SOME AGRICULTURAL PRACTICES TO IMPROVE THE PRODUCTIVITY OF CABBAGE UNDER SINAI CONDITIONS

El Sagan, Mohamed A.M.
Department of Plant Production, Desert Research Center, 1 Mathaf El-Matareya St., El-Matareya 11753, Cairo, Egypt
E-mail: drm_elsagan@yahoo.com

The field work was carried out at the Experimental Farm of the Desert Research Center, East El-Qantara, Ismailia Governorate during two consecutive seasons of 2012/2013 and 2013/2014. The experiments were conducted to investigate the effect of compost rates and foliar spray with biohorm and chitosan on growth, yield and chemical composition of two cabbage varieties grown under sandy soil. Os cross cv. had the highest values of number of leaves /plant, head diameter, head weight, the percentage of dry matter and yield as compared with Nabrawy. Compost application enhanced growth parameters and yield. The highest values were obtained with 8 and 6 ton/fed. Also, chitosan treatment significantly increased head weight and diameter, number of leaves/plant and yield. As for chemical composition, Nabarawy cv. had the highest K content. Compost application at rate of 6 ton/fed increased N and K contents. Chitosan treatment showed significant increase of N, while biohorm treatment gave the highest K, Fe and Cu contents. A linear correlation showed that average of head weight was positively correlated with both head diameter and number of leaves per head. Also, total yield was positively correlated with head weight, head diameter and number of leaves per plant. In general, it might be concluded that Os cross proved to be a high yielded cultivar as compared with Nabarawy. In addition, compost application at rate of both 8 and 6 ton/fed, gave the highest total yield. Moreover, yield of cabbage plant sprayed with chitosan had the highest values.

Keywords: compost, chitosan, biohorm, growth, yield, chemical composition, Egypt

Food and Agricultural Organization (FAO 1988) has identified cabbage as one of the top twenty vegetable crops and an important source of

global food. It has been domesticated and used for human consumption since the earliest antiquity (Smith 1995). It is a rich source of vitamin A and C.

Many investigators showed that growth characters of cabbage differ according to cultivars. Olaniyi and Ojetayo (2012) evaluated the growth of two cabbage varieties and eight fertilizer types. They showed that 12 weeks after sowing, Copenhagen Market had mean number of plant leaves, height and yield higher than that of F1 Milor variety. Also, Obiadalla et al. (2012) assessed ten Egyptian ecotypes of cabbage for yield, earliness and some quality characteristics. They found that there were yield differences among the investigated genotypes. In addition, Wambani et al. (2007) evaluated six cabbage varieties and found that Gloria cv. had the highest fresh marketable yield compared with other genotypes.

Maintenance of sufficient levels of organic matter in the soil is prerequisite for sustainable and high production of cabbage (Yamazaki and Roppongi, 1998). Enrichment of compost with mineral NPK fertilizers could further increase the Chinese cabbage yield (Wei and Liu, 2005). Also, Ibrahim et al. (2011) found that characters of cabbage cv. Balady Mohassan were significantly increased with increasing rate of rice straw compost. Moreover, Vimala et al. (2006) concluded that about 40 t/ha of processed poultry manure, as the sole source of nutrients, can be recommended for organic cultivation of cabbage.

Phallus and Marsono (2008) showed that the organic fertilizer had a complete nutrient content in small amounts. Although the used levels were low but they were able to improve soil conditions. Organic carbon content was quite high and had nutrient content of nitrogen, phosphorus, potassium and calcium. They added that organic fertilizer improved soil structure and air status, which in turn ease nutrient absorption by plants. In addition, Rono et al. (2003) showed that compost and inorganic fertilizer application gave significantly higher yields than the non-fertilized (control) plots. However, application of organic manure either at rate of 5 or 10 t/ha combined with inorganic fertilizer increased cabbages yield from 3.92 (control) to 35.37 t/ha and 66.72 t/ha, respectively.

Talkah (2004) concluded that compost can increase the productivity of bean, tomato and watermelon plants. His results indicated that the use of organic fertilizers increased fruit weight of melon plants. The same author in 2008 found significant positive effect of varieties combined with compost manure on crop production of cauliflower. Moreover, he found in 2014 that the optimum dose for cabbage Sakata cv. was 4 tons compost manure/ha.

Chitosan is derived from chitin, a polysaccharide found in exoskeleton of shellfish such as shrimp, lobster or crabs and cell wall of fungi (Wojdyla, 2001). Recently, some researchers reported that chitosan enhanced plant growth and development (Chibu and Shibayama, 2003 and

Gornik et al., 2008). They reported that application of chitosan increased key enzymes activities of nitrogen metabolism (nitrate reductase, glutamine synthetase and protease) and improved the transportation of nitrogen in the functional leaves which, in turn, enhanced plant growth and development. Also, Mondal et al. (2012) reported that growth, biochemical parameters and yield of okra were increased with increasing concentration of chitosan up to 125 ppm; with no significant differences between foliar application of chitosan at 100 or 125 ppm.

Ascorbic acid and citric acid are the common antioxidant components of biohorm and had effects on plant growth and many physiological processes. In addition, Mourad (2006) and Al-Kahal et al. (2008) reported that foliar spray of ascorbic acid and citric acid had a positive effect on plant growth and yield of many crops. Moreover, Chen and Aviad (1990) observed that the use of fulvic acid either in the nutrient solution or foliar spray at concentrations of 25 to 30 mg/l increased growth of many plants. Furthermore, fulvic acid increased uptake of N, P, K, Ca, Mg in cucumbers (Rauthan and Schnitzer, 1981) and enhanced quantitative and qualitative characteristics of tomato plants (Samavat and Samavat, 2014).

Most soils in the Eastern part of Ismailia Governorate, which located in Sinai, are sandy soils and very poor in organic matter and nutrients. Moreover, irrigation of this area depends on El-Salam canal water, which is mixed with agricultural draining water. The objective of this work was to study the effect of compost rate and spray with natural growth enhancers, *i.e.,* biohorm and chitosan on growth, yield and chemical composition of two cabbage varieties growing in sandy soil.

MATERIALS AND METHODS

The field work was carried out during two consecutive growth seasons of 2012/2013 and 2013/2014 at East El-Qantara Station of the Desert Research Center, Ismailia Governorate. The experiments were conducted to investigate the effect of compost rate and spray with natural growth enhancers (biohorm and chitosan) on growth and yield and its components as well as the chemical composition of two cabbage varieties grown in sandy soil, and irrigated with Nile water mixed with agricultural drainage water. The physical and chemical properties of the soil at the different depths as well as the chemical analysis of irrigation water and compost were presented in tables (1, 2 and 3), respectively. It was performed according to the

Table (1). Some physical and chemical properties of soil.

Soil depth (cm)	Texture class	Bulk density (mg m^{-3})	Moisture content (%)		Available soil water (%)	pH	EC (ds/m)	Soluble cations (me/l)			
			Field capacity	Wilting point				Ca^{++}	Mg^{++}	Na^{+}	K^{+}
0 - 25	Sandy loam	1.40	11.79	2.08	9.71	8.01	3.31	6.00	11.40	14.80	0.90
25 - 50	Sandy loam	1.38	11.88	3.66	8.22	7.43	3.66	9.50	12.50	14.30	0.30
50 - 75	Sandy loam	1.42	11.75	3.62	8.13	7.60	3.54	6.50	14.50	14.10	0.30
.verage	Sandy loam	1.42	11.81	3.12	8.69	7.68	3.50	7.33	12.80	14.40	0.50

pH: acidity, E.C.: electrical conductivity, me/l: milli equivalent per liter, mg m^{-3}: mega gram per cubic meter

Table (2). Chemical analysis of irrigation water.

Samples	pH	EC (ds/m)	S.A.R.	Soluble cations (me/l)				Soluble anions (me/l)			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	$CO_3^{=}$	HCO_3^{-}	$SO_4^{=}$	Cl^{-}
Initial	8.20	1.62	5.22	3.15	3.20	9.30	0.50	0.40	5.40	2.20	8.20
1st season	7.52	1.63	5.50	3.00	3.10	9.60	0.60	0.10	5.60	2.10	8.50
	8.26	1.58	5.20	3.10	3.15	9.20	0.30	0.30	3.50	3.00	9.00
2nd season	8.10	1.65	5.52	3.25	3.05	9.80	0.40	0.50	3.81	3.69	8.50
	8.30	1.51	4.48	3.20	3.25	8.05	0.60	0.30	3.50	2.30	9.00
Average	8.08	1.60	5.18	3.14	3.15	9.19	0.48	0.32	4.36	2.66	8.64

pH: acidity, E.C.: electrical conductivity, dSm^{-1}: decimenz per meter, S.A.R: sodium adsorption ratio,
me/l: mille equivalent per liter

Table (3). Analysis of the used compost manure in the two growing seasons.

Season	Moisture %	Organic matter %	C %	C/N ratio	N %	P %	K %	pH	EC (ds/m)
1st	27	36.74	19.0	1:15.8	1.20	0.78	0.82	7.76	3.44
2nd	28	34.90	17.8	1:15	1.23	0.75	0.86	7.30	3.83

methods described by Page et al. (1982) for soil analysis and Klute (1986) for irrigation water analysis. The experiment included 24 treatments, which were the combination of two cabbage cultivars (OS cross and Nabarawy), four rates of compost (0, 4, 6 and 8 ton/fed) and three foliar spray treatments (biohorm, chitosan and tap water as control).

Biohorm consists of kinetin, citric, ascorbic and fulvic acids, 20% l free amino acids, 4% molybdenum and 0.005% CO. Biohorm (produced by Union Company for Agricultural Development) was applied at the rate of 50 ml with 200 l water/fed. Chitosan (commercial compound) consists of polysaccharide derived from chitin, mineral components such as N, P, K, Fe, Zn, and Cu at concentrations of 1000, 500, 500, 100, 100 and 50 ppm, respectively. It was sprayed at the rate of 2.5 ml/l. The assigned compost treatments were added to the soil one month before transplanting. While, the foliar sprays were applied 30 and 60 days after planting date.

Split split plot design with three replications was used. Cultivars were assigned in the main plots, compost treatments were randomly arranged in the sub plots and foliar spray were distributed in the sub-sub plots. The area of the experimental unit was 10.5 m². Cabbage seedlings were transplanted on 15th and 20th November of the first and second seasons, respectively.

Calcium super-phosphate (16% P_2O_5) at rate of 350 kg/fed was added during soil preparation. Ammonium sulphate (20.5% N) applied at rate of 300 kg/fed and potassium sulphate (48% K_2O) at rate of 150 kg/fed were applied. Nitrogen and potassium quantities were divided into three doses and applied within drip irrigation system starting at 30 days after transplanting until the end of the seasons. The growing seasons extended for 110 days from transplanting.

Three plants were taken from each experimental unit at harvest to record the following data:

Growth characters:

1. Plant height and leg length
2. Head diameter and weight
3. Number of leaves/plant
4. Dry matter percentage of plant leaves, which was estimated according to A.O.A.C. (1975).
5. Total yield per fed
6. Marketable yield percentage

Chemical composition

The mineral content of plant leaves was estimated using the wet ash procedure for the dry powdered samples according to Johnson and Ulrich (1959).

1. Potassium was determined using a flame photometer according to the method of Brown and Lilliland (1964).
2. Phosphorus was determined using the colorimetric method following the procedure described by Cottenie et al. (1982).
3. Total nitrogen was determined using the modified micro Kjeldah method.
4. Heavy metals content (Ni, Pb, Cr, Cu and Fe) were determined using Inductively Coupled Argon Plasma, iCAP 6500 Duo, Thermo Scientific, England. An amount of 1000 mg/l multi-element certified standard solution, Merck, Germany was used as stock solution for instrument standardization.

Statistical Analysis

Obtained data were subjected to the statistical analysis according to Thomas and Hills (1975).

RESULTS AND DISCUSSION

1. Growth Parameters

The effect of cultivars, compost and foliar spray with growth enhancer on cabbage growth is presented in tables (4-6). Results revealed that there were significant differences between the tested cultivars. Os cross cv. had the highest values of head diameters, number of leaves/plant, head weight and the percentage of dry matter in both growing seasons. While, plant height and leg length of Nabarawy cv. significantly surpassed those of Os cross cv. in both growing seasons. Differences between cultivars could be due to genetic differences. Obtained results were in agreement with those obtained by Wambani et al. (2007), Obiadalla et al. (2012) and Talkah (2008).

Concerning the effect of compost on cabbage growth, data presented in tables 4-6 show that compost application significantly enhanced the investigated growth parameters. No clear trend was observed with respect to the studied compost rates. The enhancement effect of compost on plant growth may be due to its effect on improving soil water holding capacity and soil structure and increasing availability of nutrients needed for plant growth as the experimental soil was sandy and poor in nutrients (Table 1) and the used compost contained considerable contents of organic matter and nutrients (Table 3). Such suggestions agreed with Rono et al. (2003), Vimala et al. (2006), Phallus and Marsono (2008), Ibrahim et al. (2011) and Talkah (2008).

Regarding cabbage growth as affected with foliar spray with growth enhancers, results in tables 4-6 show that chitosan increased significantly

Table (4). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancers on plant height and leg length at harvest time during growth seasons of 2012/2013 and 2013/2014.

Characters		Plant height (cm)								Leg length (cm)							
Seasons		1st season				2nd season				1st season				2nd season			
Treatments		Bio.	Chit.	Cont.	X̄	Bio.	Chit.	Cont.	X̄	Bio.	Chit.	Cont.	X̄	Bio.	Chit.	Cont.	X̄
Cv.	Compost (ton/fed)																
Nabarawy	4	43.57	40.40	40.55	41.51	47.01	43.84	44.15	45.00	7.08	7.30	7.90	7.43	6.48	6.70	7.30	6.83
	6	40.70	40.27	37.77	39.58	44.30	43.87	35.20	41.12	8.40	8.23	6.29	7.64	7.80	7.63	6.15	7.19
	8	35.75	39.60	39.70	38.35	39.95	38.80	39.23	39.33	5.89	5.84	5.99	5.91	5.75	5.70	5.90	5.78
	control	36.95	36.55	34.40	35.97	41.15	40.45	38.30	39.97	6.75	6.25	5.65	6.22	6.75	5.60	4.68	5.68
	X̄	39.24	39.20	38.10	38.85	43.10	41.74	39.22	41.35	7.03	6.91	6.46	6.80	6.70	6.41	6.01	6.37
OS cross	4	31.10	28.50	32.70	30.77	35.00	32.40	36.60	34.67	6.27	5.23	5.30	5.60	5.30	4.73	5.03	5.02
	6	32.05	30.40	30.45	30.97	35.95	32.90	32.95	33.93	5.25	4.65	6.05	5.32	4.98	4.38	5.78	5.05
	8	33.40	30.45	32.60	32.15	36.13	33.65	35.80	35.19	6.95	5.50	5.08	5.84	6.68	5.23	4.88	5.60
	control	32.15	28.00	34.05	31.40	31.20	36.65	32.65	33.50	4.45	6.40	5.90	5.58	4.38	6.33	5.83	5.51
	X̄	32.18	29.34	32.45	31.32	34.57	33.90	34.50	34.32	5.73	5.45	5.58	5.59	5.33	5.17	5.38	5.29
X̄	4	37.33	34.45	36.63	36.14	41.00	38.12	40.38	39.83	6.68	6.27	6.60	6.51	5.89	5.72	6.17	5.92
	6	36.38	35.33	34.11	35.27	40.13	38.38	34.08	37.53	6.83	6.44	6.17	6.48	6.39	6.01	5.97	6.12
	8	34.58	35.03	36.15	35.25	38.04	36.23	37.52	37.26	6.42	5.67	5.54	5.88	6.22	5.47	5.39	5.69
	control	32.48	35.30	32.23	33.33	36.18	38.55	35.48	36.73	5.60	6.33	5.78	5.90	5.57	5.97	5.26	5.60
	X̄	35.19	35.03	34.78		38.84	37.82	36.86		6.38	6.18	6.02		6.02	5.79	5.69	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					1.06				2.25				0.99				0.87
Compost (comp.)					1.84				1.55				0.47				ns
Spray treatments (ST.)					ns				1.15				ns				ns
(Cv.) * (comp.)					2.60				2.20				0.67				0.69
(Cv.) * (ST.)					ns				1.62				ns				ns
(comp.)* (ST.)					ns				2.29				ns				ns
(Cv.)* (comp.) * (ST.)					ns				3.24				1.24				1.21

Bio.= Biohorm, Chit.= Chitosan and Cont.= Control.

Table (5). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancers on head diameter and numbers of leaves/plant at harvest time during growth seasons of 2012/2013 and 2013/2014.

Seasons		Head diameter (cm)								No. of leaves/plant							
Characters		1st season				2nd season				1st season				2nd season			
Treatments		Bio.	Chit.	Cont.	X̄	Bio.	Chit.	Cont.	X̄	Bio.	Chit.	Cont.	X̄	Bio.	Chit.	Cont.	X̄
Cv.	Compost (ton/fed)																
Nabar-awy	4	28.2	32.5	26.5	29.1	24.6	28.7	23.9	25.8	27.8	28.5	24.5	26.9	29.8	30.5	26.8	29.1
	6	27.6	27.3	27.4	27.4	25.6	27.5	26.3	26.4	23.0	28.3	24.0	25.1	25.5	30.8	26.5	27.6
	8	31.2	29.8	27.0	29.3	26.9	31.0	24.6	27.5	26.0	28.7	23.7	26.1	28.8	31.7	26.7	29.1
	control	28.7	26.2	24.7	26.5	25.5	26.1	24.4	25.3	22.3	26.7	21.7	23.6	25.3	29.5	24.2	26.3
	X̄	28.9	29.0	26.4	28.1	25.7	28.3	24.8	26.3	24.8	28.0	23.5	25.4	27.4	30.6	26.0	28.0
OS cross	4	36.3	39.1	31.8	35.7	32.5	35.8	36.6	35.0	33.7	38.3	30.7	34.2	36.2	40.8	34.7	37.2
	6	32.9	34.9	37.5	35.1	39.9	40.6	37.0	39.2	35.3	40.3	34.3	36.7	39.3	44.3	38.3	40.7
	8	36.5	34.1	37.1	35.9	39.2	42.0	37.3	39.5	37.3	42.0	33.3	37.6	42.0	47.0	38.3	42.4
	control	35.2	36.0	31.8	34.3	40.6	40.2	34.4	38.4	33.0	37.0	32.3	34.1	38.0	40.0	35.3	37.8
	X̄	35.2	36.0	34.5	35.3	38.1	39.6	36.3	38.0	34.8	39.4	32.7	35.6	38.9	43.0	36.7	39.5
X̄	4	32.3	35.8	29.1	32.4	28.6	32.3	30.3	30.4	30.8	33.4	27.6	30.6	33.0	35.7	30.8	33.1
	6	30.2	31.1	32.5	31.3	32.8	34.1	31.6	32.8	29.2	34.3	29.2	30.9	32.4	37.6	32.4	34.1
	8	33.9	31.9	32.0	32.6	33.1	36.5	30.9	33.5	31.7	35.3	28.5	31.8	35.4	39.3	32.5	35.8
	control	32.0	31.1	28.2	30.4	33.1	33.1	29.4	31.9	27.7	31.8	27.0	28.8	31.7	34.8	29.8	32.1
	X̄	32.1	32.5	30.5		31.9	34.0	30.6		29.8	33.7	28.1		33.1	36.8	31.4	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					1.54				0.67				1.27				1.33
Compost (comp.)					1.67				1.33				1.93				1.91
Spray treatments (ST.)					1.16				0.94				1.14				1.14
(Cv.) * (comp.)					ns				1.88				ns				2.71
(Cv.) * (ST.)					ns				ns				ns				ns
(comp.)* (ST.)					2.32				1.88				ns				ns
(Cv.)* (comp.) * (ST.)					ns				2.66				ns				ns

Bio.= Bioborm, Chit.= Chitosan and Cont.= Control.

Table (6). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancers on head weight and percentage of dry weight at harvest time during growth seasons of 2012/2013 and 2013/2014.

Characters		Head weight (kg)/plant								Dry matter %							
Seasons		1st season				2nd season				1st season				2nd season			
Treatments		Bio.	Chit.	Cont.	$\bar{X}$	Bio.	Chit.	Cont.	$\bar{X}$	Bio.	Chit.	Cont.	$\bar{X}$	Bio.	Chit.	Cont.	$\bar{X}$
Cv.	Compost (ton/fed)																
Nabar-awy	4	2.71	2.56	2.87	2.71	2.25	2.71	2.56	2.51	7.70	8.02	8.52	8.08	8.59	7.83	9.71	8.71
	6	2.53	2.86	2.28	2.56	2.24	2.36	2.17	2.26	7.52	7.00	8.25	7.59	8.77	8.02	9.04	8.61
	8	2.78	3.14	2.37	2.76	2.30	2.38	2.51	2.40	7.72	6.76	7.95	7.48	8.15	7.39	8.93	8.15
	control	2.12	2.42	2.25	2.26	2.44	2.97	2.17	2.52	7.87	6.71	9.36	7.98	7.73	7.21	8.60	7.85
	$\bar{X}$	2.54	2.74	2.44	2.57	2.31	2.60	2.35	2.42	7.70	7.12	8.52	7.78	8.31	7.61	9.07	8.33
OS cross	4	3.38	2.80	2.81	3.00	2.44	3.31	2.61	2.79	9.08	8.28	9.03	8.79	8.94	8.92	8.66	8.84
	6	3.37	3.32	3.74	3.48	3.80	3.54	3.53	3.62	7.93	8.95	9.63	8.84	8.86	8.75	9.86	9.15
	8	3.38	3.89	3.01	3.42	3.52	3.64	3.75	3.64	8.33	8.15	10.08	8.85	8.76	9.48	9.77	9.34
	control	2.54	3.06	2.84	2.81	2.36	2.51	2.54	2.47	6.28	5.67	6.40	6.11	8.94	9.13	9.68	9.25
	$\bar{X}$	3.16	3.27	3.10	3.18	3.03	3.25	3.11	3.13	7.91	7.76	8.78	8.15	8.87	9.07	9.49	9.15
$\bar{X}$	4	3.04	2.68	2.84	2.85	2.34	3.01	2.58	2.65	8.39	8.15	8.77	8.44	8.77	8.37	9.18	8.78
	6	2.95	3.09	3.01	3.02	3.02	2.95	2.85	2.94	7.73	7.98	8.94	8.22	8.81	8.38	9.45	8.88
	8	3.08	3.51	2.69	3.09	2.91	3.01	3.13	3.02	8.02	7.46	9.01	8.16	8.45	8.44	9.35	8.74
	control	2.33	2.74	2.54	2.54	2.40	2.74	2.35	2.50	7.07	6.19	7.88	7.05	8.33	8.17	9.14	8.55
	$\bar{X}$	2.85	3.01	2.77		2.67	2.93	2.73		7.80	7.44	8.65		8.59	8.34	9.28	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					0.32				0.46				0.34				0.64
Compost (comp.)					0.32				0.25				0.86				ns
Spray treatments (ST.)					0.17				0.21				0.74				0.44
(Cv.) * (comp.)					ns				0.36				1.21				ns
(Cv.) * (ST.)					ns				ns				ns				0.63
(comp.)* (ST.)					0.34				ns				ns				ns
(Cv.)* (comp.) * (ST.)					ns				ns				ns				ns

Bio.=Biohorm, Chit.=Chitosan and Cont.=Control

head diameter, head weight and number of leaves/plant as compared with the control treatment in both seasons; the increments could be due to the effect of chitosan on increasing key enzymes activity of nitrogen metabolism, which enhanced plant growth and development (Chibu and Shibayama, 2003, Gornik et al., 2008 and Mondal et al., 2012). Also, Biohorm increased plant height in the second season. This result agreed with those of Chen and Aviad (1990), Mourad (2006) and Al-Kahal et al. (2008). Control treatment showed significant increment of dry matter percentage in both growing seasons.

Concerning the interaction between cultivars and compost application, results in tables 4-6 show that no clear trend was observed in the investigated growth parameters, except Os cross cv. treated with compost application at rates of 8 and 6 ton/fed, which had significant increase of dry matter percentage in the first season and head weight, head diameter and number of leaves/plant in the second season. Moreover, the interaction between cultivars and foliar spray with growth enhancers showed that plant height of Nabarawy cv. combined with either biohorm or chitosan significantly surpassed Os cross cv. On the contrary, Os cross cv. combined with spraying with water had the highest value of dry matter percentage in the second season.

Whereas, the interaction between compost application and foliar spray treatments showed that compost application at rate of 8 ton/fed combined with chitosan gave significant increase of head weight in the first season and head diameter in the second season. Also, compost application at rate of 4 ton/fed combined with chitosan resulted in the highest head diameter in the first season.

Finally, the combination between the three studied factors showed that cultivar Os cross combined with compost application at rate of either 6 or 4 ton/fed and treated with chitosan recorded the highest values of head diameter.

The question of how far the different investigated growth traits were correlated with each other was of great importance. It could be seen from Fig. (1) that the average of head weight was positively correlated with either head diameter or number of leaves per head.

A linear correlation showed that correlation coefficients (r) were 0.644 and 0.798 in the first season and 0.683 and 0.757 in the second season, respectively. Corresponding coefficients of determination (r^2) were 0.4155 and 0.638 in the first season and 0.4677 and 0.574 in the second season, respectively. This indicated that 41.55 to 46.77 per cent of the variation in head weight was related to head diameter and 63.8 to 57.4 per cent of the variation in head weight was related to number of head leaves, respectively.

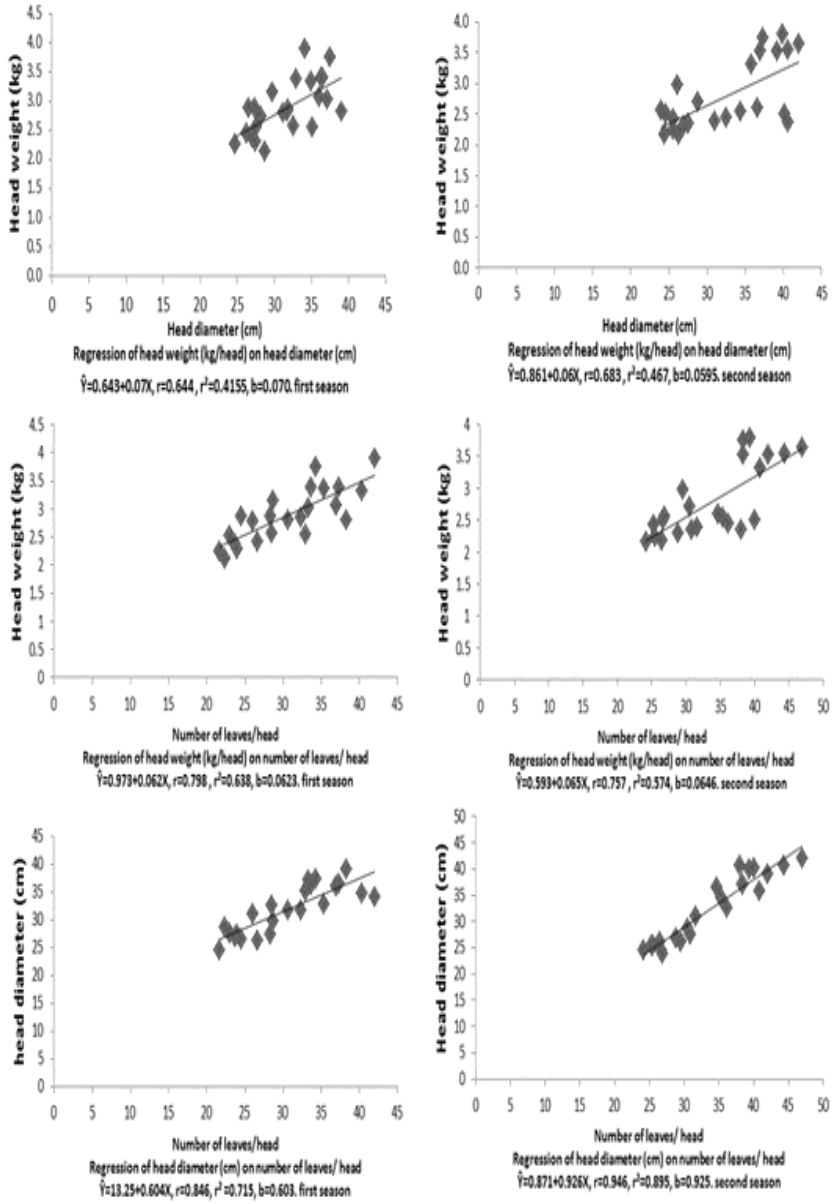

Fig. (1). Regression coefficients (b), correlation coefficients (r), coefficients of determination (r^2) and regression lines of cabbage growth traits on each other.

On the other hand, regression coefficients (b) of head weight (kg/head) on either head diameter (cm) or number of leaves per head were 0.07 and 0.0623 in the first season and 0.0595 and 0.0646 in the second season, respectively. This indicated that for each increase of one centimeter of head diameter or one leaf per head, head weight correspondingly increased by 0.07 or 0.0623 kilogram in the first season and by 0.0595 or 0.0644 kilogram in the second season, respectively. Similarly, Fig. (1) also showed that head diameter (cm) was positively correlated with number of leaves per head and its linear regression coefficient indicated that for each increase of one leaf per head, head diameter correspondingly increased by 0.603 and 0.925 centimeter in the first and second seasons, respectively.

2. Total Yield and Marketable Yield

It was quite evident from table (7) that total yield and marketable yield % of Os cross cv. significantly surpassed those of Nabarawy cv. during both growing seasons. Obtained results agreed with those found by Wambani et al. (2007), Obiadalla et al. (2012) and Olaniyi and Ojetayo (2012) and could be due to cultivar differential with respect yield.

Obtained data presented in table (7) show also that compost application had significant positive effect on total yield and marketable yield % during both growing seasons compared with control. Compost application at rate of 8 and 6 ton/fed gave higher total yield compared with 4 ton/fed treatment during the second growing season. However, marketable yield % showed no significant differences among 4, 6 and 8 ton compost /fed.

The favorable effect of compost application on total yield and marketable yield % may be due to the enhancing effect on nutrient uptake and plant growth, which in turn is reflected on increasing total yield and marketable yield %. Such results are in agreement with those obtained by Yamazaki and Roppongi (1998), Rono et al. (2003), Wei and Liu (2005), Vimala et al. (2006) and Ibrahim et al. (2011).

Concerning the effect of foliar spray treatment on cabbage yield and marketable yield %, data presented in table 7 show, generally, that the total yield of plants foliary sprayed with chitosan significantly surpassed that of either biohorm or control. In addition, marketable yield % of plants treated with either chitosan or biohorm surpassed that of control. The positive effect of chitosan may be due to enhancing effect of nitrogen metabolism (nitrate reductase, glutamine synthetase and protease) and improved the transportation of nitrogen in the functional leaves, which in turn enhanced plant growth and yield (Chibu and Shibayama, 2003 and Gornik et al., 2008). These results are in the same line with those reported by Chibu and Shibayama (2003), Gornik et al. (2008) and Mondal et al. (2012).

Table (7). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancers on yield and percentage of marketable yield at harvest time during growth seasons of 2012/2013 and 2013/2014.

Characters		Yield (ton/fed.)								% of marketable yield							
Seasons		1st season				2nd season				1st season				2nd season			
Treatments		Bio.	Chit.	Cont.	X¯	Bio.	Chit.	Cont.	X¯	Bio.	Chit.	Cont.	X¯	Bio.	Chit.	Cont.	X¯
Cv.	Compost (ton/fed)																
Nabar-awy	4	30.2	28.8	31.2	30.07	25.8	30.7	28.5	28.34	85.5	87.4	80.8	84.6	81.0	84.1	78.7	81.3
	6	28.7	33.3	25.3	29.09	25.2	26.9	24.3	25.48	87.6	88.1	83.2	86.3	85.3	83.0	77.7	82.0
	8	31.1	34.9	26.5	30.83	26.3	27.1	28.2	27.20	82.8	84.9	85.3	84.3	79.7	83.5	79.3	80.8
	control	23.8	27.2	25.4	25.47	27.9	33.9	24.7	28.83	81.9	80.7	82.2	81.6	81.0	78.0	74.3	77.8
	X¯	28.4	31.0	27.1	28.87	26.3	29.7	26.4	27.46	84.5	85.3	82.9	84.2	81.8	82.2	77.5	80.5
OS cross	4	36.8	32.7	32.2	33.89	27.5	37.4	29.7	31.55	90.3	93.0	85.0	89.4	92.7	91.0	82.7	88.8
	6	37.6	38.1	41.6	39.12	44.0	40.6	39.2	41.28	90.7	90.7	88.0	89.8	89.0	86.7	84.3	86.7
	8	38.3	43.6	35.4	39.10	40.5	42.1	41.3	41.30	90.3	88.0	87.3	88.6	89.3	87.3	83.0	86.6
	control	39.1	29.4	34.4	34.29	41.3	27.4	28.9	32.55	86.3	84.7	83.3	84.8	85.3	83.0	78.0	82.1
	X¯	38.0	36.0	35.9	36.60	38.3	36.9	34.8	36.67	89.4	89.1	85.9	88.1	89.1	87.0	82.0	86.0
X¯	4	33.5	30.8	31.7	31.98	26.7	34.1	29.1	29.94	87.9	90.2	82.9	87.0	86.8	87.6	80.7	85.0
	6	33.1	35.7	33.5	34.11	34.6	33.8	31.8	33.38	89.2	89.4	85.6	88.0	87.2	84.8	81.0	84.3
	8	34.7	39.2	31.0	34.96	33.4	34.6	34.8	34.25	86.6	86.4	86.3	86.4	84.5	85.4	81.2	83.7
	control	26.6	30.8	28.7	28.69	27.7	31.4	26.6	28.57	84.1	82.7	82.8	83.2	83.2	80.5	76.2	79.9
	X¯	31.99	34.12	31.20		30.58	33.47	30.57		86.9	87.2	84.4		85.4	84.6	79.8	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					4.43				5.34				2.77				4.36
Compost (comp.)					3.50				3.06				2.42				3.03
Spray treatments (ST.)					2.12				2.59				1.47				1.48
(Cv.) * (comp.)					ns				4.33				ns				ns
(Cv.) * (ST.)					2.99				ns				ns				ns
(comp.)* (ST.)					4.23				ns				2.94				ns
(Cv.)* (comp.) * (ST.)					ns				ns				ns				ns

Bio.= Biohorm, Chit.= Chitosan and Cont.= Control.

Concerning the interaction among cultivars, compost and foliar spray, revealed generally insignificant differences, except the interaction between cultivar and foliar spray during the first season, which indicated that the higher total yield was obtained with Os cross cv. combined with chitosan. In addition, the interaction between compost and foliar spray during the first season indicated that the highest total yield was obtained with 8 ton compost/fed application combined with chitosan. Also, the interaction between compost and foliar spray during the second season revealed that the highest marketable yield % was recorded with application of 6 ton compost/fed combined with either biohorm or chitosan. In addition, the interaction between compost and cultivar in the second season showed that the highest total yield was observed with application of either 6 or 8 compost to Os cross cv.

It may be worth to mention that the total yield of cabbage (ton/fed) was highly significant positively correlated with either head weight (kg), head diameter (cm) or number of head leaves (Fig. 2). Corresponding correlation coefficients (r) were 0.885, 0.687or 0.806 in the first season and 0.894, 0.782 or 0.795 in the second season, respectively. Corresponding regression coefficients were 10.19, 0.865 or 0.724 in the first season and 10.62, 0.809 or 0.805 in the second season, respectively. This indicated that for each increase of one kg/head, one centimeter of head diameter or one leaf per head, total yield of cabbage correspondingly increased by 10.19, 0.865 or 0.724 ton/fed in the first season and 10.62, 0.809 or 0.805 ton/fed in the second season, respectively.

In general, it might be concluded that Os cross cv. proved to be a high yielded cultivar as compared with Nabarawy. In addition, compost application at rate of either 8 or 6 ton/fed gave the highest total yield. Moreover, cabbage yield of plants sprayed with chitosan had the highest values.

3. Chemical Composition

Tables (8-11) represent mineral contents *i.e.* N, P, K and Fe as well as heavy metals (Ni, pb, Cr and Cu) of cabbage during 2012-2013 and 2013-2014 seasons in response to cultivars, compost and foliar spray treatments. As for cultivar effect, results showed insignificant differences, except K content in the second season, which was significantly higher with Nabarawy than with Os cross as well as Cr and Cu contents in the first season, which were significantly higher with Os cross than Nabarawy. Differences between cultivars could be due to genetic differences between cultivars. These results agreed with those obtained by Wambani et al. (2007) and Obiadalla et al. (2012). Regarding compost application, tables 8-11 indicat that both N and

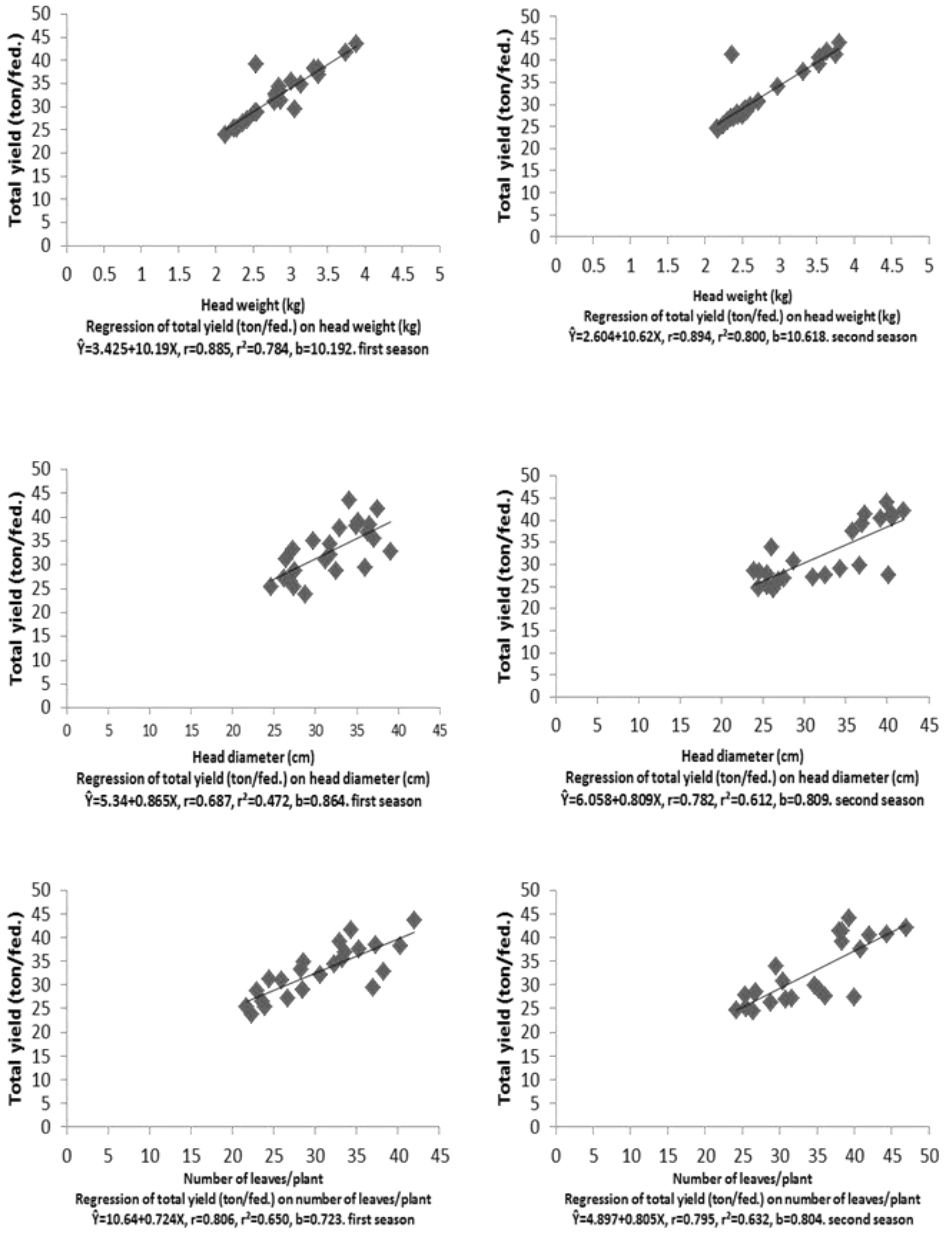

Fig. (2). Regression coefficients (b), correlation coefficients (r), coefficients of determination (r^2) and regression lines of cabbage yield on growth traits.

Table (8). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancer on nitrogen and phosphorus contents on plant leaves at harvest time during growth seasons of 2012/2013 and 2013/2014.

Characters		N %								P (ppm)							
Seasons		1st				2nd				1st				2nd			
Treatments		Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	X	Bio.	Chit.	Cont.	x
Cv.	Compost (ton/fed)																
Nubar-awy	4	2.40	2.82	3.06	2.76	2.47	2.76	2.69	2.64	1.88	1.92	1.38	1.73	1.40	1.49	1.99	1.63
	6	2.63	3.13	3.01	2.92	2.24	3.58	2.61	2.81	1.48	1.28	1.36	1.38	1.34	1.76	1.52	1.54
	8	2.72	2.85	2.37	2.65	2.90	2.75	2.30	2.65	1.81	1.50	1.27	1.53	1.64	1.67	1.44	1.58
	Control	2.78	2.02	1.62	2.14	2.32	2.03	2.07	2.14	1.80	1.27	1.57	1.54	1.64	1.15	1.31	1.37
	X	2.63	2.70	2.52	2.62	2.48	2.78	2.42	2.56	1.74	1.49	1.40	1.54	1.51	1.52	1.57	1.53
OS cross	4	2.48	2.95	2.28	2.57	2.95	2.61	2.74	2.77	1.31	1.53	1.36	1.40	1.40	1.32	1.07	1.26
	6	2.45	2.45	2.52	2.48	2.90	2.80	2.47	2.73	1.83	1.92	1.30	1.68	1.66	1.58	1.11	1.45
	8	2.75	2.11	2.02	2.29	2.48	2.21	2.48	2.39	1.41	1.16	1.34	1.30	1.22	1.27	1.23	1.24
	Control	2.17	2.79	2.17	2.38	2.17	2.55	2.09	2.27	1.45	1.32	1.26	1.34	1.20	1.40	0.98	1.19
	X	2.46	2.58	2.25	2.43	2.63	2.54	2.45	2.54	1.50	1.48	1.31	1.43	1.37	1.39	1.10	1.29
$\bar{X}$	4	2.44	2.89	2.67	2.66	2.71	2.69	2.72	2.70	1.60	1.72	1.37	1.56	1.40	1.41	1.53	1.45
	6	2.54	2.79	2.77	2.70	2.57	3.19	2.54	2.77	1.65	1.60	1.33	1.53	1.50	1.67	1.32	1.50
	8	2.74	2.48	2.20	2.47	2.69	2.48	2.39	2.52	1.61	1.33	1.30	1.41	1.43	1.47	1.34	1.41
	Control	2.48	2.41	1.90	2.26	2.25	2.29	2.08	2.21	1.63	1.30	1.41	1.44	1.42	1.28	1.15	1.28
	X	2.55	2.64	2.38		2.56	2.66	2.43		1.62	1.49	1.35		1.44	1.46	1.33	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					ns				ns				ns				ns
Compost (comp.)					0.21				0.20				ns				ns
Spray treatments (ST.)					ns				0.17				ns				ns
(Cv.) * (comp.)					0.29				ns				ns				ns
(Cv.) * (ST.)					ns				ns				ns				ns
(comp.)* (ST.)					ns				0.34				ns				ns
(Cv.)* (comp.) * (ST.)					ns				0.48				ns				ns

Bio.= Biohorm, Chit.= Chitosan and Cont.= Control.

Table (9). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancer on potassium and irion contents on plant leaves at harvest time during growth seasons of 2012/2013 and 2013/2014.

Characters		K								Fe							
Seasons		1st				2nd				1st				2nd			
Treatments		Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	X	Bio.	Chit.	Cont.	x
Cv.	Compost (ton/fed)																
Nahar-awy	4	48.3	45.7	44.7	46.2	42.7	46.3	47.3	45.4	4.00	6.99	4.67	5.22	5.67	5.73	7.66	6.35
	6	50.7	47.7	42.7	47.0	50.3	50.0	46.3	48.9	8.77	4.54	4.09	5.80	5.75	4.53	5.03	5.10
	8	51.0	44.3	42.0	45.8	49.3	47.0	42.7	46.3	5.46	3.10	4.32	4.29	3.72	3.83	6.18	4.58
	Control	39.7	41.7	33.3	38.2	47.3	42.7	41.0	43.7	6.67	6.20	4.59	5.82	6.34	5.00	4.78	5.37
	X	47.4	44.8	40.7	44.3	47.4	46.5	44.3	46.1	6.23	5.21	4.42	5.28	5.37	4.77	5.91	5.35
OS cross	4	42.7	42.7	33.3	39.6	49.0	44.7	41.7	45.1	5.79	5.98	4.35	5.37	5.67	5.65	4.71	5.35
	6	50.3	52.7	40.0	47.7	46.0	47.0	46.7	46.6	5.44	4.77	5.92	5.38	5.04	5.20	5.33	5.19
	8	46.7	46.3	38.0	43.7	41.7	51.0	48.3	47.0	4.97	4.84	8.11	5.97	5.28	5.59	7.55	6.14
	Control	41.0	41.3	34.0	38.8	40.7	37.7	36.3	38.2	7.38	3.47	7.98	6.28	6.97	4.79	4.19	5.31
	X	45.2	45.8	36.3	42.4	44.3	45.1	43.3	44.2	5.90	4.77	6.59	5.75	5.74	5.31	5.44	5.50
X¯	4	45.5	44.2	39.0	42.9	45.8	45.5	44.5	45.3	4.90	6.48	4.51	5.30	5.67	5.69	6.19	5.85
	6	50.5	50.2	41.3	47.3	48.2	48.5	46.5	47.7	7.11	4.66	5.00	5.59	5.39	4.87	5.18	5.15
	8	48.8	45.3	40.0	44.7	45.5	49.0	45.5	46.7	5.22	3.97	6.21	5.13	4.50	4.71	6.86	5.36
	Control	40.3	41.5	33.7	38.5	44.0	40.2	38.7	40.9	7.02	4.84	6.28	6.05	6.66	4.89	4.49	5.34
	X	46.3	45.3	38.5		45.9	45.8	43.8		6.06	4.99	5.50		5.55	5.04	5.68	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					ns				1.66				ns				ns
Compost (comp.)					3.03				2.2				Ns				0.44
Spray treatments (ST.)					2.57				1.35				0.54				ns
(Cv.) * (comp.)					ns				3.11				ns				0.62
(Cv.) * (ST.)					ns				ns				0.76				ns
(comp.)* (ST.)					ns				2.70				1.07				1.35
(Cv.)* (comp.) * (ST.)					ns				ns				1.52				ns

Bio.= Bioherm, Chit.= Chitosan and Cont.= Control.

Table (10). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancer on heavy metal contents (Ni and Pb) on plant leaves at harvest time during growth seasons of 2012/2013 and 2013/2014.

Characters		Ni (ppm)								Pb (ppm)							
Seasons		1[st]				2[nd]				1[st]				2[nd]			
Treatments		Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	X	Bio.	Chit.	Cont.	x
Cv.	Compost (ton/fed)																
Nahar-awy	4	0.0276	0.0257	0.0329	0.0287	0.0260	0.0298	0.0279	0.0279	0.0132	0.0120	0.0115	0.0122	0.0155	0.0235	0.0164	0.0185
	6	0.0249	0.0258	0.0282	0.0263	0.0259	0.0273	0.0269	0.0267	0.0234	0.0135	0.0118	0.0162	0.0127	0.0104	0.0359	0.0196
	8	0.0272	0.0318	0.0251	0.0280	0.0314	0.0265	0.0259	0.0279	0.0124	0.0133	0.0129	0.0128	0.0161	0.0425	0.0489	0.0358
	control	0.0268	0.0270	0.0248	0.0262	0.0274	0.0257	0.0258	0.0263	0.0134	0.0173	0.0139	0.0148	0.0189	0.0391	0.0154	0.0244
	X	0.0266	0.0276	0.0278	0.0273	0.0277	0.0273	0.0266	0.0272	0.0156	0.0140	0.0125	0.0140	0.0158	0.0289	0.0291	0.0246
OS cross	4	0.0254	0.0278	0.0269	0.0267	0.0259	0.0267	0.0279	0.0268	0.0115	0.0688	0.0111	0.0305	0.0306	0.0161	0.0113	0.0193
	6	0.0253	0.0275	0.0261	0.0263	0.0266	0.0268	0.0268	0.0267	0.0118	0.0143	0.0132	0.0131	0.0126	0.0139	0.0148	0.0138
	8	0.0287	0.0247	0.0262	0.0265	0.0274	0.0252	0.0261	0.0262	0.0180	0.0150	0.0152	0.0161	0.0170	0.0151	0.0165	0.0162
	control	0.0251	0.0327	0.0264	0.0281	0.0262	0.0294	0.0206	0.0254	0.0190	0.0133	0.0186	0.0170	0.0171	0.0150	0.0131	0.0151
	X	0.0261	0.0282	0.0264	0.0269	0.0265	0.0270	0.0253	0.0263	0.0151	0.0278	0.0145	0.0191	0.0193	0.0150	0.0139	0.0161
$\bar{X}$	4	0.0265	0.0268	0.0299	0.0277	0.0260	0.0282	0.0279	0.0274	0.0123	0.0404	0.0113	0.0213	0.0230	0.0198	0.0139	0.0189
	6	0.0251	0.0266	0.0271	0.0263	0.0263	0.0271	0.0268	0.0267	0.0176	0.0139	0.0125	0.0146	0.0127	0.0122	0.0253	0.0167
	8	0.0280	0.0282	0.0256	0.0273	0.0294	0.0258	0.0260	0.0271	0.0152	0.0141	0.0140	0.0144	0.0165	0.0288	0.0327	0.0260
	control	0.0259	0.0298	0.0256	0.0271	0.0268	0.0275	0.0232	0.0258	0.0162	0.0153	0.0162	0.0159	0.0180	0.0270	0.0143	0.0198
	X	0.0264	0.0279	0.0271		0.0271	0.0272	0.0260		0.0153	0.0209	0.0135		0.0175	0.0220	0.0215	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					ns				ns				ns				ns
Compost (comp.)					ns				ns				ns				ns
Spray treatments (ST.)					ns				ns				ns				ns
(Cv.) * (comp.)					0.00190				ns				0.009				ns
(Cv.) * (ST.)					ns				ns				ns				ns
(comp.)* (ST.)					0.00314				ns				0.013				ns
(Cv.)* (comp.) * (ST.)					0.00440				ns				0.018				ns

Bio.= Bioherm, Chit.= Chitosan and Cont.= Control.

Table (11). Effect of cabbage cultivars, compost rate and foliar spray with growth enhancer on heavy metal contents (Cr and Cu) on plant leaves at harvest time during growth seasons of 2012/2013 and 2013/2014.

Characters		Cr (ppm)								Cu (ppm)							
Seasons		1st				2nd				1st				2nd			
Treatments		Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	x	Bio.	Chit.	Cont.	x
Cv.	Compost (ton/fed)																
Nahar-amy	4	0.0765	0.0878	0.1040	0.0894	0.0821	0.0956	0.1037	0.0938	0.0169	0.0164	0.0170	0.0167	0.0187	0.0200	0.0162	0.0183
	6	0.0946	0.0892	0.0705	0.0847	0.0888	0.0783	0.1010	0.0894	0.0179	0.0106	0.0177	0.0154	0.0144	0.0104	0.0080	0.0109
	8	0.1112	0.0694	0.0954	0.0920	0.0800	0.0852	0.0769	0.0807	0.0153	0.0138	0.0159	0.0150	0.0417	0.0138	0.0170	0.0242
	control	0.0680	0.1103	0.0977	0.0920	0.0925	0.1034	0.0970	0.0976	0.0169	0.0160	0.0145	0.0158	0.0198	0.0207	0.0141	0.0182
	X	0.0875	0.0892	0.0919	0.0895	0.0859	0.0906	0.0947	0.0904	0.0167	0.0142	0.0163	0.0157	0.0236	0.0162	0.0138	0.0179
OS cross	4	0.0971	0.0860	0.0887	0.0906	0.0934	0.0869	0.0972	0.0925	0.0193	0.0211	0.0181	0.0195	0.0203	0.0147	0.0098	0.0149
	6	0.1142	0.1121	0.0873	0.1045	0.1135	0.1038	0.0916	0.1030	0.0180	0.0186	0.0170	0.0179	0.0125	0.0118	0.0223	0.0155
	8	0.1003	0.0821	0.0916	0.0913	0.0942	0.0852	0.0932	0.0909	0.0165	0.0200	0.0140	0.0168	0.0116	0.0184	0.0086	0.0129
	control	0.0963	0.0745	0.0809	0.0839	0.0890	0.0766	0.0539	0.0732	0.0175	0.0168	0.0392	0.0245	0.0101	0.0110	0.0099	0.0103
	X	0.1019	0.0886	0.0871	0.0926	0.0975	0.0881	0.0840	0.0899	0.0178	0.0191	0.0221	0.0197	0.0136	0.0140	0.0126	0.0134
X¯	4	0.0868	0.0869	0.0964	0.0900	0.0877	0.0912	0.1005	0.0931	0.0181	0.0187	0.0175	0.0181	0.0195	0.0174	0.0130	0.0166
	6	0.1044	0.1006	0.0789	0.0946	0.1011	0.0910	0.0963	0.0962	0.0180	0.0146	0.0174	0.0166	0.0135	0.0111	0.0151	0.0132
	8	0.1057	0.0757	0.0935	0.0916	0.0871	0.0852	0.0850	0.0858	0.0159	0.0169	0.0149	0.0159	0.0267	0.0161	0.0128	0.0185
	control	0.0821	0.0924	0.0893	0.0879	0.0908	0.0900	0.0755	0.0854	0.0172	0.0164	0.0268	0.0201	0.0149	0.0158	0.0120	0.0142
	X	0.0947	0.0889	0.0895		0.0917	0.0894	0.0893		0.0173	0.0167	0.0192		0.0186	0.0151	0.0132	
L. S. D. (0.05) for:																	
Cultivars (Cv.)					0.0022				ns				0.0036				ns
Compost (comp.)					ns				ns				0.0350				0.0028
Spray treatments (ST.)					ns				ns				0.0041				ns
(Cv.) * (comp.)					ns				0.014				0.0050				ns
(Cv.) * (ST.)					ns				0.010				ns				ns
(comp.)* (ST.)					0.0170				ns				ns				0.0050
(Cv.)* (comp.) * (ST.)					0.0240				ns				0.0120				0.0080

Bio.= Biohorm, Chit.= Chitosan and Cont.= Control.

K contents were significantly increased with compost addition; 6 ton/fed, which has given generally the highest values in both growing seasons. Also, compost application at rate of 4 ton/fed increased significantly Fe content in the second season.

On the contrary, compost application increased Cu content in the first season but decreased it in the second seasons. The enhancement effect of compost on nutrient contents may be due to its effect on improving soil water holding capacity and soil structure as well as increasing availability of nutrients needed for plant growth. Such suggestions agreed with Rono et al. (2003), Vimala et al. (2006), Phallus and Marsono (2008) and Ibrahim et al. (2011).

With respect to the effect of foliar spray treatment on chemical composition, results revealed significant increment of nitrogen content. Chitosan had the highest value in the second season. Such increments could be due the effect of chitosan on increased key enzymes activities of nitrogen metabolism, which agreed with those recorded by Chibu and Shibayama (2003) and Gornik et al. (2008). Results, also, showed that both biohorm and chitosan significantly increased K content in both seasons. Obtained results were in agreement with those of Rauthan and Schnitzer (1981). As regard to the different interaction effects on chemical composition, no clear trend was obtained.

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بعض الممارسات الزراعية لتحسين إنتاجية الكرنب تحت ظروف سيناء

محمد عبد المعطي السجان
قسم الإنتاج النباتي، مركز بحوث الصحراء، المطرية، القاهرة، مصر

تم تنفيذ التجربة فى المزرعة التجريبية لمركز بحوث الصحراء بالقنطرة شرق، محافظة الاسماعيلية، خلال موسمي الزراعة ٢٠١٢/٢٠١٣ – ٢٠١٣/٢٠١٤. وأجريت التجربة لدراسة تأثير معدلات الكمبوست والرش الورقي على النمو، المحصول والتركيب الكيميائي لصنفين من الكرنب تحت ظروف الأراضي الرملية. وأظهرت النتائج تفوق الصنف أو إس كروس فى صفات عدد الأوراق/الرأس، قطر الرأس، وزن الرأس، نسبة المادة الجافة وكذلك المحصول الكلي مقارنة بالصنف النبراوى. إضافة الكمبوست أدى إلى زيادة قيم كلًا من صفات النمو والإنتاجية للكرنب وأعطت أعلى القيم فى معاملات ٨ و٦ طن/فدان. كذلك أظهرت النتائج أن معاملة الرش بالشيتوسان أعطت أعلى قيم فى صفات وزن الرأس وقطر الرأس وعدد الأوراق/النبات كذلك المحصول الكلي . أما بالنسبة للتركيب الكيميائي فقد أعطى الصنف النبراوي أعلى قيمة فى محتوى البوتاسيوم، كما أظهرت معاملة إضافة الكمبوست بمعدل ٦ طن/فدان زيادة فى محتوى النتروجين والبوتاسيوم، كذلك معاملة الرش بالشيتوسان أظهرت تفوقًا معنويًا فى محتوى النتروجين، بينما أعطت معاملة البيوهورم أعلى القيم فى محتوى البوتاسيوم والحديد والنحاس .

أظهرت العلاقة الخطية إرتباطًا إيجابيًا بين وزن الرأس مع كلًا من قطر الرأس وعدد الأوراق/الرأس، أيضًا إرتبطت كمية المحصول الكلي إيجابيًا بكلًا من وزن الرأس وقطر الرأس وعدد الأوراق/الرأس. بصفه عامة يمكن أن نستخلص أن الصنف أو إس كروس تفوق فى كمية المحصول مقارنةً بالصنف النبراوى. بالإضافة إلى ذلك، أعطت إضافة الكمبوست بمعدل ٨ أو ٦ طن/فدان كذلك معاملة الرش بالشيتوسان إلى زيادة فى كمية المحصول الكلي.