50 ab	9.00 jk	10.65 a
120	0	1.452 ij	29.24 g	15.88 b	9.22 gh	1.421 g-i	29.33 e-g	14.25 bc	9.47 d-f
	5	1.631 fg	33.59 de	13.21 de	9.90 c-e	1.691 d	31.50 de	11.33 e-g	9.53 d-f
	10	1.811 bc	36.95 b	11.75 e	10.11 cd	1.848 bc	33.83 a-c	10.00 h-k	10.07 bc
	15	1.942 a	39.42 a	9.24 f	10.31 bc	2.000 a	34.83 a	8.92 k	10.63 a

cauliflower becoming thicker as they shorten to form a regular corymbs.

II. Nutritional value of cauliflower curds:

(A) Effect of inorganic nitrogen fertilizer levels:

Addition of inorganic N fertilizer improved the nutrient content of cauliflower curds (Table 5). All three levels of inorganic N had significant effect on the content of protein nitrogen and true protein in the first season compared with control treatment (soil N), while there were insignificant differences among these three levels. In the second one, significant differences were observed with the addition of 80 and 120 Kg N fad.$^{-1}$ compared with the lowest level of inorganic N (40 Kg N fad.$^{-1}$) and control treatment (zero level, soil N). Protein concentration in plants is highly dependent on N availability. The non-protein nitrogen increased significantly parallel with inorganic N fertilizer rate up to 80 Kg N fad.$^{-1}$ in both seasons. The levels of nitrate; the main constitute of non-protein nitrogen; and phenolic compounds increased significantly in correspond to the inorganic N levels as elevated from zero to 120 Kg N fad.$^{-1}$. With an increase in the inorganic N fertilization levels from 40 to 120 Kg N fad.$^{-1}$, the content of nitrate rose by 31.58% and 37.04% in the first and second seasons, respectively. The same result was indicated by Lisiewska and Kmiecik (1996), who reported that the content of nitrates in cauliflower increased by 33.0% by increasing N fertilization dose from 80 to 120 kg N ha^{-1}, confirming the role of inorganic N fertilization in the accumulation of nitrate (Greenwood and Hunt, 1986). Generally, nitrate accumulation in vegetables could be due to the imbalance between nitrate absorption and reduction by plants. When nitrate-N is adequate in soil, plants usually absorb much more nitrate than they can reduce. Therefore, reducing soil nitrate and nitrate absorption by plants are of great importance for the purpose of reducing nitrate accumulation in vegetables (Wang and Li, 2003). It is expected to get high content of nitrate in cauliflower curds as a result of using inorganic N levels compared with organic N rates in both seasons. The same result was obtained by Montemurro *et al*., (2008), who illustrated in lettuce plants that mineral fertilizer treatments showed the highest values of nitrate in both leafstalks and leaves than those reached by organic treatments.

Dietary polyphenols represent a group of secondary metabolites which widely occur mainly in fruits, vegetables, and cereals. These are mostly derivatives, and/or isomers of flavones, isoflavones, flavonols, catechins, and phenolic acids (Duthie *et al*., 2000). Our results indicated that addition of different levels of inorganic N fertilizer caused gradual increase in phenolic acids content of curds from 2.75 and 2.78 up to 3.15 and 3.13 mg/DM in the first and second seasons, respectively.

(B) Effect of organic nitrogen fertilizer (chicken manure) rates:

The organic N fertilizer exhibited similar effect to the inorganic one (Table 5), as the rate of organic N fertilizer increased the protein and non protein nitrogen, true protein, nitrate content and phenolic compounds are increased in both seasons. The medium and high rates of chicken manure (10 and 15 m^3 fad.$^{-1}$) have comparable effect on protein nitrogen and true protein levels in the first season and nitrate level in both seasons. Phenolic compounds which are the main antioxidants in vegetables are increased significantly by 14.85 and 15.75% in corresponding to the addition of the highest rate of chicken manure (15 m^3 fad.$^{-1}$) in both seasons of experiment. The rate of nitrate accumulation was low in reflect to the addition of organic N compared to the effect of inorganic N. Inorganic N fertilizer found to accumulate more nitrate in the curds. Wang *et al*., (2008) reported that N sources containing NO_3 and/or NH_4-N are widely used in vegetables production in different countries.

The N fertilizer added to the soil is the major source of nitrate accumulation, and nitrate-N fertilizers tend to increase nitrate concentration in vegetable crops much more than other fertilizers. This confirms the results of Pimpini *et al*., (1973), who argued that the accumulation of nitrate in cauliflower plants could be influenced to a great extend by an application of mineral fertilizers containing nitrate as ammonium nitrate or calcium nitrate compared with cyanamide, ammonium sulphate or urea.

(C) Effect of interaction (inorganic N levels x organic N rates):

Table (5) showed that the doses of both types of N fertilization increased all the nutrients content increased in parallel. Addition of 120 and 80 Kg N fad.$^{-1}$ of ammonium nitrate in coordination with 15 and 10 m^3 fad.$^{-1}$ of chicken manure in corresponding order, exhibited the highest effect among all other interaction treatments. The true protein increased from 17.98 to 24.56% in the first season and from 17.85 to 25.56% in the second season as a result of addition of 120 Kg N fad.$^{-1}$ inorganic and 15 m^3 fad.$^{-1}$ of organic N fertilizers. That reflects an increase of 36.6% and 43.2% of the true protein in the first and second seasons, respectively. Similar trend was observed by Everaarts and Booij, (2000) for white cabbage plants where high N fertilization up to 400 kg N ha^{-1} was associated with high protein content of the leaves.

Table 5. The nutritional value characters of "Amshiry" cultivar cauliflower curds, as influenced by different inorganic N fertilizer levels and chicken manure rates, during two seasons of experiment

Season		2006/2007					2007/2008				
Characters		Protein-nitrogen (g/100g DM)	True protein (g/100g DM)	Non protein nitrogen (g/100g DM)	NO_3 content (%)	Phenolic compounds (mg/g DM)	Protein-nitrogen (g/100g DM)	True protein (g/100g DM)	Non protein nitrogen (g/100g DM)	NO_3 content (%)	Phenolic compounds (mg/g DM)
(A) Inorganic N levels (NH_4NO_3, Kg N. fad.$^{-1}$)											
0		3.18 b	19.86 b	0.87 c	0.36 d	2.75 d	3.07 c	19.19 c	0.83 b	0.34 d	2.78 d
40		3.67 a	22.92 a	0.99 b	0.57 c	2.90 c	3.30 b	20.60 b	0.90 b	0.54 c	2.89 c
80		3.68 a	23.00 a	1.16 a	0.66 b	3.05 b	3.63 a	22.69 a	1.00 a	0.64 b	2.98 b
120		3.69 a	23.08 a	1.11 a	0.75 a	3.15 a	3.58 a	22.38 a	1.03 a	0.74 a	3.13 a
(B) Organic N rates (Chicken manure, m^3 fad.$^{-1}$)											
0		3.30 c	20.60 c	0.83 d	0.55 b	2.76 d	3.27 c	20.47 c	0.71 d	0.53 b	2.73 d
5		3.53 b	22.07 b	0.96 c	0.57 b	2.89 c	3.23 d	20.20 c	0.92 c	0.55 b	2.87 c
10		3.67 a	22.94 a	1.12 b	0.61 a	3.03 b	3.46 b	21.64 b	1.00 b	0.59 a	3.02 b
15		3.72 a	23.25 a	1.23 a	0.62 a	3.17 a	3.61 a	22.56 a	1.07 a	0.61 a	3.16 a
(C) Inorganic N levels (NH_4NO_3, Kg N. fad.$^{-1}$) x Organic N rates (Chicken manure, m^3 fad.$^{-1}$)											
0	0	2.88 g	17.98 g	0.65 i	0.32 a	2.58 h	2.86 l	17.85 k	0.63 i	0.30 a	2.61 k
	5	3.09 f	19.29 f	0.83 gh	0.36 a	2.69 g	3.05 k	19.06 j	0.82 g	0.34 a	2.70 j
	10	3.34 e	20.89 e	0.96 e-g	0.38 a	2.84 ef	3.22 h-j	20.14 hi	0.88 f	0.36 a	2.83 h
	15	3.40 e	21.27 e	1.05 d-f	0.39 a	2.89 de	3.16 j	19.73 i	0.99 d	0.37 a	2.98 ef
40	0	3.53 c-e	22.08 c-e	0.80 h	0.53 a	2.74 g	3.29 gh	20.58 gh	0.65 i	0.51 a	2.73 ij
	5	3.71 a-c	23.19 a-c	0.97 e-g	0.55 a	2.83 f	3.21 ij	20.06 hi	0.90 f	0.52 a	2.82 h
	10	3.71 a-c	23.16 a-c	1.07 c-e	0.58 a	2.93 d	3.28 hi	20.50 h	0.95 e	0.56 a	2.93 g
	15	3.72 a-c	23.23 a-c	1.12 cd	0.61 a	3.09 c	3.40 ef	21.27 ef	1.09 b	0.59 a	3.09 d
80	0	3.45 de	21.54 de	0.92 f-h	0.63 a	2.86 ef	3.59 d	22.41 d	0.78 h	0.60 a	2.77 i
	5	3.64 b-d	22.75 b-d	1.02 d-f	0.65 a	2.93 d	3.46 e	21.60 e	0.98 de	0.63 a	2.95 fg
	10	3.80 ab	23.77 ab	1.26 b	0.68 a	3.12 c	3.69 c	23.06 c	1.10 ab	0.66 a	3.08 d
	15	3.83 ab	23.94 ab	1.43 a	0.69 a	3.29 b	3.79 b	23.69 b	1.13 a	0.68 a	3.12 cd
120	0	3.33 e	20.79 e	0.95 e-g	0.71 a	2.84 ef	3.36 fg	21.02 fg	0.80 gh	0.70 a	2.82 h
	5	3.69 bc	23.06 bc	1.00 d-f	0.72 a	3.10 c	3.41 ef	20.08 hi	0.97 de	0.70 a	3.01 e
	10	3.83 ab	23.92 ab	1.19 bc	0.80 a	3.24 b	3.66 cd	22.85 cd	1.05 c	0.78 a	3.23 b
	15	3.93 a	24.56 a	1.30 b	0.78 a	3.41 a	4.09 a	25.56 a	1.08 bc	0.79 a	3.46 a

Values within the same column area having similar letter are not significantly different at 5% probability level.

Nitrate content as a harmful ion in cauliflower curds considers as an important characteristic to be monitored in cauliflower, particularly, for children and patients nutrition (Makovic and Djurovka, 1990). Results presented in Table (5) showed that all interaction treatments were insignificantly affected nitrate content of cauliflower curds. These results were in the same tendency of Makovic and Djurovka, (1990), who found that during cauliflower fertilization with increasing N doses from 0 to 200 kg N ha^{-1} nitrate content of curds was insignificantly changed. In general, nitrate accumulates in vegetables originated from residual soil N, as well as from application of inorganic and organic N fertilization. For this reason, the key measure for reducing nitrate accumulation in vegetables lies in proper N fertilizer management (Schenk, 1998). Addition of high level of N was reported as the key factor associated with excessive accumulation of nitrates in different species of vegetables (Greenwood and Hunt, 1986 and Elia *et al*., 1998). Similar to previous obtained information by Pimpini *et al*., (1973), our results under line the important for the practice as the grower inclines to apply higher N doses to gain higher yields for vegetable crops. Moreover, a satisfactory high yield quantity should be ascertained, but on the other hand a jumpy increase of the nitrate in the plant should be avoided.

Polyphenols are the most abundant antioxidants in human diets. They are secondary metabolites of plants and denote many substances with aromatic rings (Duthie *et al*., 2000). Extra amount of phenolic compounds was developed by the addition of both inorganic and organic fertilizers. The highest levels of both inorganic N fertilizer and chicken manure raised the phenolic compounds in the curds by 32.2 % and 32.5% in the first and second seasons, respectively. Increasing the level of phenolic compounds in cauliflower curds posses an advantage for health benefit where those phytochemicals exhibit many biologically significant functions, such as protection against oxidative stress, and degenerative diseases.

III. Macro- and micro-nutrient concentrations of cauliflower curds:

The results presented in Tables (6 and 7) demonstrate the average concentrations of macro- and micro-nutrient in curds of cauliflower "Amshiry" cultivar as affected by both inorganic and organic N fertilizers as well as their interactions.

Macronutrient concentration

(A) Effect of inorganic nitrogen fertilizer levels:

Table (6) showed that macro-nutrient (N, P, K, Ca, and Mg) were, significantly, affected by adding inorganic N levels in both seasons. The medium and high levels of mineral N fertilizer (80 and 120 kg N $fad.^{-1}$) were more superior for increasing the contents of all macro-nutrient under consideration compared with the lowest level of inorganic N (40 kg N $fad.^{-1}$) in both seasons, with the exception of K concentration which was insignificantly affected in the second one. This result is in accordance with Csizinszky (1996), who found that N and P concentrations in green cauliflower curds were higher with mineral N fertilizer at 294 than at 98 kg ha^{-1}. Superiority of the medium and high levels of inorganic N (NH_4NO_3) regarding N status in cauliflower curds compared with control treatment (soil N) in both seasons could be a resultant of relatively lower availability rate of NH_4 form and presence of NO_3, which seemed to be relatively easier in absorption by plants as indicated by El-Leboudi *et al*., (1984). Generally, the positive influences of mineral N application on macro-nutrient contents of cauliflower curds appeared to enhance vegetative growth which ultimately leads to more photosynthetic activities (Sharma *et al*., 2002), accordingly increased assimilation of carbohydrates and their translocation to the reproductive tissues, namely curds.

(B) Effect of organic nitrogen fertilizer (chicken manure) rates:

The results in table (6) reflected significant differences in concentrations of macro-nutrient; i.e., N, P, K, Ca and Mg of cauliflower curds in both seasons of experiment as a result of using various rates of chicken manure. It is noticeable that the highest rate of chicken manure (15 m^3 $fad.^{-1}$) was superior for increasing the percentage of all macro-nutrient concentrations in cauliflower curds linearly in both seasons of study. The superiority of chicken manure for N, P, K, Ca and Mg contents can be attributed to its narrow C/N ratio (Table 2) which lead to rapid mineralization and decomposition in soil (Helmy and Ramadan, 2008). Moreover, it can be referred to the ability of organic matter in rendering soil nutrients more available and chelating of these elements by humic substances. That will help in increasing the respiration rate, the metabolism and the growth of plants, causing the plant to require more nutrients from soil and fertilizers (El-Shafie and El-Gamaily, 2002). It is interested to find out that chicken manure at the highest rate (15 m^3 $fad.^{-1}$) relatively increased percentage of all macro-nutrient contents under consideration more than inorganic N fertilizer in both seasons. This finding is similar to that obtained in cabbage (Smith and Hadley, 1988 and Zahradnik and Petrikova, 2007). Zahradnik and Petrikova, (2007) found in head cabbage that Mg content was, significantly, higher when the organic fertilizers were used compared with mineral fertilizers.

Table 6. The macro-nutrient concentrations of "Amshiry" cultivar cauliflower curds, as influenced by different inorganic N fertilizer levels and chicken manure rates, during two seasons of experiments

Season		2006/2007					2007/2008				
Characters		N (%)	P (%)	K (%)	Ca (%)	Mg (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
(A) Inorganic N levels (NH_4NO_3, Kg N. $fad.^{-1}$)											
0		4.05 c	0.51 b	3.31 b	1.44 c	0.12 c	3.90 c	0.49 c	3.22 b	1.06 d	0.13 c
40		4.65 b	0.56 b	3.38 b	1.47b c	0.14 b	4.19 b	0.52 b	3.45 a	1.37 c	0.16 b
80		4.84 a	0.66 a	3.51 a	1.55 b	0.15 ab	4.63 a	0.57 a	3.48 a	1.47 b	0.17 b
120		4.80 a	0.69 a	3.53 a	1.66 a	0.16 a	4.61 a	0.57 a	3.51 a	1.60 a	0.18 a
(B) Organic N rates (Chicken manure, m^3 $fad.^{-1}$)											
0		4.12 d	0.45 d	3.07 d	1.37 d	0.11 d	3.98 d	0.40 d	2.82 d	1.12 d	0.12 d
5		4.49 c	0.53 c	3.38 c	1.48 c	0.13 c	4.15 c	0.50 c	3.37 c	1.28 c	0.16 c
10		4.79 b	0.64 b	3.53 b	1.58 b	0.16 b	4.46 b	0.59 b	3.67 b	1.48 b	0.17 b
15		4.95 a	0.79 a	3.74 a	1.70 a	0.18 a	4.68 a	0.69 a	3.81 a	1.62 a	0.19 a
(C) Inorganic N levels (NH_4NO_3, Kg N. $fad.^{-1}$) x Organic N rates (Chicken manure, m^3 $fad.^{-1}$)											
0	0	3.53 h	0.37 h	2.97 h	1.23 h	0.11 a	3.49 l	0.34 a	2.60 e	0.83 g	0.11 a
	5	3.93 g	0.51 fg	3.33 e-g	1.43 fg	0.11 a	3.87 k	0.43 a	3.03 d	0.93 g	0.12 a
	10	4.30 f	0.53 e-g	3.40 c-g	1.53 d-f	0.13 a	4.10 i	0.53 a	3.53 bc	1.23 e	0.13 a
	15	4.46 e	0.61 d	3.57 b-e	1.57 de	0.14 a	4.15 i	0.66 a	3.73 a-c	1.23 e	0.14 a
40	0	4.33 ef	0.46 g	3.03 h	1.37 g	0.11 a	3.94 j	0.41 a	2.87 d	1.10 f	0.12 a
	5	4.68 d	0.51 fg	3.37 d-g	1.43 fg	0.13 a	4.11 i	0.46 a	3.47 c	1.30 e	0.16 a
	10	4.77 cd	0.58 de	3.43 b-f	1.47 e-g	0.15 a	4.23 h	0.54 a	3.67 a-c	1.47 d	0.18 a
	15	4.83 c	0.70 c	3.70 ab	1.63 b-d	0.17 a	4.49 e	0.67 a	3.80 ab	1.63 bc	0.20 a
80	0	4.36 ef	0.50 fg	3.17 f-h	1.40 g	0.12 a	4.36 g	0.45 a	2.93 d	1.23 e	0.12 a
	5	4.66 d	0.55 d-f	3.40 c-g	1.47 e-g	0.14 a	4.44 ef	0.52 a	3.47 c	1.33 e	0.16 a
	10	5.06 b	0.67 c	3.63 a-d	1.60 cd	0.16 a	4.79 c	0.63 a	3.70 a-c	1.53 cd	0.19 a
	15	5.26 a	0.91 a	3.83 a	1.73 b	0.19 a	4.92 b	0.69 a	3.83 a	1.80 a	0.21 a
120	0	4.28 f	0.47 g	3.13 gh	1.47 c-g	0.12 a	4.16 i	0.37 a	2.87 d	1.33 e	0.13 a
	5	4.69 d	0.54 d-f	3.43 b-f	1.60 cd	0.14 a	4.38 fg	0.59 a	3.53 bc	1.57 b-d	0.18 a
	10	5.02 b	0.78 b	3.67 a-c	1.70 bc	0.18 a	4.71 d	0.65 a	3.77 ab	1.67 b	0.20 a
	15	5.23 a	0.95 a	3.90 a	1.87 a	0.21 a	5.17 a	0.74 a	3.87 a	1.83 a	0.22 a

Values within the same column area with the same letter are not significantly different at 5% probability level

Magnesium is important for human health mainly for skin, bones and enzyme production. The previous result can support the finding of Smith and Hadley, (1988) that organic N is initially unavailable when applied to the soil. However, N is subsequently released at varying rates during growth of plants, depending on the nature of the proteins involved in, by microbial degradation in the soil. Therefore, it can be stated that N release characteristics of chicken manure applied seem better synchronized for the nutrient requirement of cauliflower crop than inorganic N form; i.e. ammonium nitrate.

(C) Effect of interaction (inorganic N levels x organic N rates):

Table (6) revealed that the interaction treatments between the medium and high levels of inorganic N (80 and 120 kg N fad.$^{-1}$) combine with the highest rate of chicken manure (15 m^3 fad.$^{-1}$) had a significant effect on N, K and Ca concentrations in both seasons and on P concentration in the first season only. However, concentrations of Mg in both seasons and P in the second one were insignificant indicates that both factors acted independently from each others. High percentages of N, P, K and Ca of cauliflower curds were recorded when plants received the highest combine levels of inorganic N (120 kg N fad.$^{-1}$) and chicken manure (15 m^3 fad.$^{-1}$). That may be contributed to the ability of inorganic N to accelerate organic manure degradation. In fact, the rapid degradation of complex organic substances into less complex compounds, which are subsequently transformed in low molecular weight organic elements, allows more elements to be utilized by the plants (Montemurro *et al*., 2008).

Micronutrient concentration

(A) Effect of inorganic nitrogen fertilizer levels:

Micro-nutrient concentrations exhibited different behavior under various inorganic N fertilizer levels during the two cultivation seasons (Table 7). In the first one, Mn and Zn concentrations were affected by inorganic N fertilizer levels, while, Na, Fe, and Cu concentrations were insignificantly affected by any application. However in the second season, the results illustrated a progressive significant increase in curd's Na, Fe, Zn, and Cu contents with the application of inorganic N fertilizer up to 120 kg N fad.$^{-1}$. Similar findings were obtained by Csizinszky (1996), who mentioned that Fe and Zn concentrations in green cauliflower curds increased with increasing inorganic N level up to 294 kg N ha^{-1}. On the contrary, gradual decrease in curd's Mn content occurred when N applied level reached to the highest level (120 kg N fad.$^{-1}$) in both seasons. This result can be explained based on carbohydrates synthesis required Mn as coenzymes such as nicotine amide adenine dinucleotide (NAD) malic enzyme and phosphoenol pyruvate carboxykinase. These enzymes have an absolute Mn requirement that can not be replaced by Mg. So, the more N added, the more carbohydrates synthesis, the more Mn required (Romheld and Marschner, 1991). This may illustrate the decreasing in Mn concentration with inorganic N increasing.

A positive response of inorganic N fertilizer applied levels on micro-nutrient contents during the second season could be refer to the available amount of most micro-nutrients present in the soil for growing plants was relatively high comparing with the first one (Table 1).

(B) Effect of organic nitrogen fertilizer (chicken manure) rates:

Results in Table (7) indicated that the content of all micro-nutrient in cauliflower curds was, significantly, increased with increasing chicken manure up to the highest rate; 15 m^3 fad.$^{-1}$ in most cases. It is noticeable that the highest rate of chicken manure (15 m^3 fad.$^{-1}$) recorded the highest values of some micro-nutrient contents more than any level of inorganic N fertilizer. This was true in both growing seasons. This result coincide with the finding of Ahmed *et al*., (2008), who demonstrated that organic fertilization besides providing plants with a source of N undoubtedly supplied the growing plants with also the required micro- and macro-nutrient elements. Naturally, such elements play an important role in the metabolic processes of plants such as photosynthesis, respiration and carbohydrate synthesis (Marschner, 1994). Chicken manure contains macro- and micro-nutrients other than N (Table 2) which must have contributed to their superiority over the treatments that received the inorganic N levels. The favorable effect of chicken manure on the micro-nutrient content might be refer to that, chicken manure may have acted as chelating agents caused nutrients forms more readily absorbed by plants. In addition to, the production of organic and inorganic acids during the degradation of such organic manure as a result of the microorganism's activities must lead to decrease in soil pH which would produce more chelating ions, and consequently, increase in available forms of elements in the rhizosphere zone as reported by El-Shafie and El-Gamaily, (2002); Helmy and Ramadan, (2008).

(C) Effect of interaction (inorganic N levels x organic N rates):

Table (7) revealed that the interaction between different inorganic N levels and chicken manure rates had a significant effect on micro-nutrient concentrations (Fe, Mn, Zn and Cu) but with different trends in both seasons of study. For example, the highest values of Fe and Zn percentages of cauliflower curds were recorded

Table 7. The micro-nutrient concentrations of "Amshiry" cultivar cauliflower curds, as influenced by different inorganic N fertilizer levels and chicken manure rates, during two seasons of experiments

Season		2006/2007					2007/2008				
Characters		Na (%)	Fe ppm	Mn ppm	Zn ppm	Cu ppm	Na (%)	Fe ppm	Mn ppm	Zn ppm	Cu ppm
(A) Inorganic N levels (NH_4NO_3, Kg N. fad.$^{-1}$)											
0		0.33 a	49.92 a	32.67 a	65.00 b	7.16 a	0.30 b	35.92 d	32.25 a	61.00 d	7.50 c
40		0.36 a	50.08 a	33.17 a	66.50 ab	8.16 a	0.34 a	44.00 c	33.92 a	68.42 c	8.50 b
80		0.39 a	54.25 a	30.00 ab	73.17 a	8.25 a	0.35 a	57.92 b	29.17 b	75.17 b	10.50 a
120		0.41 a	52.17 a	26.25 b	72.08 a	8.66 a	0.36 a	69.25 a	23.67 c	80.75 a	11.00 a
(B) Organic N rates (Chicken manure, m^3 fad.$^{-1}$)											
0		0.35 d	42.75 d	28.42 b	60.25 d	6.92 a	0.28 d	38.50 d	26.75 c	63.25 d	6.75 d
5		0.37 c	48.92 c	28.92 b	67.17 c	7.75 a	0.33 c	49.25 c	28.17 c	68.33 c	8.75 c
10		0.38 b	54.42 b	31.33 a	72.58 b	8.33 a	0.36 b	56.25 b	31.00 b	74.58 b	10.17 b
15		0.39 a	60.33 a	33.42 a	76.83 a	9.25 a	0.39 a	63.08 a	33.08 a	78.67 a	11.84 a
(C) Inorganic N levels (NH_4NO_3, Kg N. fad.$^{-1}$) x Organic N rates (Chicken manure, m^3 fad.$^{-1}$)											
0	0	0.30 a	41.67 f	29.67 c-e	57.00 f	6.33 a	0.26 a	30.33 j	30.00 b-e	53.67 l	5.33 h
	5	0.34 a	48.33 de	29.33 c-e	63.00 d-f	6.67 a	0.30 a	36.00 j	30.33 b-e	58.00 k	7.00 f-h
	10	0.34 a	53.00 cd	34.00 a-c	68.00 cd	7.33 a	0.32 a	37.33 hi	33.33 a-c	64.00 i	8.00 d-f
	15	0.36 a	56.67 bc	37.67 a	72.00 bc	8.33 a	0.34 a	40.00 gh	35.33 a	68.33 h	9.67 cd
40	0	0.34 a	41.33 f	30.67 cd	60.00 ef	7.00 a	0.29 a	32.00 j	30.67 b-d	60.00 j	5.67 gh
	5	0.34 a	48.00 de	32.33 b-d	64.33 de	8.00 a	0.33 a	39.67 g-i	33.33 a-c	64.67 i	7.33 e-g
	10	0.36 a	51.67 cd	33.67 a-c	69.00 cd	8.33 a	0.36 a	46.67 f	35.33 a	72.00 g	9.00 de
	15	0.38 a	59.33 ab	36.00 ab	73.00 bc	9.33 a	0.38 a	57.67 e	36.33 a	77.00 e	12.00 ab
80	0	0.36 a	42.00 f	28.67 c-e	62.33 d-f	7.33 a	0.29 a	41.67 g	27.33 de	68.00 h	7.67 ef
	5	0.39 a	51.67 cd	29.00 c-e	72.33 bc	8.00 a	0.34 a	55.33 c	27.00 de	74.00 f	9.67 cd
	10	0.39 a	60.00 ab	30.33 cd	77.00 ab	8.67 a	0.37 a	62.00 d	29.33 c-e	78.00 de	12.00 ab
	15	0.41 a	63.33 a	32.00 b-d	81.00 a	9.00 a	0.40 a	72.67 b	33.00 a-c	80.67 c	12.67 ab
120	0	0.39 a	46.00 ef	24.67 e	61.67 d-f	7.00 a	0.28 a	50.00 f	19.00 f	71.33 g	8.33 d-f
	5	0.40 a	47.67 de	25.00 e	69.00 cd	8.33 a	0.34 a	66.00 c	22.00 f	78.67 d	11.00 bc
	10	0.41 a	53.00 cd	27.33 de	76.33 ab	9.00 a	0.40 a	79.00 a	26.00 e	84.33 b	11.67 ab
	15	0.42 a	62.00 a	28.00 de	81.33 a	10.33 a	0.43 a	82.00 a	27.67 de	88.67 a	13.00 a

Values within the same column area having similar letter, are not significantly different at 5% probability level.

when plants fertilized with the medium or the highest level of inorganic N fertilizer (80 or 120 kg N $fad.^{-1}$) and the highest rate of organic N fertilizer (15 m^3 $fad.^{-1}$) in the first season. However, in the second one the highest values of Fe and Zn percentages were recorded when cauliflower plants fertilized with the highest level of inorganic N fertilizer (120 kg N $fad.^{-1}$) and the medium or the highest rate of chicken manure (10 or 15 m^3 $fad.^{-1}$). With the exception of Na and Cu concentrations were insignificantly affected by any interaction treatment in both seasons or in the first one each in order.

It is obvious from the results of the current study that the interaction between the medium or the highest level of inorganic N (80 or 120 kg N $fad.^{-1}$) and the highest rate of organic N (15 m^3 $fad.^{-1}$) showed significant superior effect on most macro- and micro-nutrient concentrations such as N, P, K, Ca, Fe, Zn and Cu. Such results could be refer to that N element has an active role in improving roots dimension by increasing division and elongation of cell, and in turn enhanced nutrient absorption. Moreover, large root surface allow an increase in the microorganisms as bacteria population activities resulted from degradation of organic matter, namely chicken manure (Kaoulnik *et al*., 1981).

CONCLUSION

Nitrogen fertilization, as an important agricultural practice for cauliflower crop production, has to be well managed in order to obtain maximum yield with high quality. Ammonium nitrate as inorganic N fertilizer and chicken manure as organic one can offer good production for cauliflower plants with better curds quality. Instead of increasing the amounts of inorganic N fertilizer in cauliflower fields, the collaborative effect of inorganic N fertilizer (80 kg N $fad.^{-1}$ as NH_4NO_3) and organic N fertilizer (15 m^3 $fad.^{-1}$; i.e., 72 kg N $fad.^{-1}$ as chicken manure) would be recommended as the best combination not only for obtaining good curds quality characters with high nutritional value of cauliflower "Amshiry" cultivar but also for reduction the amounts of inorganic N fertilization applied to such economic vegetable crop under the studied conditions.

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الملخص العربي

كفاءة السماد النيتروجيني المعدني والعضوي على جودة أقراص القنبيط

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أجريت تجربتين حقليتين في محطة البحوث الزراعية التابعة لكلية الزراعة جامعة الإسكندرية في الموسميين الشتويين لعامي ٢٠٠٦-٢٠٠٧ و ٢٠٠٧-٢٠٠٨ بغرض تقييم كفاءة إستخدام مستويات مختلفة من السماد النيتروجينى المعدنى (٤٠- ٨٠ - ١٢٠كجم ن/ فدان نترات الأمونيوم) علاوة علي معاملة المقارنة (بدون إضافة سماد النيتروجين المعدني) وسماد مخلفات الدواجن العضوي بمعدلات (٥- ١٠- ١٥م^{3}/ فدان) بالإضافة إلي معاملة المقارنة (عدم إضافة السماد العضوي) وكذلك التأثير المشترك لهما على جودة أقراص القنبيط صنف " أمشيرى".

أظهرت النتائج تأثيرات إيجابية نتيجة لإضافة سماد النيتروجين المعدني وسماد مخلفات الدواجن العضوي على جودة أقراص القنبيط. كما أن سماد النيتروجين المعدني كان أكثر تأثيراً فى زيادة جودة الأقراص في حالة وجوده مع السماد العضوي مقارنة بحالة وجوده منفردا.

أدي إضافة المستوى المرتفع من السماد النيتروجينى المعدني (١٢٠كجم ن/ فدان) إلي زيادة معنوية في كل من وزن القرص، المركبات الفينولية، زيادة تركيز عناصر الكالسيوم والماغنسيوم بالقرص بينما قلل معنوياً من طول الحوامل الزهرية لأقراص القنبيط، في حين وجد أن كل من المستويين المتوسط والمرتفع من سماد النيتروجين المعدني (٨٠ و ١٢٠كجم ن/ فدان) قد أديا إلى زيادة في صفات قطر القرص، محتوى الأقراص من المادة الجافة، النيتروجين البروتيني، البروتين الحقيقى، النيتروجين اللابروتيني وكذلك زيادة تركيزات بعض العناصر الكبرى والصغرى مثل النيتروجين، الفوسفور، البوتاسيوم، الصوديوم، الزنك في أقراص القنبيط مقارنة بالمعاملات الأخرى. كما أظهرت النتائج أن إستخدام سماد مخلفات الدواجن بمعدله المرتفع (١٥ م^{3}/ فدان) قد عكس تفوقا واضحا علي جميع صفات جودة الأقراص موضع الدراسة.

قد عكس التأثير المشترك (تأثير التداخل) بين السمادين النيتروجينى المعدني والعضوى بمعدلاتهم المختلفة نتائج إيجابية علي معظم صفات جودة أقراص القنبيط المدروسة.

تشير نتائج تلك الدرسة أن إستخدام المستوى المتوسط من السماد النيتروجينى المعدنى (٨٠ كجم ن/ فدان) مع المعدل المرتفع من سماد مخلفات الدواجن (١٥م^{3}/ فدان أو ٧٢ كجم ن/ فدان) أعطى تفوقا للصفات المميزة لجودة الأقراص مع زيادة القيمة الغذائية للقرص.

يمكن التوصية من هذه الدراسة أنه بدلا من زيادة إستخدام المعدلات المرتفعة من السماد النيتروجينى المعدنى في حقول إنتاج القنبيط فإن إستخدام السماد النيتروجينى المعدنى عند المستوي ٨٠ كجم ن/ فدان مع سماد مخلفات الدواجن عند المعدل ١٥م^{3}/ فدان (٧٢ كجم ن/ فدان) ليس فقط من أجل الحصول علي محصول إقتصادي مرتفع ولكن أيضا للحصول علي أقراص عالية الجودة وذات قيمة غذائية مرتفعة لنبات القنبيط صنف "أمشيرى" تحت ظروف منطقة الدراسة.