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RESPONSE OF CABBAGE (*Brassica oleraceae* var. *Capitata* L.) CV. BRUNSWICK TO PLANT DENSITY, ORGANIC FERTILIZERS AND NITROGEN AND PHOSPHORUS RATES.

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ABSTRACT

To study the influence of plant density, chicken manures and N, P rates on growth, yield and quality of cabbage cv. Brunswick, two field experiments were conducted at Experimental Farm of Baramoon, Dakahlia Governorate during the winter seasons 2002/03 and 2003/04. Eighteen treatments representing all possible combinations of three plant spacing (25 x 75 cm), (35 x 75 cm) and (45 x 75 cm) to give plant density 16000, 11000 and 8500 plants / fed., two chicken manure levels (0 and 20 m^3/fed.) and three N, P levels (60 kg N + 30 kg P_2O_5/fed, 80 kg N + 40 kg P_2O_5/fed and 100 kg N + 50 kg P_2O_5/fed) were used in split-split plot design with three replicates.

The obtained results can be summarized as follows:-

1. Effect of plant density:

Plant density had a significant effect on all traits under study in both seasons. High plant density (16 thousand plants / fed) resulted in a decrease of plant fresh weight, outer leaves weight, head diameter, head weight and mean time from transplanting to maturity. Increasing the plant density increased total yield, dry matter % in inner leaves and vitamin C content. Lower plant density (8.5 thousand per fed) caused a significant increase in accumulation of N, P, K and NO^-_3 on cabbage leaves.

2. Organic fertilizer:

Chicken manure fertilization had a significant effect on all traits under study in both seasons. Plant fresh weight, outer leaves weight, head weight, head diameter and yield (ton/fed) were significantly increased by application of 20 m^3 chicken manure / fed, but DM% and mean time from transplanting to maturity were significantly decreased by application of 20 m^3 chicken manure / fed. N, P, K accumulation in all leaves, V.C content and protein % were significantly increased and NO^-_3 accumulation was significantly decreased as a result of chicken manure application.

3. Nitrogen and phosphorus rates:

Increasing nitrogen and phosphorus rates up to 100 kg N + 50 kg P_2O_5/fed caused significant increases in all traits under study, except DM% and V.C content, these traits were significantly decreased as the levels of N + P fertilizers increases. These results were true in both seasons.

The interaction effects among the experimental factors were almost significant in both seasons.

Finally, for the best cabbage yield cv Brunswick, it could be recommended 11 thousands plant / fed + 20 m^3 / fed chicken manure + 100 kg N + 50 kg P_2O_5 / fed.

INTRODUCTION

Cabbage (*Brassica oleraceae* var. *capitata* L.) is a popular winter vegetable crop in Egypt. Yield should be improved through introducing high yield cultivars and/or suitable production and management practices, i.e. plant density, organic manure and N, P rates.

In Egypt, after high Dam construction, the Egyptian soils had suffering from insufficient organic matter contents as well as macro- and micro-

nutrients, alongside with the relatively low availability of these elements under alkaline conditions as reported by El-Mowelhi *et al.* (1973).

With regard to organic fertilization, recently on the way of clean agriculture with minimum pollution effects, the use of natural materials such as organic manures is recommended to substitute the chemical fertilizers (Khalil *et al* , 2000). Amendment the soil with organic manure improves their physical, chemical and biological properties and hence the availability of plant nutrients (El-Fouly *et al.*, 1997).

The application of organic manures to soil caused a reduction in the soil pH (Khalifa, 1993; Koriem, 1993 and Mehana, 1998). Hamiss and Abdel-Salam (1999) reported that most organic manures are used primarily as a source of nitrogen, however they also contain many major and micro-elements. Badawi (2002) reported that organic agriculture is promising for present and future where organic fertilizer plays double organic roles, since it is both a soil conditioner and a fertilizer. Such organic fertilizer besides furnishing plant food, benefits the soil by increasing its water holding capacity and improving its structure.

On cabbage, Farooque and Islam (1989) found that application (per ha) of 8.3 t FYM + 200 kg mustard oil cake + 326 kg urea + 125 kg triple super phosphate + 200 kg muriate of potash gave the highest marketable yield (13.7 t/ha), the control yield was 6.3 t/ha.

The effect of plant density on cabbage have been reviewed by some investigators; Khadir *et al.* (1989), Stofella and Fleming (1990) and Mahmoud *et al.* (2004), they reported that yield increased with increasing plant density, while plant weight, head weight and diameter was increased with decreasing plant density.

As regard to N and P rates, some researchers in Egypt demonstrated that response of cabbage plants to nitrogen and phosphorus rates may differ from location to another and may depend on the growth cultivar (Hassan *et al.*, 1994; El-Shabrawy *et al.*, 1999 and Mahmoud *et al.*, 2004). Many investigators have been reported that cabbage yield was significantly increased as N, P rates were increased up to 120 kg N + 46.5 kg P_2O_5/fed (Srinvas, 1984; Hassan *et al.*, 1994; Dixit, 1997 and El-Shabrawy *et al.*, 1999).

The objective of this study was to determine the influence of plant density, chicken manure and N, P rates on growth, yield and quality of cabbage under environmental conditions of Dakahlia Governorate.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive winter seasons of 2002/03 and 2003/04 at Baramoon Experimental Farm, Dakahlia Governorate to study the effect of plant density, organic manure and N, P fertilization rates on vegetative growth, yield and quality of cabbage plants. Brunswick cv. was used in these experiments.

Some physical and chemical properties of the experimental soil at the depth of 0-30 cm were determined according to standard procedures as described by Page (1982) and Klute (1986) (Table 1). The chemical analysis of the used chicken manure was determined by using standard methods described by AOAC (Table 2).

Table 1. Some physical and chemical properties of the experimental soil during 2002/03 and 2003/04. seasons.

Properties	Values		Properties	Values	
	2002/03	2003/04		2002/03	2003/04
Sand (%)	27.8	27.1	pH* value	7.9	7.7
Silt (%)	31.5	31.9	EC (dSm^{-1})	0.9	0.7
Clay (%)	40.6	40.9	Total N (%)	0.12	0.10
Texture class	Clay-loam		Available P (ppm)	11.2	11.0
$CaCO_3$ (%)	3.6	3.4	Exchangeable K		
OM (%)	2.3	2.4	(ppm)	304	293

* pH (1 : 25 soil extract).

Table 2. Some properties of chicken manure used in 2002/03 and 2003/04. seasons.

Properties	Values		Properties	Values	
	2002/03	2003/04		2002/03	2003/04
N (%)	1.86	2.02	Fe (ppm)	1370	1330
P (%)	1.71	1.68	Mn (ppm)	180	198
K (%)	2.15	2.26	Zn (ppm)	129	137
OM (%)	48.3	47.2	Cu (ppm)	56	58
C / N ratio	13.9	13.2	EC (dSm^{-1})	0.9	0.8
pH	8.1	7.8			

Each experiment included 18 treatments, which were combination of three plant spacing (45 x 75 cm, 35 x 75 cm and 25 x 75 cm) to give three plant density 8500, 11000 and 16000 plants / fed, two chicken manure levels (0, 20 m^3/fed) and three nitrogen (N) and phosphorus (P_2O_5) levels, i.e. (60 + 30), (80 + 40) and (100 + 50) kg/fed N + P_2O_5, respectively.

The experiments were laid out in split-split plot design in complete randomized block design with four replications. The main plots contained the three treatments of plant density, whereas the sub-plots were devoted to two levels of chicken manure (0 and 20 m^3/fed) and sub-sub plots were allocated to three levels of nitrogen and phosphorus Each sub-sub plot area contained 4 rows, each row was 75 cm wide and 4 m long. The sub-sub plot area was 12 m^2.

Seeds of cabbage cv. Brunswick were sown in the nursery on 9 and 12 September in both seasons, respectively, while transplanting took place when seedlings were 6 weeks old Chicken manure was applied before transplanting in furrow and raked lightly with the soil.

Nitrogen and phosphorus treatments in the form of ammonium sulphate (20.6% N), and calcium super phosphate (15.5% P_2O_5), respectively, and potassium sulphate (48% K_2O) at rate of 48 kg K_2O/fed were applied at two equal doses, one was added after 21 days and the other after 40 days from seedling transplanting. The normal agricultural practices were followed until harvest.

At harvest, five plants from each sub-sub plot were randomly taken and the following characters were recorded:

1. Vegetative growth and yield parameters:

Plant fresh weight (kg/fed), head weight (kg/plant), head diameter (cm) and outer leaves (kg/plant). After all plants in each sub-sub plot reached

lower plant density (8500 plant / fed) gave the highest values of protein % in both seasons. Increasing protein % in lower plant density may be due to increasing of N leaf content (Table 6).

As regard to N, P, K and nitrate accumulation, data in Table 6 show that there were significant effects for the plant density on chemical analysis in both season. The results indicate that the lower plant density increased significantly N, P, K and nitrate accumulation in comparison with other plant densities. Similar results were obtained by Mahmoud *et al.* (2004).

Table 5. Mean effect of plant density, chicken manure and N, P levels on head quality during 2002/03 and 2003/04 seasons.

Treatments	Dry matter (%)		Vitamin C (mg/100g fresh wt.)		Protein (%)	
	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
Plant density (plant/fed):						
8500	7.8 c	7.5 c	26.0 c	29.0 c	16.7 a	15.8 a
11000	8.4 b	8.0 b	32.0 b	34.0 b	15.6 b	14.8 b
16000	9.3 a	8.8 a	38.0 a	40.0 a	12.9 c	12.5 c
Chicken manure (m^3/fed):						
0	8.7 a	8.4 a	31.0 b	33.0 b	14.7 b	14.0 b
20	8.4 b	7.9 b	33.0 a	35.0 a	15.4 a	14.8 a
N + P_2O_5 (kg/fed):						
60 + 30	9.1 a	8.7 a	35.0 a	38.0 a	13.2 b	12.5 b
80 + 40	8.4 b	8.0 b	32.0 b	35.0 b	15.8 a	15.0 a
100 + 50	7.9 c	7.6 c	29.0 c	31.0 c	16.2 a	15.6 a

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

2. Influence of organic fertilizer:

2.1. Vegetative growth parameters:

Data in Table 3 show that chicken manure application increased significantly growth parameters in both seasons Treatment received 20 m^3/fed chicken manure increased significantly plant fresh weight, outer leaves weight and head diameter. Similar results were obtained by Yamazaki and Roppongi (1998), they reported that application of organic manure improved soil chemical properties and increased available elements and increased soil cation exchange capacity, and these, in turn, enhanced growth parameters

2.2. Yield and its components:

Data listed in Table 4 show that application of chicken manure increased significantly head weight, head yield and decrease mean time from transplanting to maturity. The high yield reflected increases in average head weight. Similar results were obtained by Ibrahim *et al.* (2004).

2.3. Head quality and chemical analysis:

Data in Table 5 show that application of chicken manure increased significantly V.C content and protein % and reduced DM% in both seasons.

As regard to N, P, K and nitrate accumulation, data in Table 6 show that fertilizing cabbage plants with chicken manure increased significantly N, P and K accumulation and reduced nitrate accumulation in leaves. In the same line, Yamazaki and Roppongi (1980) on cabbage and Ibrahim *et al.* (2004) on cauliflower, they reported that organic manure reduced nitrate accumulation and increased N, P and K contents.

Table 6. **Mean effect of plant density, chicken manure and N, P levels on chemical analysis of cabbage leaves during 2002/03 and 2003/04 seasons.**

Treatments	N accumulation* (mg/plant)		P accumulation* (mg/plant)		K accumulation* (mg/plant)		NO_3** (mg/kg dry wt.)	
	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
Plant density (plant/fed):								
8500	9663 a	9499 a	1763 a	1665 a	12608 a	12520 a	94 a	97 a
11000	8068 b	7918 b	1503 b	1429 b	10893 b	10796 b	80 b	82 b
16000	5440 c	5265 c	1162 c	1073 c	7756 c	7669 c	63 c	65 c
Chicken manure (m^3/fed):								
0	7013 b	6850 b	1351 b	1256 b	9456 b	9367 b	83 a	86 a
20	8433 a	8271 a	1601 a	1523 a	11381 a	11289 a	75 b	78 b
N + P_2O_5 (kg/fed):								
60 + 30	5837 c	6015 c	5837 c	1252 c	1156 c	8521 c	65.0 c	68.0 c
80 + 40	7982 b	8146 b	7982 b	1504 b	1432 b	10784 b	80.0 b	83.0 b
100 + 50	8863 a	9004 a	8863 a	1673 a	1580 a	11952 a	92.0 a	94.0 a

* in total leaves. ** in inner leaves.

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

3. Influence of nitrogen and phosphorus levels:

3.1. Vegetative growth parameters:

It is evident from the data in Table 3 that the growth parameters of cabbage plants as expressed as plant fresh weight, outer leaves weight and head diameter were significantly increased by different treatments in both seasons. The highest values were obtained from 100 kg N + 50 kg P_2O_5 /fed in both seasons.

The results might be due to the fact that cabbage plants need nitrogen and phosphorus for healthy, especially where soils are poor in nitrogen and organic matter as in case of this study situation (Table 1). These results are in good accordance with results of Hassan *et al.* (1994), El-Shabrawy *et al.* (1999) and Mahmoud *et al.* (2004) on cabbage, they reported that increasing nitrogen and phosphorus levels increased vegetative growth.

3.2. Yield and its components:

Data presented in Table 4 show that nitrogen and phosphorus rates increased significantly head weight, head yield and mean time from transplanting to maturity in both seasons. Similar results were obtained by Hassan *et al* (1994), El-Shabrawy *et al.* (1999), Ibrahim (2001) and Mahmoud *et al.* (2004).

3.3. Head quality and chemical analysis:

Data presented in Tables 5 and 6 show that increasing nitrogen and phosphorus rates up to 100 kg N + 50 kg P_2O_5 /fed decreased significantly

DM %, VC content and increased significantly protein %, nitrate accumulation in inner leaves and N, P, K accumulation in total leaves in both seasons. Similar results were obtained by Ibrahim (2001) and Mahmoud *et al.* (2004) on cabbage.

4. Influence of interaction between plant density and organic fertilizer:

4.1. Vegetative growth parameters:

The interaction between plant density and organic manure had a significant effect on plant fresh weight, outer leaves weight and head diameter in both seasons.

From Table 7, it is apparent that highest values of plant fresh weight, outer leaves weight and head diameter were obtained from lower plant density (8500 plant/fed) with application of 20 m^3/fed chicken manure.

Table 7. Mean effect of plant density and chicken manure interaction on some vegetative growth parameters of cabbage plants during 2002/03 and 2003/04 seasons.

Treatments		Plant fresh weight (kg/plant)		Outer leaves weight (kg/plant)		Head diameter (cm)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	2002/03	2003/04	2002/03	2003/04	2002/03	2003/04
8500	0	4.26 b	4.53 b	2.04 b	2.15 b	23.5 a	24.3 a
	20	4.61 a	5.00a	2.24 a	2.40 a	23.4 a	24.4 a
11000	0	3.26 d	3.48 c	1.34 d	1.50 d	22.5 c	22.7 c
	20	4.12 c	4.46 b	2.06 b	2.20 b	22.9 b	23.3 b
16000	0	2.64 e	2.66 e	1.22 e	1.20 e	20.7 e	21.0 e
	20	3.25 d	3.30 d	1.65 c	1.62 c	21.2 d	21.5 d

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

In the same, line, Firoz *et al.* (2000) reported that widest plant spacing increased growth of cabbage plants. Also, chicken manure considered a source of nutrients (Table 2), as well as to its effect on improving soil properties and supplying it with available nutrients (Clark *et al.*, 1998; Khafagy, 1999 and Bulluck *et al.*, 2002).

4.2. Yield and its components:

The interaction between plant density and organic manure had a significant effect on yield and its components in both seasons.

Data presented in Table 8 show that the highest values of head weight were obtained from lower plant density (8500 plant/fed) with chicken manure. But, the highest values of yield were noticed with the treatments of 11000 and 16000 plant/fed with 20 m^3 chicken manure/fed. Moreover, the highest mean time from transplanting to maturity was noticed with high plant density without chicken manure. But, the lowest mean time from transplanting to maturity were resulted from lower plant density with chicken manure.

4.3. Head quality and chemical analysis:

The interaction between plant density and chicken manure had a significant effect on head quality and chemical analysis in both seasons.

Data in Table 9 show that DM% and vitamin C content were significantly increased with high plant density without chicken manure application. But protein % was increased by lower plant density (8500 plant/fed) with chicken manure or without and also by 11000 plant/fed with chicken manure treatment.

Table 8. Effect of plant density and chicken manure interaction on yield and its components during 2002/03 and 2003/04 seasons.

Treatments		Head weight (kg/plant)		Head yield (Ton/fed)		MTTM* (day)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	0	1.99 b	2.12 b	22 18 d	23.50 e	123 cd	126 e
	20	2.10 a	2.27 a	24.82 c	25.90 d	120 d	122 f
11000	0	1.77 d	1.85 d	24.70 c	26.02 cd	134 b	135 c
	20	1.83 c	2 01 c	28.30 a	28.95 ab	125 c	128 d
16000	0	1.31 f	1.37 f	26.5 b	27.50 bc	145 a	148 a
	20	1.45 e	1.53 e	29.6 a	30.42 a	136 b	140 b

* MTTM: Mean time from transplanting to maturity.
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Table 9. Effect of plant density and chicken manure interaction on head quality during 2002/03 and 2003/04 seasons.

Treatments		Dry matter (%)		Vitamin C (mg/100g fresh wt)		Protein (%)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	0	8.1 d	7.7 d	25 d	28 d	16.8 a	15.9 a
	20	7.5 e	9.2 e	27 d	30 d	16.8 a	15.8 a
11000	0	8.6 c	8.2 c	30 c	33 c	15.3 b	14.3 b
	20	8.2 d	7.8 d	33 b	35 b	15.9 ab	15.2 a
16000	0	9.5 a	9.1 a	37 a	40 a	12 1 d	11.7 d
	20	9.0 b	8.6 b	39 a	41 a	13.7 c	13 3 c

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 regard to N, P, K accumulation in all leaves and NO'_3 accumulation in inner leaves, data presented in Table 10 show that the effect of different treatments on these traits was significantly in both seasons. The highest values of these traits were obtained at lower plant density with chicken manure in comparison with other treatments. This might be due to the same treatment improved plant fresh weight and outer leaves weight (Table 7), that might be related closely with water and minerals uptake, this effect is attributed to the chicken manure, which themself considered a source of nutrients (Table 2), as well as to their effect on improving soil properties and supplying it with available nutrients. In the same line, Sharma and Arya (2001) on cabbage, found that the uptake of N, P and K increased significantly with organic manure.

Table 10. Effect of plant density and chicken manure interaction on chemical analysis of cabbage leaves during 2002/03 and 2003/04 seasons.

Treatments		N accumulation* (mg/plant)		P accumulation* (mg/plant)		K accumulation* (mg/plant)		NO_3** (mg/kg dry wt.)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	0	9286 b	9126 b	1663 b	1565 b	11917 c	11840 c	98 a	101 a
	20	10039 a	9872 a	1863 a	1765 a	13298 a	13122 a	90 b	93 b
11000	0	7077 d	6934 d	1353 c	1258 c	9488 d	9391 d	84 c	87 c
	20	9095 c	8902 c	1653 b	1601 b	12298 b	12290 b	76 d	78 d
16000	0	4675 f	4491 f	1037 d	943 d	6964 f	6870 f	66 e	69 e
	20	6204 e	6038 e	1286 c	1203 c	8547 e	8467 e	59 f	62 f

* In total leaves. ** in inner leaves.

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

5. Influence of interaction between plant density and nitrogen and phosphorus rates:

5.1. Vegetative growth parameters:

Data in Table 11 show that all vegetative growth parameters were significantly affected by the interaction treatments in both seasons. The highest values were obtained from lower plant density (8500 plant/fed) x 100 kg N + 50 kg P_2O_5 /fed in both seasons. On the contrary, plants supplied with 60 kg N + 30 kg P_2O_5 /fed under high plant density (16000 plant/fed) had the poorest plant growth parameters. These findings were true in both seasons. In the same line, Ferreira *et al.* (2002) found that high values for relative growth and net assimilation rate were recorded in plants growing under greater spacing with mineral fertilization.

Table 11. Effect of plant density and N, P levels interaction on some vegetative growth parameters of cabbage plants during 2002/03 and 2003/04 seasons.

Treatments		Plant fresh weight (kg/plant)		Outer leaves weight (kg/plant)		Head diameter (cm)	
Plant density (plant/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	60 + 30	3.09 e	4.02 c	1.78 d	1.87 d	22.8 b	23.6 cd
	80 + 40	4.72 a	5.08 a	2.29 b	2.43 b	23.6 a	24.6 ab
	100 + 50	4.76 a	5.11 a	2.37 a	2.51 a	24.0 a	24.8 a
11000	60 + 30	3.01 e	3.22 e	1.34 g	1.45 f	21.7 c	21.9 e
	80 + 40	3.75 c	4.02 c	1.70 e	1.84 d	22.8 b	23.1 d
	100 + 50	4.32 b	4.70 b	2.05 c	2.18 c	23.7 a	24.1 bc
16000	60 + 30	2.30 g	2.36 g	1.05 h	1.07 g	20.2 e	20.4 f
	80 + 40	2.97 f	3.03 f	1.43 f	1.42 f	21.1 d	21.4 e
	100 + 50	3.60 d	3.57 d	1.81 d	1.74 e	21.7 c	22.0 e

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

5.2. Yield and its components:

Data presented in Table 12 show that yield and its components were significantly affected by interaction between plant density and N and P rates in both seasons. The highest values of head weight were obtained from lower plant densities (8500 plant/fed) x 80 kg N + 40 kg P_2O_5 /fed. While, the highest values of yield and mean time from transplanting to maturity were obtained from high plant density (16000 plant/fed) x 100 kg N + 50 kg P_2O_5 /fed in both seasons. Similar results were obtained by Hill (1990) and Ferreira *et al.* (2002). They found that the highest values of yield were reached in the smallest spacing with mineral fertilizer.

5.3. Head quality and chemical analysis:

The interaction between plant density and N + P levels had a significant effect on head quality and chemical analysis in both seasons.

Table 12. Effect of plant density and N, P levels Interaction on yield and its components during 2002/03 and 2003/04 seasons.

Treatments		Head weight (kg/plant)		Head yield (Ton/fed)		MTTM* (day)	
Plant density (plant/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	60 + 30	1.85 c	1.96 c	20.80 f	22.26 f	112 h	114 g
	80 + 40	2.16 a	2.32 a	24.82 d	25.78 d	122 f	125 f
	100 + 50	2.12 b	2.30 ab	24.88 d	26.05 d	131 e	132 e
11000	60 + 30	1.53 e	1.62 d	22.48 e	23.73 e	120 g	124 f
	80 + 40	1.85 c	1.96 c	27.06 c	27.97 c	131 e	131 e
	100 + 50	2.02 b	2.21 b	30.00 b	30.76 b	138 c	139 c
16000	60 + 30	1.15 g	1.20 f	23.87 d	25.13 d	137 d	137 d
	80 + 40	1.40 f	1.46 e	28.15 e	28.96 c	141 b	145 b
	100 + 50	1.60 d	1.70 d	32.24 d	32.83 a	147 a	150 a

* MTTM: Mean time from transplanting to maturity.

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Data presented in Table 13 show that the highest values of DM% and vitamin C content were obtained from high plant density (16000 plant/fed) and 60 kg N + 30 kg P_2O_5/fed. While, the highest values of protein % were obtained from lower plant density (8500 plant/fed) x 80 kg N + 40 kg P_2O_5/fed.

As regard to chemical analysis, data in Table 14 show that N, P, K accumulation in total leaves and NO_3 accumulation in inner leaves were significantly affected by interaction between plant density and N + P levels in both seasons. The highest means of these traits were obtained with treatments of 8500 plant/fed with 100 kg N + 50 kg P_2O_5/fed. Similar results were obtained by Khadir *et al.* (1989) on cabbage, they reported that lower plant density + 600 kg urea / ha increased leaf N and protein %.

Table 13. Effect of plant density and N, P levels interaction on head quality during 2002/03 and 2003/04 seasons.

Treatments		Dry matter (%)		Vitamin C (mg/100g fresh wt)		Protein (%)	
Plant density (plant/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	60 + 30	8.5 d	8.1 cd	29 e	32 e	15.5 cd	14.8 cd
	80 + 40	7.6 ef	7.3 fg	26 f	29 f	17.9 a	16.9 a
	100 + 50	7.3 f	7.1 g	24 g	26 g	16.8 b	15.9 ab
11000	60 + 30	9.1 bc	8.7 b	35 c	38 c	13.3 e	12.1 e
	80 + 40	8.3 d	7.9 de	32 d	34 d	16.3 bc	15.5 bc
	100 + 50	7.8 e	7.5 ef	29 e	30 e	17.2 ab	16.7 a
16000	60 + 30	9.8 a	9.3 a	43 a	45 a	10.9 f	10.5 f
	80 + 40	9.3 b	8.9 b	38 b	41 b	13.2 e	12.7 e
	100 + 50	8.7 cd	8.3 c	34 c	36 d	14.7 d	14.3 d

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Table 14. Effect of plant density and N, P levels interaction on chemical analysis of cabbage leaves during 2002/03 and 2003/04 seasons.

Treatments		N accumulation* (mg/plant)		P accumulation* (mg/plant)		K accumulation* (mg/plant)		NO_3** (mg/kg dry wt.)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	60 + 30	8243 d	8062 d	1560 d	1459 d	10855 e	10754 e	81 de	85 de
	80 + 40	10330 a	10167 a	1819 b	1723 b	13270 b	13169 b	95 b	98 b
	100 + 50	10414 a	10268 a	1912 a	1814 a	13699 a	13635 a	107 a	108 a
11000	60 + 30	6024 f	5876 f	1262 f	1168 f	8775 g	867 g	65 f	66 f
	80 + 40	8537 c	8390 c	1500 d	1469 d	11214 d	11115 d	85 d	87 d
	100 + 50	9642 b	9487 b	1748 c	1651 c	12691 c	12596 c	90 c	93 c
16000	60 + 30	3777 h	3574 h	934 g	841 g	5933 i	5837 i	49 g	52 g
	80 + 40	5572 g	5367 g	1193 f	1103 f	7867 h	7797 h	61 f	64 f
	100 + 50	6970 e	6833 e	1358 e	1275 e	9468 f	9372 f	78 e	81 e

* In total leaves ** In inner leaves

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

6. Influence of interaction between organic fertilizer and N + P rates:

6.1. Vegetative growth parameters:

Data presented in Table 15 show that all vegetative growth parameters were significantly affected by the interaction treatments in both seasons. The highest values were obtained by applying chicken manure (20 m^3/fed) combined with 100 kg N + 50 kg P_2O_5/fed. This result may be due to chicken manure had a high content of nutrients elements (Table 2) and it may be also improve the soil properties and increased N, P and K elements in cabbage leaves (Table 18). In addition, the superiority in plant growth may be due to increase in nutrients resulted from combining both organic and mineral fertilizers. Similar results were obtained by El-Zawaily *et al.* (2002). They found that applying organic manure combined with ammonium sulphate at 180 kg N/fed tended to produce the highest vegetative growth of pepper plants.

Table 15. Effect of chicken manure and N, P levels interaction on some vegetative growth parameters of cabbage plants during 2002/03 and 2003/04 seasons.

Treatments		Plant fresh weight (kg/plant)		Outer leaves weight (kg/plant)		Head diameter (cm)	
Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
0	60 + 30	2.72 f	2.87 e	1.17 e	1.26 e	21.4 d	21.7 c
	80 + 40	3.51 d	3.66 d	1.58 d	1.64 d	22.3 c	22.8 b
	100 + 50	3.93 c	4.15 c	1.85 c	1.92 c	23.0 ab	25.5 d
20	60 + 30	3.36 d	3.53 d	1.61 d	1.68 d	21.7 d	22.2 c
	80 + 40	4.11 b	4.43 b	2.04 b	2.16 b	22.6 bc	23.4 a
	100 + 50	4.50 a	4.77 a	2.30 a	2.37 a	23.2 a	23.6 a

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

6.2. Yield and its components:

Data in Table 16 clear that the interaction between organic manure and N + P rates had a significant effect on yield and its components in both seasons. The results indicate that 20 cm^3 chicken manure/fed combined with 100 kg N + 50 kg P_2O_5/fed gave the highest values of head weight and head yield. While, 100 kg N + 50 kg P_2O_5/fed without organic manure increased significantly mean time from transplanting to maturity in both seasons. Similar results were obtained by Dixit (1997) on cabbage who found that addition of FYM to N treatments further increased yield (20 ton/ha FYM + 160 Kg N / ha).

6.3. Head quality and chemical analysis:

Data in Table 17 show that all head quality were significantly affected by interaction effect between organic manure and N + P levels. The highest values of DM% were obtained from plant fertilized with 60 kg N + 30 kg P_2O_5/fed without chicken manure.

Table 16. Effect of chicken manure and N, P levels interaction on yield and its components during 2002/03 and 2003/04 seasons.

Treatments		Head weight (kg/plant)		Head yield (Ton/fed)		MTTM* (day)	
Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
0	60 + 30	1.43 e	1.48 e	20.57 d	22.07 d	126 d	130 d
	80 + 40	1.75 c	1.82 c	24.94 c	26.08 c	135 c	137 c
	100 + 50	1.88 b	2.03 b	27.88 b	28.88 b	140 a	142 a
20	60 + 30	1.60 d	1.70 d	24.20 c	25.34 c	117 e	119 e
	80 + 40	1.85 b	2.00 b	28.41 b	29.05 b	127 d	130 d
	100 + 50	2.00 a	2.20 a	30.17 a	30.88 a	137 b	139 b

* MTTM: Mean time from transplanting to maturity.
Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Table 17. Effect of chicken manure and N, P levels interaction on quality of cabbage leaves during 2002/03 and 2003/04 seasons.

Treatments		Dry matter (%)		Vitamin C (mg/100g fresh wt)		Protein (%)	
Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
0	60 + 30	9.4 a	9.0 a	34 b	37 b	12.6 d	11.8 d
	80 + 40	8.7 b	8.2 b	31 c	34 d	15.3 b	14.6 b
	100 + 50	8.1 c	7.8 cd	28 d	30 f	16.3 a	15.6 a
20	60 + 30	8.8 b	8.4 b	36 a	39 a	13.8 c	13.1 c
	80 + 40	8.1 c	7.8 c	33 b	36 c	16.3 a	15.5 a
	100 + 50	7.7 d	7.5 d	30 c	31 e	16.1 a	15.6 a

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 regard to VC content, the highest values were obtained from plants fertilized with 60 kg N + 30 kg P_2O_5/fed combined with chicken manure. Similar results were obtained by El-Aidy *et al.* (2002) reported that applying organic manure combined with ammonium sulphate at 90 kg N/fed increased significantly VC content on pepper fruits.

For protein %, the highest values were obtained from cabbage plants fertilized with chicken manure and 100 kg N + 50 kg P_2O_5/fed or 80 kg N + 40 kg P_2O_5/fed in both seasons. This treatments increased leaf N content (Table 18), which increased protein.

Table 18. Effect of chicken manure and N, P levels interaction on chemical analysis of cabbage leaves during 2002/03 and 2003/04 seasons.

Treatments		N accumulation* (mg/plant)		P accumulation* (mg/plant)		K accumulation* (mg/plant)		NO_3** (mg/kg dry wt.)	
Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
0	60 + 30	5146 f	4986 f	1106 d	1011 e	7536 f	7440 f	69 e	72 e
	80 + 40	7373 d	7201 d	1382 c	1289 d	9729 d	9636 d	84 c	87 c
	100 + 50	8519 c	8363 c	1565 b	1467 c	11104 c	11027 c	95 a	98 a
20	60 + 30	6883 e	6688 e	1397 c	1302 d	9506 e	9406 e	61 f	63 f
	80 + 40	8919 b	8762 b	1625 b	1574 b	11838 b	11752 b	76 d	79 d
	100 + 50	9489 a	9362 a	1780 a	1693 a	12800 a	12709 a	88 b	90 b

* In total leaves. ** In inner leaves.

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Data in Table 18 show that N, P, K accumulation in all leaves and nitrate accumulation in inner leaves were significantly affected by interaction effect between chicken manure x N + P rates in both seasons. The highest values of N, P and K accumulation were obtained from plants fertilized with chicken manure and 100 kg N + 80 kg P_2O_5/fed in both seasons These results may be due to the role of organic and mineral fertilizers in improving both availability and uptake of nutrients from soil by cabbage plants In this

respect, El-Zawaily *et al.* (2002) reported that applying chicken manure combined with ammonium sulphate at 180 kg N significantly increased N, P and K on pepper leaves.

As regard to NO^-_3 accumulation in Table 18 show that the highest values of NO^-_3 were obtained from plants fertilized with 100 kg N + 50 kg P_2O_5/fed without addition chicken manure. Similar results were obtained by Yamazaki and Roppongi (1998), who found that leaf nitrate concentration was lower by organic manure compared with chemical fertilizer. Also, El-Aidy *et al.* (2002) found that ammonium sulphate + chicken manure decreased nitrate on pepper fruits.

7. Influence of interaction between plant density, chicken manure and N and P levels:

7.1. Vegetative growth parameters:

Concerning the interaction between plant density, chicken manure and N + P levels, data in Table 19 show that plant fresh weight, outer leaves weight and head diameter were significantly affected by interaction in both seasons. The highest values were obtained from lower plant density (8500 plant/fed) x chicken manure x 80 kg N + 40 kg P_2O_5/fed without significant differences between 8500 plant / fed x chicken manure x 100 kg N + 50 kg P_2O_5/fed. This results indicate that decrease number of plants in unit area and adding chicken manure combined with N + P gave the plants more chance for absorbing nutrients and this, in turn, increased plant growth.

Table 19. Effect of interaction between plant density, chicken manure and N, P levels on some vegetative growth parameters of cabbage plants during 2002/03 and 2003/04 seasons.

Treatments			Plant fresh weight (kg/plant)		Outer leaves weight (kg/plant)		Head diameter (cm)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	0	60 + 30	3.57 ef	3.74 e	1.67 g	1.74 gh	22.6 de	23.5 cde
		80 + 40	4.48 b	4.78 b	2.14 d	2.25 c	23.7 ab	24.6 ab
		100 + 50	4.74 ab	5.08 a	2.32 c	2.46 b	24.1 a	24.9 a
	20	60 + 30	4.07 cd	4.30 cd	1.88 f	2.03 e	22.9 b	23.7 bcde
		80 + 40	4.96 a	5.38 a	2.44 ab	2.61 a	23.5 abc	25.1 a
		100 + 50	4.78 ab	5.16 a	2.41 b	2.56 a	23.8 a	24.3 abcd
11000	0	60 + 30	2.61 h	2.76 h	1.01 k	1.12 k	21.4 f	21.5 gh
		80 + 40	3.38 fg	3.53 f	1.39 h	1.51 i	22.6 de	22.8 ef
		100 + 50	3.80 de	4.15 d	1.61 g	1.74 gh	23.5 abc	23.8 bcd
	20	60 + 30	3.40 f	3.68 ef	1.66 g	1.78 g	22.00 e	22.3 fg
		80 + 40	4.12 c	4.50 bc	2.02 e	2.16 d	22.9 cd	23.3 de
		100 + 50	4.83 d	5.23 a	2.50 a	2.63 a	23.9 a	24.4 abc
16000	0	60 + 30	1.96 i	2.12 i	0.82 l	0.91 l	20.1 h	20.2 i
		80 + 40	2.67 h	2.65 h	1.20 j	1.14 k	20.7 gh	20.9 hi
		100 + 50	3.38 g	3.21 g	1.62 g	1.56 i	21.4 f	21.7 gh
	20	60 + 30	2.61 h	2.60 h	1.28 i	1.22 j	20.3 h	20.5 i
		80 + 40	3.26 g	3.40 fg	1.66 g	1.70 h	21.5 fg	21.8 gh
		100 + 50	3.89 d	3.93 de	2.01 e	1.93 f	21.9 ef	22.2 fg

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

7.2. Yield and its components:

Concerning the effect of interaction between plant density x chicken manure x N + P levels, data in Table 20 show that head weight, head yield (ton/fed) and mean time from transplanting maturity were significantly affected by these interaction in both seasons. The highest values of head weight were obtained from lower plant density (8500 plant/fed) x chicken manure + 80 kg N + 40 kg P_2O_5/fed. But, the highest head yield / fed were obtained from 11000 and 16000 plant/fed when these plants treated with chicken manure with 100 kg N + 50 kg P_2O_5/fed in both seasons. Similar results were obtained by Farooque and Islam (1989), they found that closest spacing + 326 kg urea/ha + 125 kg/ha triple superphosphate + 200 kg muriate + 8.3 t/ha FYM gave the highest marketable yield of cabbage.

As regard to mean time from transplanting to maturity, data in Table 20 show that the lowest values were obtained from lower plant density x chicken manure x 60 kg N + 30 kg P_2O_5/fed in both seasons.

Table 20. Effect of interaction between plant density, chicken manure and N, P levels on yield and its components during 2002/03 and 2003/04 seasons.

Treatments			Head weight (kg/plant)		Head yield (Ton/fed)		MTTM* (day)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	0	60 + 30	1.72 fg	1.81 ef	18.75 k	20.40 h	115 i	118 k
		80 + 40	2.09 bc	2.23 bc	22.88 hij	24 04efgh	123 g	127 i
		100 + 50	2.15 ab	2.31 ab	24.91fgh	26.03 de	130 e	133 fg
	20	60 + 30	1.99 cd	2.12 cd	22.85 h	24.11efgh	108 j	110 l
		80 + 40	2.22 a	2.41 a	26.76 e	27.51 cde	120 h	123 j
		100 + 50	2.09 bc	2.28 b	24.84fgh	26.07 de	131 e	132 g
11000	0	60 + 30	1.48 hi	1.52 g	20.95 jk	22.39 gh	125 fg	129 hi
		80 + 40	1.82 ef	1.85 e	25.11fgh	26.50cdef	135 d	135 f
		100 + 50	2.01 c	2.19 bcd	28.05 d	29.16 bcd	141 c	141 cd
	20	60 + 30	1.57 h	1.72 f	24.00ghi	25.07 efg	115 i	118 k
		80 + 40	1.89 de	2.07 d	29.01cde	29.43 bcd	126 f	128 i
		100 + 50	2.03 c	2.24 bc	31.86 ab	32.35 ab	135 d	137 e
16000	0	60 + 30	1.07 l	1.12 j	22.00 ij	23.42 fgh	139 c	143 c
		80 + 40	1.35 j	1.39 h	26.83 ef	27.70 cde	146 b	149 b
		100 + 50	1.50 hi	1.60 g	30.67 bc	31.45 ab	149 a	153 a
	20	60 + 30	1.22 k	1.27 i	25.74 fg	26.84cdef	127 f	131 gh
		80 + 40	1.44 ij	1.54 g	29.46 cd	30.21 bc	136 d	140 d
		100 + 50	1.69 g	1.79 ef	33.80 a	34.21 a	144 b	148 b

*** MTTM: Mean time from transplanting to maturity.**

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

7.3. Head quality and chemical analysis:

Regarding to the effect of interaction between plant density, chicken manure and N + P levels on head quality, data in Table 21 show clearly that high plant density (16000 plant/fed) without addition chicken manure + 60 kg N + 30 kg P_2O_5/fed significantly increased DM% and VC content in both seasons. While, protein % was significantly increased by lower plant density (8500 plant/fed) without chicken manure x 80 kg N + 40 kg P_2O_5/fed in both seasons.

Table 21. Effect of interaction between plant density, chicken manure and N, P levels on head quality during 2002/03 and 2003/04 seasons.

Treatments			Dry matter (%)		Vitamin C (mg/100g fresh wt)		Protein (%)	
Plant density (plant/fed)	Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	0	60 + 30	8.9 bc	8.4 def	28 gh	31 def	15.2 cde	14.4 def
		80 + 40	8.0 efg	7.6 hijk	25 ij	28 g	18.2 a	17.1 a
		100 + 50	7.4 gh	7.2 jkl	23 j	25 h	17.0 ab	16.3 abc
	20	60 + 30	8.1 def	7.8 ghi	29 gh	32 de	15.7 bcde	15.2 bcde
		80 + 40	7.2 h	7.0 kl	27 hi	30 ef	17.6 a	16.7 ab
		100 + 50	7.1 h	6.9 l	25 ij	27 g	16.5 abcd	15.4 bcd
11000	0	60 + 30	9.5 ab	9.0 bc	33 de	36 c	12.6 gh	11.3 h
		80 + 40	8.5 cde	8.0 fgh	30 fg	33 d	15.7 bcde	15.0 cde
		100 + 50	7.9 efg	7.6 hijk	28 gh	29 fg	17.5 a	16.7 ab
	20	60 + 30	8.7 cd	8.3 efg	37 bc	39 b	13.9 fg	13.0 fg
		80 + 40	8.1 def	7.7 ghij	34 de	36 c	16.8 abc	16.1 abc
		100 + 50	7.7 fgh	7.4 ijkl	29 gh	31 ef	16.9 a	16.7 ab
16000	0	60 + 30	9.9 a	9.7 a	42 a	44 a	10.0 h	9.6 i
		80 + 40	9.6 a	9.2 ab	37 bc	40 b	11.9 g	11.7 gh
		100 + 50	8.9 bc	8.5 cdef	32 ef	35 c	14.4 ef	13.8 ef
	20	60 + 30	9.6 a	9.0 bcd	43 a	45 a	11.7 g	11.3 h
		80 + 40	8.9 bc	8.6 bcde	39 b	41 b	14.5 ef	11.8 ef
		100 + 50	8.4 cde	8.0 efgh	35 cd	36 c	15.0 de	14.8 cde

Values having the same alphabetical letter within each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Table 22. Effect of interaction between plant density, chicken manure and N, P levels on chemical analysis of cabbage leaves during 2002/03 and 2003/04 seasons.

Treatments			N accumulation* (mg/plant)		P accumulation* (mg/plant)		K accumulation* (mg/plant)		NO_3** (mg/kg dry wt.)	
Plant density (plant/ fed)	Chicken manure (m^3/fed)	N + P_2O_5 (kg/fed)	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04	2002/ 03	2003/ 04
8500	0	60 + 30	7329 fg	7168 h	1414 e	1316 e	9851 h	9749 h	87 de	90 efg
		80 + 40	10198 b	10020 c	1735 c	1638 c	12541 d	12450 d	98 b	101 bc
		100 + 50	10331ab	10190abc	1840 b	1724 b	13360 c	13320 c	109 a	111 a
	20	60 + 30	9157 d	8956 e	1705 c	1602 c	11859 e	11760 e	75 h	79 hi
		80 + 40	10462 a	10320 ab	1902ab	1808 ab	13999 b	13890 b	92 cd	95 cde
		100 + 50	10497 a	10340 a	1983 a	1885 a	14037 b	13950 b	104 a	105 b
11000	0	60 + 30	4761 j	4617 k	1053 g	963 g	7315 k	7215 k	68 i	71 j
		80 + 40	7494 f	7354 g	1412 e	1316 e	9911 h	9816 h	89 cde	92 def
		100 + 50	8977 d	8831 e	1595 d	1495 d	11238 f	11140 f	94 bc	97 cd
	20	60 + 30	7286 g	7135 h	1470 e	1373 e	10235 g	10140 g	61 jk	62 kl
		80 + 40	9580 c	9428 d	1587cd	1622 c	12516 d	12410 d	80 gh	82 hi
		100 + 50	10307ab	10140 bc	1901ab	1808 ab	14144 a	14050 a	86 ef	89 fg
16000	0	60 + 30	3347 m	3174 n	852 h	752 h	5442 n	5354 n	52 l	55 m
		80 + 40	4428 k	4232 l	999 g	913 g	6736 l	6645 l	65 ij	68 jk
		100 + 50	6249 i	6068 j	1259 f	1164 f	8715 j	8611 j	81 fg	85 gh
	-20	60 + 30	4206 l	3974 m	1015 g	929 g	6423 m	6320 m	46 m	48 n
		80 + 40	6715 h	6542 i	1387 e	1292 e	8998 i	8948 i	57 kl	60 lm
		100 + 50	7690 e	7598 f	1456 e	1386 e	10220 g	10130 g	75 h	77 i

* In total leaves. ** In inner leaves.

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 regard to chemical analysis, data in Table 22 showed that N, P, K accumulation in all leaves and nitrate accumulation in inner leaves were significantly affected by plant density x chicken manure x N + P rates in both seasons. The highest values were obtained from lower plant density (8500 plant/fed) + chicken manure + 100 kg N + 50 kg P_2O_5/fed.

As regard to NO^-_3 accumulation in head leaves, the lowest values were obtained from high plant density x chicken manure x 60 kg N + 30 kg P_2O_5/fed. In general NO_3 accumulation is in range of 48-111 mg/kg dry weight. This range considers less than the critical concentration tolerated by human body.

CONCLUSION

This investigation suggest that using 11000 plant/fed x application of chicken manure (20 m^3/fed) x 100 kg N + 50 kg P_2O_5/fed is indispensable for improving cabbage (cv. Brunswick) growth / yield and quality.

REFERENCES

AOAC (1990). Association of Official Analytical Chemists. Official Methods of Analysis. 15th Ed. Washington, DC, USA.

Badawi, M.A. (2002). Organic farming of tomato in sandy soil. Minufiya J. Agric. Res., 27(1):75-86.

Bulluck, L.R.; Brosius, M.; Evanylo, G.K. and Restaino, J.B (2002). Organic and synthetic fertility amendments influence soil microbial, physical and chemical properties on organic and conventional farm. Applied Soil Ecology, 19:147-160.

Chapman, H.D. and Pratt, P.F. (1961). Methods of Analysis for Plants and Waters. Publication No. 4034, Agric. Sci. Publication, Univ. of California, Berkeley, California, USA.

Clark, M.S.;-Horwath, W.R.; Shennan, C. and Scow, K.M. (1998). Changes in soil chemical resulting from organic and law input farming practices. Agron. J , 90:662-671.

Dixit, S.P. (1997). Effect of nitrogen and farmyard manure on the production of cabbage in dry temperate high hills zone of *Himachal Pradesh*. Annals Agric. Res., 18(2):258-261 (C.F. Hort. Abst., 67(11):9445).

Duncan, B.D. (1965). Multiple range and multiple F test. Biometrics, 11:1-42.

El-Aidy, F.; El-Zawaily, A.I.; El-Sawy, B.I. and Bayoumi, Y.A. (2002). Effect of organic and mineral fertilization on sweet pepper under plastic houses. II. Fruit yield and its quality. 2nd Inter. Conf. Hort. Sci., 10-12 Sept, Kafr El-Sheikh, Tanta Univ , Egypt. J. Agric. Res. Tanta Univ., 28(3/II):576-589.

El-Fouly, M.M.; Fawzi, A.F.A. and El-Sayed, A.A. (1997). Nutritional deficiencies in cotton in Egypt. Proc. FAO, IRCRNC, Joint Meeting the Working Group 4 & 3 (Cotton Nutritional & Growth Regulators), 20-23 March, 1995, Cairo, Egypt, PP. 59-65, 1997.

El-Mowelhi, N.M.; Hossein, M.A.; Mitkess, M.I.M. and Shobassy, A.I. (1973). Micro-nutrients status in some soils of Egypt. Agric. Res. Rev., Cairo, 51(2).91-120.

El-Shabrawy, R A.; Mohamed, F.I. and Rezkallah, W.R. (1999). Effect of sulphur, nitrogen and phosphorus soil application on growth, yield, quality and chemical contents of cabbage plants (*Brassica oleraceae* var. *Capitata* L.). J. Agric. Sci. Mansoura Univ., 24(9):4999-5009.

El-Zawaily, A.I.; El-Aidy, F.; El-Sawy, B.I. and Bayoumi, Y.A. (2002). Effect of organic mineral fertilization on sweet pepper plants grown under plastic houses. I. Vegetative growth and chemical analysis. 2nd Inter. Conf. Hort. Sci., 10-12 Sept., Kafr El-Sheikh, Tanta Univ., Egypt. J. Agric. Res. Tanta Univ., 28(3/II):562-575.

Farooque, A.M. and Islam, A.F.M. (1989). Effect of spacing and different management practices on the growth and yield of cabbage. Bangladesh Hort., 17(1):45-47

Ferreira, W.R.; Ranal, M.A. and Filgueira, F A.R (2002). Fertilizers and spacing between plants in the yield of Malgsian cabbage. Hort. Brasileira, 20(4):635-640.

Firoz, Z.A.; Masud, M.A.T. and Rahman, M.A. (2000). Effect of spacing and mulching on the growth and yield of Chinese cabbage. Bangladesh J. Agric. Res., 25(1):95-102.

Hamiss, M.R. and Abdel-Salam, M.E. (1999). Fertilizer management for cotton in Egypt. Adv. Agric. Res. Egypt, 1(1):53-113.

Hassan, M.N.M.; Mahmoud, S.H.; Gad El-Hak, S.H. and Mahmoud, M.M. (1994). Influence of nitrogen, phosphorus and potassium fertilization rates on growth and yield of cabbage. Minia J., 16(1):21-42

Hill, T R. (1990). Effect of plant spacing and nitrogen fertilizer on the yield and plant conformation of Chinese cabbage (*Brassica compestris sp. Pekinensis*). Australian J. Exper. Agric., 30(3):437-439.

Ibrahim, E.A. (2001). Effect of transplant age, biofertilization and nitrogen fertilizer on growth and yield of cabbage. Ph.D. Thesis, Fac. Of Agric., Mansoura Univ., Egypt.

Ibrahim, E.A.; Abo El-Nasr, M.E. and El-Shabrawy, R.A. (2004). Response of cauliflower to organic and bio-fertilizers and nitrogen levels. J. Agric. Sci. Mansoura Univ., 29(10):5763-5772

Jackson, M.L. (1973). Soil Chemical Analysis. 2nd Ed., Prentice Hall of Indian Private Limited, New Delhi.

Jacobs, M.B. (1951). The Chemical Analysis of Foods and Food Products. 1st Ed., PP. 724-732. D. Van. Nostrand Comp., New York, USA.

Khadir, Q.A.; Marzat, S.K. and Sodoun, S.A. (1989). Effect of different levels of urea fertilizer and plant spacing on growth and yield of cabbage Dirasat, 16(9):88-105.

Khafagy, E.E.E. (1999). Reducing potential for adverse environmental impacts of inorganic nitrogen in agro-ecosystem. M.Sc. Thesis, Fac. Of Agric., Mansoura Univ., Egypt.

Khalifa, M.R. (1993). Some soil properties, yield and elemental composition of seeds and leaves of broad bean plants as influenced by some organic waste products. J Agric. Res. Tanta Univ., 19(4):1000-1011.

Khalil, M.E.A.; Nadia M. Badran and El-Emam, M.A.A. (2000). Effect of different organic manures on growth and nutritional status of corn. Egyptian J. Soil Sci., 40(1/2):245-263.

Klute, A. (1986). Methods of Soil Analysis. 2nd Ed. Part 1, Soil Sci., Amer., Madison, Wisc, USA.

Koriem, M.A. (1993). Influence of sewage sludge and farmyard manure applications on some properties of clay soil and root yield of carrot. J. Agric. Res. Tanta Univ., 19(4):1012-1022.

Mahmoud, M.R.; El-Shabrawy, R.A. and El-Masri, M.F. (2004). Effect of plant spacing, nitrogen fertilizer levels and zinc foliar spray on productivity of cabbage in calcareous soil. J. Agric. Sci. Mansoura Univ., 29(9):5147-5158.

Mehana, T.A. (1998). Effect of N-serve nitrogen stablizer and chicken manure on some soil properties and mineral composition of maize plants. 7th Conf. Agric. Dev. Res., Fac. Agric., Ain Shams Univ., Cairo, December 15-17, Annals Agric. Sci., SP. Issue I, 333-348.

Page, A.L. (1982). Methods of Soil Analysis. 2nd Ed., Part 1, Soil Sci. Soc. Amer., Madison, Wisc, USA.

Sharma, K.C. and Arya, P.S. (2001). Effect of nitrogen and farmyard manure on cabbage (*Brassica oleraceae* var. *Capitata*) in dry zone of Himachal Pradesh. Indian J. Agric. Sci., 71(1):60-61.

Singh, J.P. (1988) A rapid for determination of nitrate in soil and plant extracts. Plant and Soil, 110:137-139

Srinvas, S.K. (1984). Note on response of cabbage to plant density and fertilizers. J. Hort., 41(3/4).

Stoffella. P.J. and Fleming, M.F. (1990). Plant population influences yield and variability of cabbage. J. Amer. Soc. Hort. Sci., 115(5):708-711.

Yamazaki, H. and Roppongi, K. (1998). The effect of organic matters application for leaf vegetable yield and quality. Bulletin of the Saitama Hort. Exper. Sta., No. 21:7-20.

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إستجابة نباتات الكرنب صنف بروتزويك للكثافة النباتية والتسميد العضوى ومعدلات التسميد النيتروجينى والفوسفاتى

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أجريت تجربتان حقليتان فى محطة بحوث البساتين بالبرامون – دقهلية لدراسة تأثير كل من الكثافة النباتية ٨,٥ ، ١١ ، ١٦ ألف نبات للفدان (حيث تم شتل النباتات على مسافات ٤٥ × ٧٥ سم ، ٣٥ × ٧٥ سم ، ٢٥ × ٧٥ سم) وإضافة سماد الدواجن بمعدل صفر ، ٢٠ م^3 للفدان والتسميد بالنيتروجين والفوسفور بمعدل ٦٠ + ٣٠ ، ٨٠ + ٤٠ ، ١٠٠ + ٥٠ كجم ن + فو$_2$أ$_5$ للفدان على التوالى. إستخدم تصميم القطع المنشقة فى قطاعات كاملة العشوائية فى ثلاث مكررات ، حيث وزعت الكثافة النباتية فى القطع الرئيسية ومستويات سماد الدواجن فى القطع الشقية الأولى بينما خصصت القطع الشقية الثانية لمعدلات التسميد النيتروجينى والفوسفاتى. وتلخص أهم النتائج فيما يلى:-

١- تأثير الكثافة النباتية: أثرت الكثافة النباتية معنوياً على جميع الصفات المدروسة فى كلا الموسمين. حيث أدت الكثافة النباتية العالية ١٦ ألف نبات للفدان إلى نقص معنوى فى متوسط وزن النبات ، متوسط وزن الأوراق الخارجية وقطر ووزن الرأس ، بينما زاد المحصول معنوياً بزيادة الكثافة النباتية بسبب زيادة المادة الجافة وفيتامين ج ونقص فى البروتين ، بينما أدت الكثافة النباتية المنخفضة (٨,٥ ألف نبات للفدان) إلى زيادة معنوية فى محتوى أوراق الكرنب من النيتروجين والفوسفور والبوتاسيوم وتراكم النترات.

٢- تأثير التسميد العضوى: أدى التسميد العضوى بسماد الدواجن بمعدل ٢٠ م^3 للفدان إلى زيادة معنوية فى متوسط وزن النبات ووزن الأوراق الخارجية ووزن الرأس ، المحصول الكلى للفدان وتقليل عدد الأيام من الشتل حتى الحصاد. ونقص فى المادة الجافة ، بينما زاد فيتامين ج والبروتين نتيجة إضافة سماد الدواجن. كما أدى التسميد العضوى إلى زيادة محتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم وتقليل محتوى الأوراق معنوياً من النترات.

٣- تأثير التسميد النيتروجينى والفوسفاتى: أدى التسميد النيتروجينى والفوسفاتى بمعدل ١٠٠ كجم ن + ٥٠ كجم فو$_2$أ$_5$ للفدان إلى زيادة معنوية فى متوسط وزن النبات ، وزن الأوراق الخارجية ، وقطر ووزن الرأس وزيادة المحصول / فدان وزيادة عدد الأيام من الشتل حتى الحصاد. بينما التسميد بمعدل ٦٠ كجم ن + ٣٠ كجم فو$_2$أ$_5$ للفدان أدى إلى زيادة المادة الجافة وفيتامين ج . بينما زادت نسبة البروتين ومحتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم وتراكم النترات بزيادة معدل التسميد النيتروجينى والفوسفاتى حتى ١٠٠ كجم ن + ٥٠ كجم فو$_2$أ$_5$ للفدان.

هذا وقد كان للتفاعل بين عوامل الدراسة تأثيراً معنوياً على جميع الصفات المدروسة.

وتوصى الدراسة للحصول على أعلى محصول وجودة بشتل نباتات الكرنب صنف بروتزويك بـ ١١ ألف نبات / فدان وإضافة ٢٠ م^3 سماد دواجن للفدان والتسميد بـ ١٠٠ كجم ن + ٥٠ كجم فو$_2$أ$_5$ للفدان تحت الظروف المماثلة لمحافظة الدقهلية.