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EFFECT OF COMPOST, HUMIC ACID AND NITROGEN FERTILIZER RATES ON:
1- GROWTH OF SUGAR BEET CROP

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ABSTRACT

Two field experiments were carried out at Hafeer Shehap El-Deen, El Khashaa Region, Kafr El-Sheikh Governorate, during the two seasons of 2010/2011 and 2011/2012 to study the effect of compost (0, 2, 4 and 6 t/fed), humic acid (0, 2 and 4 kg/fed) and nitrogen fertilizer rates (40, 60 and 80 kg N/fed) on growth of sugar beet cv. Gloria. Each rate of compost was performed in separate experiment. Every experiment of compost rates was carried out in split plot design with four replications.

The main plots were occupied with rates of humic acid. The sub-plots were devoted with nitrogen fertilizer rates. The obtained results could be summarized as follows:

1. Organic fertilized sugar beet plants with 6 tons compost/fed produced the maximum averages of all growth characters at the period of 120 and 150 days from sowing (DFS) in both seasons. Followed by using of 4 tons compost/fed then 2 tons compost/fed at 120 and 150 DFS in both growing seasons.
2. Using the highest rate of humic acid (4 hg/fed) was more effective than other studied humic acid rates in increasing all studied growth characters at 120 and 150 DFS and produced the highest values in both seasons.
3. Fertilizing sugar beet plants with 80 kg N/fed significantly increased all studied growth and markedly recorded the highest values of these characters in both seasons.

It can be concluded that organic fertilizing sugar beet using 6 tons compost/fed beside 4 kg humic acid/fed and mineral fertilizing with 80 kg N/fed to maximizing its growth under the environmental conditions of Kafr El-Sheikh Governorate.

Keywords: Sugar beet, *Beta vulgaris L*, organic fertilization, compost rates, humic acid rates, nitrogen fertilizer rates, growth.

INTRODUCTION

Sugar beet is a specially type of *Beta vulgaris* L. grown for sugar production and is considered the second important sugar crop in Egypt and in many countries all over the world after sugar cane (*Sacchurum officinarum* L.). The importance of sugar beet to agriculture is not only confined to sugar production, but also to its products which are used for alcohol production and considered as an important source of food for livestock. It, also, has a wide adaptability to be grown in poor, saline, alkaline and calcareous soils. Thus, it can be economically grown in the newly reclaimed lands as that at the Northern parts of Egypt, and makes the soil in good conditions for the benefit of the following cereal crops. Developing high yielding varieties and its high demand for agricultural practices and other production input is necessary. Thereby, using organic fertilization (compost and humic acid) and nitrogen fertilizer are among factors that enhance sugar beet growth.

Compost is the stable humus-like product resulting from the biological decomposition of organic matter under controlled conditions. Compost additions to soil help create organic reserves that release nutrients incrementally over many years. Compost can therefore be applied in large quantities to soil systems with little danger of excess nutrient accumulation. There are many researches with respect to the effects of compost rates as follows: Toderi et al. (1999) showed that the use of organic materials (maize and wheat straw compost) improved soil organic matter, nitrogen content, P_2O_5 concentration, exchangeable cations and apart of Fe, this consequently enhancement plant growth and development as well as yield. Ali et al. (2003) recorded that organic manure (bio – compost or compost) improved the physical properties of the soil and increased the supplying of available nutrients to plants. Hoitink and Changa (2004) stated that compost is a source of slow release nutrients, and contains a number of macro and micronutrients. Composts may reduce certain soil diseases to below critical threshold levels. Nofal, Fatma et al. (2005) noticed that the increment in maize grain yield due to applying rice straw compost may be attributed to organic manure contains of microorganisms which fix and release phytohormones, which stimulate plant growth. Brown et al. (2006) found that compost had more readily available nitrogen than manure for early season sugar beet growth, but nitrogen mineralized after sugar beet plantings was greater from manure. Though, compost provided less available nitrogen that increased sugar beet growth. Szymczak-Nowak and Tyburski (2006) showed that effect of compost application on sugar beet development depends on a method of application and weather conditions (soil water regime). Walker and Bernal (2008) showed that the compost and manure increased markedly the shoot growth of the salt-tolerant *Beta maritima* L. (sea beet) and *Beta vulgaris* L. (sugar beet). In the case of *B. vulgaris*, increases in shoot $H_2PO_4^-$ and B and, for manure-treated soil, a decrease in shoot Na^+

Humic acid is a principal component of humic substances, which are the major organic constituents of soil (humus). It is produced by biodegradation of organic matter. It is not a single acid; rather, it is a complex mixture of many different acids containing carboxyl and phenolate groups. Humic acids can form complexes with ions that are commonly found in the environment creating humic colloids. Humic and fulvic acids (fulvic acids are humic acids of lower molecular weight and higher oxygen content than other humic acids) are commonly used as a soil supplement in agriculture. Chen and Aviad (1990) concluded that humic substances have been reported to influence plant growth both directly and indirectly. The indirect effects of humic compounds on soil fertility include. (i) Increase in the soil microbial population including beneficial microorganisms. (ii) Improved soil structure. (iii) Increase in the cation exchange capacity and the pH buffering capacity of the soil. Directly, humic acid compounds may have various biochemical effects either at cell wall, membrane level or in the cytoplasm, including increased photosynthesis and respiration rates in plants, enhanced protein synthesis and plant hormone like activity . Ayuso et al. (1996) revealed that humic substances can provide plant and soil with a concentrated dose of essential nutrients, vitamins and trace elements to improve plant growth, yield and its quality in various cereal crops. Dixit and Kishore (1997) showed that adding humus to the soil in sugar beet cultivation had a significant increases in yields. They added that humus can cause long-term soil carbon storage, root and shoot growth in plants, nitrogen uptake and storage, increased photosynthesis. Chen et al. (1999) stated that the stimulatory effects of humic substances have been directly correlated with enhanced uptake of macronutrients, such as nitrogen, phosphorus and sulfur and micronutrients, that is, Fe, Zn, Cu and Mn. Fecková et al. (2005) revealed that foliar spraying sugar beet during the vegetative growth with "Humix univerzál plus" which contain growth stimulators (humates, ethanolamine, ureasalicylate) significantly increased growth. Mollasadeghi (2010) found that humic acid reduces application rate of the fertilizer, and enhances plant tolerance against stresses such as heat, drought and cold as well as makes it more resistant in dealing with diseases, insect and other environmental and agronomical pressures. In addition, it increases overall production of the plant i.e. the yield and invigorates the stem. Samavat and Malakoti (2010) reported that the application of humic acid in food solution causes the branch and root growth, hence increasing nitrogen content in shoots. Sharaf (2012) found that maximum values of all growth characters were recorded by the yeast treatment followed by macro and micronutrients treatment, then amino acids treatment and humic acid treatment as compared with control treatment.

Nitrogen fertilizer has a pronounced effect on the growth and physiological and chemical characteristics of the crop. So that nitrogen caused desirable effect on sugar beet growth (Seadh, 2004 ; Ibrahim, 2007 ; Hamada, 2009 and Attia et al., 2011). Sharaf (2012) concluded that maximum values of all growth characters were resulted from using the highest rate of nitrogen fertilizer (120 kg N/fed) as compared with other rates (80 and 100 kg N/fed).

Therefore, this study aimed to determine the effect of compost, humic acid and nitrogen fertilizer rates on growth of sugar beet under the environmental conditions of Kafr El-Sheikh Governorate.

MATERIALS AND METHODS

The present investigation was carried out at Hafeer Shehap El-Deen, El Khashaa Region, Kafr El-Sheikh Governorate, during the two successive winter seasons of 2010/2011 and 2011/2012 to study the effect of compost, humic acid and nitrogen fertilizer rates on growth of sugar beet cv. Gloria.

Each rate of compost (0 t/fed *i.e.* control treatment, 2, 4 and 6 t/fed) was performed in separate experiment. Compost was added to experimental units after plowing and leveling and before ridging. Chemical analysis of compost is presented in Table 1. Every experiment of compost rates was carried out in split plot design with four replications.

Table 1: Chemical analysis of used compost during 2010/2011 and 2011/2012 seasons.

Properties	2010/2011 season	2011/2012 season
Weight of 1m^3 (kg)	830	835
Organic matter %	30.00	31.70
Organic carbon %	16.92	17.35
C/N ratio	11.80 : 1	12.90 : 1
Moisture %	28.50	28.40
EC(ds/m,1:10 water extract)	5.30	5.00
pH(1:10 water suspension)	6.80	6.90
N %	1.70	1.90
P %	1.15	1.25
K %	1.30	1.20-

The main plots were occupied with rates of Hammr fertilizer as a source of humic acid (86 % humic acid in powder form + 6 % K_2O) as soil application *i.e.* without humic acid (control treatment), 2 and 4 kg humic acid/fed.

The sub-plots were devoted at random with nitrogen fertilizer rates *i.e.* 40, 60 and 80 kg N/fed. Nitrogen in forms of ammonium nitrate (33.5%) was applied in two equal doses, the first was applied after thinning sugar beet plants (35 days after sowing) and the second had done before the third irrigation (60 days after sowing).

Table 2: Mechanical and chemical soil characteristics* at the experimental site during the two growing seasons of 2010/2011 and 2011/2012.

may have been involved.

Soil analysis		First season 2010/2011	Second season 2011/2012
A: Mechanical properties:			
Clay (%)		35.52	36.50
Silt (%)		24.08	24.12
Fine sand (%)		40.40	39.38
Texture class		Silty clay loam	Silty clay loam
B: Chemical analysis:			
Soil reaction pH		7.50	7.60
EC (ds/m^2) in soil water extraction (1:5) at 25^{0}C		4.00	3.90
Organic matter (%)		1.69	1.82
Available (ppm)	N	35.00	38.00
	P	16.50	18.50
	K	245.0	240.0
Soluble cations meq/L	Ca^{++}	6.82	5.90
	Mg^{+}	2.25	2.51
	Na^{+}	3.35	3.20
Soluble anions meq/L	CO_3^{--}	4.90	4.70
	HCO_3^{-}	4.03	4.10
	Cl^{-}	3.25	3.04
	SO_4^{-}	4.60	4.55

*** Soil and Water Analysis Institute, Agricultural Research Center (ARC).**

Each experimental basic unit (sub-plot) included five ridges, each 60 cm apart and 3.5 m length, resulted an area of 10.5 m^2 (1/400 fad). The preceding summer crop was rice (*Oryza sativa* L.) in both seasons.

Soil samples were taken at random from the experimental field area at a depth of 0-30 cm from soil surface and prepared for both mechanical and chemical analysis.The results are presented in Table 2.

The experimental field was well prepared by two ploughing, leveling, compaction, division and then divided to the experimental units. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 150 kg/fed. Potassium sulphate (48 % K_2O) at the rate of 50 kg/fed was applied before the third irrigation.

Sugar beet balls were hand sown 3-5 balls/hill using dry sowing method on one side of the ridge in hills 20 cm apart at the 1st and 10th of October in first and second seasons, respectively. The plots were irrigated immediately after sowing directly. Plants were thinned at the age of 35 days from planting to obtain one plant/hill (35000 plants/fad). Plants were kept free from weeds, which were manually controlled by hand hoeing at two times. Other cultural practices for growing sugar beet were performed as recommendations of Ministry of Agriculture and Land Reclamation were followed, except the factors under study .

STUDIED CHARACTERS

Two samples were taken during the growth periods *i.e.* 120 and 150 days from sowing (DFS), five guarded plants were chosen at random from outer ridges of each sub-plot. Each sample was separated into foliages and roots, then the roots and foliages were cut to small pieces. The following growth attributes was determined:

1. Root fresh weight (g).
2. Root dry weight (g).
3. Foliage fresh weight (g).
4. Foliage dry weight (g).

To determine root and foliage dry weights, all plant fractions were air-dried, then oven dried at 70 °C till constant weight obtained.

5. Root length (cm).
6. Root diameter (cm).
7. Leaf area index (LAI): Leaf area measurement determined by the disk method using 10 disks of 1.0 cm diameter according to Watson (1958) and then the following equation was used.

$$\text{LAI} = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Plant ground area (cm}^2\text{)}}$$

8. Crop growth rate (CGR) in g/day: Determined according to Radford`s (1967), where: W_1 and W_2 refer to dry weight of plant at sampling time T_1 (120 DAS) and T_2 (150 DAS), respectively .

$$\text{CGR} = \frac{W_2-W_1}{T_2-T_1}$$

9. Relative growth rate (RGR) in g/g/day: Determined according to Watson (1958).

$$RGR = \frac{\log_e W_2 - \log e W_1}{T_2 - T_1}$$

10. Net assimilation rate (NAR) in g/cm2/day: Determined according to Radford`s (1967), where: W_1, A_1 and W_2, A_2, respectively refer to dry weight and leaf area of plant at sampling time T_1 and T_2, respectively .

$$NAR = \frac{(W_2 - W_1)(\log_e A_2 - \log_e A_1)}{(T_2 - T_1)(A_2 - A_1)}$$

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split – plot design to each experiment (compost rates), then combined analysis was done between compost rates experiments as published by Gomez and Gomez (1984) by using "MSTAT-C " computer software package. Least Significant Difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedcor and Cochran (1980).

RESULTS AND DISCUSSION

1- Compost rates effect:

The statistical analysis of obtained results showed that all growth characters which estimated at 120 and 150 days after sowing *i.e.* root fresh and dry weights (Table 3), foliage fresh and dry weights (Table 4), root length and diameter (Table 5), leaf area index [LAI] (Table 6), crop growth rate [CGR], relative growth rate [RGR] and net assimilation rate [NAR] (Table 7) exhibited significant effect due to compost rates in both samples and seasons, excluding of root length at 120 days after sowing in the first season. The maximum averages of all growth characters at the period of 120 and 150 DFS were achieved when organic fertilized sugar beet plants with 6 t compost/fed in both seasons. Followed by using of 4 tons compost/fed then 2 ton compost/fed at 120 and 150 DFS in both growing seasons of this study. On the other hand, the lowest values of all growth characters at the period of 120 and 150 DFS were resulted from control treatment (without compost) in the first and second seasons. The increase in growth characters caused by using highest rate of compost may be ascribed to that compost is a source of slow release nutrients, and contains a number of macro and micronutrients (Hoitink and Changa, 2004), as well as, improve soil organic matter, nitrogen content, P_2O_5 concentration, exchangeable cations and apart of Fe (Toderi et al., 1999) consequently enhance establishment and growth of sugar beet (Walker and Bernal, 2008).

2- Humic acid effect:

Humic acid rates exhibited significant effect on root fresh and dry weights (Table 3), foliage fresh and dry weights (Table 4), root length and diameter (Table 5), leaf area index [LAI] (Table 6), crop growth rate [CGR], relative growth rate [RGR] and net assimilation rate [NAR] (Table 7) which estimated at 120 and 150 days from sowing in both seasons, with exception root length at 120 DFS in both seasons and at 150 DFS in the second season as well as root diameter at 150 DFS in the first season and 120 DFS in the second season. It can be observed that using the highest rate of humic acid as Hammer commercial fertilizer (4 kg/fed) was more effective than other studied humic acid rates in increasing all studied growth characters at the period of 120 and 150 DFS and produced the highest values in both seasons. Whilst, control treatment (without humic acid) gave the lowest means of all studied growth characters in both seasons. This increase in growth characters of sugar beet by increasing humic acid rates may be attributed to its effect on providing plant and soil with a concentrated dose of essential nutrients, vitamins and trace elements (Ayuso et al., 1996) which improve growth and leaf canopy of sugar beet. These findings are in line with those reported by Sharaf (2012).

Table 3: Averages of root fresh and dry weights (g/plant) at 120 and 150 days from sowing (DFS) as affected by compost, humic acid and nitrogen fertilizer rates as well as their interactions during 2010/2011 and 2011/2012 seasons.

Characters / Treatments	Root fresh weight (g/plant)				Root dry weight (g/plant)			
Seasons	**2010/2011**		**2011/2012**		**2010/2011**		**2011/2012**	
Sampling times (DFS)	120	150	120	150	120	150	120	150
A: Compost rates:								
Without (control)	326.4	457.1	289.6	534.8	70.56	101.52	67.44	124.51
2 tons compost/fed	344.9	474.9	322.4	553.4	75.38	107.35	71.93	134.57
4 tons compost/fed	363.1	497.5	340.3	559.4	78.74	115.42	75.71	146.47
6 tons compost/fed	371.8	573.5	362.1	599.0	82.45	128.86	81.29	154.62
F. test	*	*	*	*	*	*	*	*
NLSD at 5%	7.8	7.4	8.4	8.3	1.46	1.74	1.74	1.80
B: Humic acid rates:								
Without (control)	307.9	471.3	302.8	489.9	67.27	107.75	68.14	127.12
2 kg humic/fed	360.4	497.7	327.2	572.6	79.16	112.29	73.33	140.32
4 kg humic/fed	386.3	533.2	355.8	622.5	83.92	119.82	80.81	152.68
F. test	*	*	*	*	*	*	*	*
NLSD at 5%	6.3	5.0	5.2	9.8	0.96	1.44	1.38	1.70
C: Nitrogen fertilizer rates:								
40 kg N/fed	308.4	467.4	301.1	527.1	64.96	103.88	66.76	126.25
60 kg N/fed	353.5	504.5	328.2	555.6	78.12	113.66	74.00	138.98
80 kg N/fed	392.7	530.2	356.5	602.4	87.28	122.32	81.51	154.89
F. test	*	*	*	*	*	*	*	*
NLSD at 5%	7.4	4.6	5.9	7.7	0.86	1.12	1.36	1.47
D: Interactions:								
A×B	*	*	NS	*	*	*	*	*
A×C	*	*	*	NS	NS	*	NS	NS
B×C	NS	*	*	*	*	*	*	*
A×B×C	*	*	*	*	NS	*	*	*

3- Nitrogen fertilizer rates effect:

From obtained results, nitrogen fertilizer rates significantly affected root fresh and dry weights (Table 3), foliage fresh and dry weights (Table 4), root length and diameter (Table 5), leaf area index [LAI] (Table 6), crop growth rate [CGR], relative growth rate [RGR] and net assimilation rate [NAR] (Table 7) at 120 and 150 days from sowing in both seasons. It can be easily consider that raising nitrogen rates markedly accompanied with obvious increase in all studied characters in both seasons. Application of 80 kg N/fed significantly resulted in the highest values of all studied characters of sugar beet in the two growing seasons. In addition, application of 60 kg N/fed produced the best results after aforementioned rate without significant differences between them in some characters in both seasons. However, the lowest values of all studied characters were resulted from application of 40 kg N/fed in the two seasons. These results are attributed to the role of nitrogen in increases the vegetative growth through enhancing leaf initiation, increment chlorophyll concentration in leaves and photosynthesis process, consequently increase in root length and diameter which led to increase in root fresh weight/plant. The previous results are in good agreement with those obtained by Ibrahim (2007). Hamada (2009), Attia et al. (2011) and Sharaf (2012).

Table 4: Averages of foliage fresh and dry weights (g/plant) at 120 and 150 days from sowing (DFS) as affected by compost, humic acid and nitrogen fertilizer rates as well as their interactions during 2010/2011 and 2011/2012 seasons.

Characters / Treatments	Foliage fresh weight (g/plant)				Foliage dry weight (g/plant)			
Seasons	**2010/2011**		**2011/2012**		**2010/2011**		**2011/2012**	
Sampling times (DFS)	120	150	120	150	120	150	120	150
A: Compost rates:								
Without (control)	324.2	393.0	361.7	383.3	39.91	49.30	38.55	52.95
2 tons compost/fed	342.2	414.4	382.6	406.2	42.58	51.84	41.39	55.14
4 tons compost/fed	374.3	427.9	410.2	428.5	45.13	55.53	44.61	58.52
6 tons compost/fed	395.2	471.7	451.4	575.6	54.95	65.33	49.24	74.57
F. test	*	*	*	*	*	*	*	*
NLSD at 5%	6.4	5.8	5.3	8.5	1.32	1.51	1.14	1.60
B: Humic acid rates:								
Without (control)	323.8	362.3	371.2	370.1	41.00	48.14	39.06	49.30
2 kg humic/fed	350.1	440.8	404.0	455.9	45.59	55.79	43.49	60.61
4 kg humic/fed	403.0	477.1	429.2	519.1	50.33	62.56	47.79	70.98
F. test	*	*	*	*	*	*	*	*
NLSD at 5%	6.9	5.7	4.1	8.2	0.93	1.32	0.68	1.28
C: Nitrogen fertilizer rates:								
40 kg N/fed	324.6	397.4	385.7	420.5	41.10	49.83	39.23	57.29
60 kg N/fed	353.7	432.5	397.7	449.2	44.97	55.73	42.63	59.23
80 kg N/fed	398.6	450.4	421.0	475.4	50.86	60.94	48.48	64.36
F. test	*	*	*	*	*	*	*	*
NLSD at 5%	5.9	4.4	4.3	6.2	0.91	1.22	0.64	1.15
D: Interactions:								
A×B	*	*	*	*	*	*	*	NS
A×C	*	*	*	*	*	*	*	NS
B×C	*	*	*	*	*	*	*	*
A×B×C	*	*	*	*	*	*	*	*

Table 5: Averages of root length and diameter (cm) at 120 and 150 days from sowing (DFS) as affected by compost, humic acid and nitrogen fertilizer rates as well as their interactions during 2010/2011 and 2011/2012 seasons.

Characters / Treatments	Root length (cm)				Root diameter (cm)			
Seasons	2010/2011		2011/2012		2010/2011		2011/2012	
Sampling times (DFS)	120	150	120	150	120	150	120	150
A: Compost rates:								
Without (control)	24.91	26.38	30.25	29.42	6.61	7.22	6.45	7.78
2 tons compost/fed	26.10	27.85	30.27	30.87	6.92	8.30	6.71	8.27
4 tons compost/fed	27.41	27.92	30.79	30.98	7.08	8.70	6.72	8.47
6 tons compost/fed	27.55	30.21	31.56	31.93	7.19	8.72	6.98	8.75
F. test	*	*	NS	*	*	*	*	*
NLSD at 5%	1.66	0.72	-	1.01	0.42	0.50	0.31	0.45
B: Humic acid rates:								
Without (control)	26.35	27.38	30.59	30.43	6.66	8.09	6.58	7.95
2 kg humic/fed	26.50	28.30	30.64	30.61	7.03	8.29	6.73	8.27
4 kg humic/fed	26.63	28.60	30.92	31.36	7.16	8.33	6.83	8.73
F. test	NS	*	NS	NS	*	NS	NS	*
NLSD at 5%	-	0.77	-	-	0.33	-	-	0.34
C: Nitrogen fertilizer rates:								
40 kg N/fed	25.88	27.26	30.12	30.20	6.62	7.94	6.54	8.12
60 kg N/fed	26.28	27.77	30.96	30.92	7.00	8.15	6.74	8.32
80 kg N/fed	27.31	29.24	31.07	31.28	7.23	8.63	6.87	8.51
F. test	*	*	*	*	*	*	*	*
NLSD at 5%	1.11	0.67	0.74	0.80	0.25	0.29	0.26	0.27
D: Interactions:								
A×B	NS	*	NS	*	NS	NS	NS	NS
A×C	NS	NS	NS	NS	NS	NS	NS	NS
B×C	NS	*	NS	*	*	NS	NS	NS
A×B×C	NS	NS	NS	NS	NS	NS	NS	NS

Table 6: Averages of leaf area index (LAI) at 120 and 150 days from sowing (DFS) as affected by compost, humic acid and nitrogen fertilizer rates as well as their interactions during 2010/2011 and 2011/2012 seasons.

Characters / Treatments	LAI			
Seasons	2010/2011		2011/2012	
Sampling times (DFS)	120	150	120	150
A: Compost rates:				
Without (control)	4.06	5.22	3.92	5.32
2 tons compost/fed	4.19	5.46	4.21	5.55
4 tons compost/fed	4.31	5.72	4.49	5.78
6 tons compost/fed	4.74	6.21	4.97	6.08
F. test	*	*	*	*
NLSD at 5%	0.07	0.10	0.08	0.05
B: Humic acid rates:				
Without (control)	3.82	5.48	3.98	5.46
2 kg humic/fed	4.43	5.61	4.38	5.69
4 kg humic/fed	4.72	5.87	4.83	5.90
F. test	*	*	*	*
NLSD at 5%	0.08	0.09	0.07	0.02
C: Nitrogen fertilizer rates:				
40 kg N/fed	4.09	5.41	4.17	5.51
60 kg N/fed	4.26	5.63	4.34	5.69
80 kg N/fed	4.62	5.92	4.69	5.84
F. test	*	*	*	*
NLSD at 5%	0.06	0.07	0.06	0.03
D: Interactions:				
A×B	*	NS	*	*
A×C	NS	NS	*	NS
B×C	NS	NS	*	NS
A×B×C	*	NS	*	NS

Table 7: Averages of crop growth rate (CGR), relative growth rate (RGR) and net assimilation rate (NAR) as affected by compost, humic acid and nitrogen fertilizer rates as well as their interactions during 2010/2011 and 2011/2012 seasons.

Characters / Treatments	CGR (g/day)		RGR (g/g/day)		NAR ($g/cm^2/day$)	
Seasons	**2010/2011**	**2011/2012**	**2010/2011**	**2011/2012**	**2010/2011**	**2011/2012**
A: Compost rates:						
Without (control)	1.34	2.38	0.122	0.140	1.34	2.38
2 tons compost/fed	1.37	2.54	0.123	0.145	1.37	2.54
4 tons compost/fed	1.57	2.82	0.127	0.148	1.57	2.82
6 tons compost/fed	1.89	3.28	0.134	0.154	1.89	3.28
F. test	*	*	*	*	*	*
NLSD at 5%	0.12	0.13	0.004	0.002	0.12	0.13
B: Humic acid rates:						
Without (control)	1.58	2.30	0.127	0.141	1.44	2.30
2 kg humic/fed	1.44	2.80	0.125	0.148	1.58	2.80
4 kg humic/fed	1.60	3.16	0.128	0.152	1.60	3.16
F. test	*	*	*	*	*	*
NLSD at 5%	0.07	0.09	0.002	0.001	0.07	0.09
C: Nitrogen fertilizer rates:						
40 kg N/fed	1.50	2.58	0.126	0.145	1.50	2.58
60 kg N/fed	1.54	2.72	0.127	0.146	1.54	2.72
80 kg N/fed	1.58	2.97	0.129	0.149	1.58	2.97
F. test	*	*	*	*	*	*
NLSD at 5%	0.04	0.10	0.001	0.002	0.02	0.10
D: Interactions:						
A×B	*	*	*	*	*	*
A×C	*	*	*	NS	*	*
B×C	*	*	*	*	*	*
A×B×C	*	*	NS	*	*	*

4- Interactions effect:

With regard to the interactions among the studied factors, great deals of them were statistically significant in most cases. Thus, the author will discuss only some of them dealing with root and foliage fresh weights and leaf area index.

The interaction among compost, humic acid and nitrogen fertilizer rates exhibited significant effect on root fresh weight at 120 and 150 days from sowing in the first and second seasons (Table 8). The highest values of root fresh weight (461.0 and 657.3 g/plant) and (425.0 and 696.9 g/plant) were resulted from application of 6 tons compost/fed and 4 kg humic acid/fed in combination with 80 kg N/fed at 120 and 150 DFS in the first and second seasons, respectively. Meanwhile, cultivation sugar beet without organic fertilization by compost or humic acid and using the lowest rate of nitrogen (40 kg N/fed) produced the lowest values (216.9 and 415.5 g/plant) and (227.9 and 444.5 g/plant) of root fresh weight at 120 and 150 DFS in the first and second seasons, respectively.

Data registered in Table 9 show that foliage fresh weight at 120 and 150 days from sowing in the first and second seasons was significantly affected by the interaction among compost, humic acid and nitrogen fertilizer rates. Using the interaction treatment of 6 tons compost/fed + 4 kg humic acid/fed + 80 kg N/fed produced the highest averages of foliage fresh weight (504.8 and 553.9 g/plant) and (512.5 and 660.5 g/plant) at 120 and 150 DFS in the first and second seasons, respectively. Whereas, lowest values of this trait (265.2 and 229.1 g/plant) and (325.7 and 245.5 g/plant) was resulted from control treatment of studied factors (0 tons compost/fed + 0 kg humic acid/fed + 40 kg N/fed) at 120 and 150 DFS in the first and second seasons, respectively.

Table 8: Averages of root fresh weight (g/plant) at 120 and 150 days from sowing (DFS) as affected by the interaction among compost, humic acid and nitrogen fertilizer rates during 2010/2011 and 2011/2012 seasons.

Compost rates	Humic acid rates	120 days from sowing			150 days from sowing		
		40 kg N/fed	60 kg N/fed	80 kg N/fed	40 kg N/fed	60 kg N/fed	80 kg N/fed
2010/2011 season							
Without (control)	Without	216.9	302.1	315.5	415.5	448.7	453.0
	2 kg humic/fed	290.5	340.1	370.6	418.7	466.5	478.0
	4 kg humic/fed	315.8	344.5	389.2	461.2	477.5	494.6
2 tons compost/fed	Without	261.5	304.2	354.1	429.4	444.7	457.7
	2 kg humic/fed	303.4	361.3	390.0	448.0	494.6	497.0
	4 kg humic/fed	337.0	367.8	424.5	493.2	498.7	510.5
4 tons compost/fed	Without	277.1	308.9	367.5	419.1	479.7	481.2
	2 kg humic/fed	319.5	381.0	400.8	455.3	498.1	507.0
	4 kg humic/fed	349.7	404.7	448.5	531.6	534.0	571.9
6 tons compost/fed	Without	300.5	308.5	377.7	486.9	523.5	616.4
	2 kg humic/fed	357.9	397.3	412.5	495.8	575.0	638.4
	4 kg humic/fed	371.7	421.3	461.0	554.6	613.4	657.3
F. test		*			*		
LSD at 5 %		25.6			15.8		
2011/2012 season							
Without (control)	Without	227.9	268.9	297.8	444.5	447.0	459.5
	2 kg humic/fed	278.2	290.0	303.2	502.0	541.9	633.7
	4 kg humic/fed	303.2	304.4	333.5	544.6	592.3	647.9
2 tons compost/fed	Without	256.9	297.7	324.6	459.1	477.7	492.9
	2 kg humic/fed	280.5	333.7	353.1	526.7	572.5	600.2
	4 kg humic/fed	329.1	350.3	376.0	568.1	612.6	670.8
4 tons compost/fed	Without	290.2	319.5	347.1	473.1	477.7	492.9
	2 kg humic/fed	299.0	333.3	381.4	533.6	576.9	629.2
	4 kg humic/fed	338.5	358.8	394.9	568.1	612.6	670.8
6 tons compost/fed	Without	317.2	329.4	356.9	524.6	532.5	597.5
	2 kg humic/fed	323.1	366.8	384.0	540.8	576.9	636.7
	4 kg humic/fed	370.2	386.5	425.0	639.4	646.3	696.9
F. test		*			*		
LSD at 5 %		20.6			26.9		

Table 9: Averages of foliage fresh weight (g/plant) at 120 and 150 days from sowing (DFS) as affected by the interaction among compost, humic acid and nitrogen fertilizer rates during 2010/2011 and 2011/2012 seasons.

Compost rates	Humic acid rates	120 days from sowing			150 days from sowing		
		40 kg N/fed	60 kg N/fed	80 kg N/fed	40 kg N/fed	60 kg N/fed	80 kg N/fed
2010/2011 season							
Without (control)	Without	265.2	285.8	333.8	229.1	321.1	385.8
	2 kg humic/fed	300.9	312.8	367.4	408.7	420.5	419.7
	4 kg humic/fed	328.7	341.0	382.3	440.8	451.7	459.6
2 tons compost/fed	Without	286.0	296.7	354.0	288.2	378.4	413.2
	2 kg humic/fed	314.8	338.8	381.0	415.3	432.8	439.7
	4 kg humic/fed	334.7	366.2	407.8	445.5	451.6	465.0
4 tons compost/fed	Without	300.4	341.5	365.4	304.2	399.4	415.8
	2 kg humic/fed	336.2	354.1	383.8	435.6	438.6	444.9
	4 kg humic/fed	386.5	395.9	502.0	446.0	472.4	494.5
6 tons compost/fed	Without	304.7	346.9	405.2	389.6	403.5	419.6
	2 kg humic/fed	339.0	376.8	395.5	468.0	473.3	493.1
	4 kg humic/fed	398.5	488.2	504.8	498.3	546.4	553.9
F. test		*			*		
LSD at 5 %		20.5			15.2		
2011/2012 season							
Without (control)	Without	325.7	340.6	363.0	245.5	317.8	345.0
	2 kg humic/fed	347.2	354.3	358.0	381.4	397.0	402.4
	4 kg humic/fed	369.7	377.3	419.5	440.3	455.4	464.8
2 tons compost/fed	Without	352.9	355.8	372.0	324.6	337.8	386.3
	2 kg humic/fed	349.5	372.0	406.9	393.5	404.4	411.5
	4 kg humic/fed	388.6	403.7	442.4	453.1	466.2	478.0
4 tons compost/fed	Without	367.9	369.6	381.4	325.1	340.8	391.4
	2 kg humic/fed	394.7	426.1	437.6	397.4	425.0	455.5
	4 kg humic/fed	435.7	433.8	445.1	475.0	491.3	555.2
6 tons compost/fed	Without	387.9	413.2	424.4	452.2	474.9	500.4
	2 kg humic/fed	454.1	458.3	489.4	527.6	621.3	654.0
	4 kg humic/fed	455.1	467.5	512.5	630.8	658.6	660.5
F. test		*			*		
LSD at 5 %		14.8			21.5		

With connection the effect of the triple interaction on LAI, it was significant at 120 DFS in the two seasons of study (Table 10). The highest means of LAI (5.46 and 5.80) were resulted from application organic fertilization as 6 tons compost/fed and 4 kg humic acid/fed in addition mineral fertilizing with 80 kg N/fed at 120 DFS in the first and second seasons, respectively. While, the lowest ones (3.38 and 3.47) were obtained with control treatment of studied factors (without compost and humic acid and 40 kg N/fed) at 120 DFS in the first and second seasons, respectively.

It was worthy to mentioned that this research aimed to reducing amount of mineral nitrogen fertilizer that applying in sugar beet fields and exchange it with organic fertilization with compost and humic acid in order to minimize pollution rate and maintenance of environment that consider as national goal. It can be concluded that, application of 4 tons compost/fed + 4 kg humic acid/fed + 60 kg N/fed (saving 20 kg N/fed) that significantly increased root and foliage fresh weight as well as LAI at both growth samples as compared with treatment that farmers usually applied (without compost and humic acid and using maximum rate of nitrogen fertilizer *i.e.* 80 kg N/fed or more) in both seasons.

Table 10: Averages of leaf area index (LAI) at 120 days from sowing (DFS) as affected by the interaction among compost, humic acid and nitrogen fertilizer rates during 2010/2011 and 2011/2012 seasons.

Compost rates	Humic acid rates	2010/2011 season			2011/2012 season		
		40 kg N/fed	60 kg N/fed	80 kg N/fed	40 kg N/fed	60 kg N/fed	80 kg N/fed
Without (control)	Without	3.38	3.62	3.84	3.47	3.53	3.73
	2 kg humic/fed	3.89	4.16	4.49	3.60	3.78	3.98
	4 kg humic/fed	4.18	4.36	4.60	4.28	4.34	4.55
2 tons compost/fed	Without	3.42	3.68	3.92	3.70	3.94	4.01
	2 kg humic/fed	4.16	4.17	4.52	3.89	4.24	4.55
	4 kg humic/fed	4.30	4.54	4.96	4.32	4.46	4.77
4 tons compost/fed	Without	3.61	3.80	4.18	4.01	4.07	4.25
	2 kg humic/fed	4.19	4.43	4.74	4.24	4.62	4.66
	4 kg humic/fed	4.36	4.39	5.09	4.43	4.52	5.66
6 tons compost/fed	Without	3.80	4.20	4.37	4.22	4.32	4.53
	2 kg humic/fed	4.66	4.55	5.23	4.58	4.70	5.79
	4 kg humic/fed	5.14	5.24	5.46	5.28	5.53	5.80
F. test		*			*		
LSD at 5 %		0.20			0.21		

It could be stated that maximizing sugar beet growth could be achieved by organic by using 6 tons compost/fed in addition 4 kg humic acid/fed and mineral fertilizing with 80 kg N/fed under the environmental conditions of Kafr El-Sheikh Governorate. It can be also recommended that application of 4 tons compost/fed + 4 kg humic acid/fed + 60 kg N/fed (saving 20 kg N/fed) that significantly increased sugar beet growth as compared with treatment that farmers usually applied (without compost and humic acid and using 80 kg N/fed) to reduce environmental pollution.

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تأثير مستويات الكمبوست وحمض الهيومك والسماد النيتروجينى على:
1 - نمو محصول بنجر السكر

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أجريت تجربتان حقليتان بمنطقة حفير شهاب الدين – منطقة الخاشعة – محافظة كفر الشيخ خلال موسمى 2011/2010 و 2012/2011 لدراسة تأثير معدلات الكمبوست ، حمض الهيومك والسماد النيتروجينى على صفات النمو لمحصول بنجر السكر صنف جلوريا. أجري كل مستوى من مستويات الكمبوست (بدون ، 2 ، 4 و 6 طن كمبوست/فدان) فى تجربة مستقلة ثم نفذت كل تجربة (مستويات الكمبوست) فى تصميم القطع المنشقة مرة واحدة فى أربع مكررات. ثم أجرى التحليل التجميعى لتجارب مستويات الكمبوست. حيث اشتملت القطع الرئيسية على مستويات حمض الهيومك (بدون ، 2 و4 كجم حمض هيومك/فدان) ، بينما احتوت القطع الشقية على مستويات السماد النيتروجينى (40 ، 60 و80 كجم نيتروجين/فدان) ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

١ -وجد أن أعلى القيم لجميع صفات النمو تحت الدراسة بعد 120 و150 يوم من الزراعة تم الحصول عليها من التسميد العضوى بـ 6 طن كمبوست / فدان في كلا الموسمين. تلا هذه المعاملة إستخدام 4 طن كمبوست / فدان ثم 2 طن كمبوست / فدان بعد 120 و150 يوم من الزراعة في كلا الموسمين.

٢ -أعطت المعاملة بالمعدل الأعلى لحمض الهيومك (4 كجم/فدان) أفضل النتائج وكانت متفوقة على إستخدام 2 كجم حمض هيومك للفدان أو معاملة المقارنة ، حيث سجلت أعلى القيم لجميع صفات النمو الخضرى تحت الدراسة فى كلا الموسمين.

٣ -أدى التسميد النيتروجينى بمعدل 80 كجم/فدان إلى زيادة معنوية والحصول على أعلى القيم لجميع الصفات تحت الدراسة عند 120 و150 يوم من الزراعة فى كلا الموسمين. فى حين أن إستخدام 40 كجم نيتروجين/فدان قد سجل أقل القيم لجميع الصفات تحت الدراسة فى كلا الموسمين.

من النتائج المتحصل عليها فى هذه الدراسة يمكن التوصية بالتسميد العضوى لبنجر السكر بـ 6 طن كمبوست و 4 كجم حمض هيومك لكل فدان بالإضافة إلى التسميد المعدنى بـ 80 كجم نيتروجين/فدان للحصول على أعلى نمو تحت ظروف محافظة كفر الشيخ. كما يمكن التوصية أيضاً بالتسميد العضوى بـ 4 طن كمبوست و 4 كجم حمض هيومك و التسميد المعدنى بـ 60 كجم نيتروجين/فدان (توفير 20 وحدة نيتروجين/فدان) للحصول على نمو أفضل من المعاملة المعتادة لمعظم المزارعين (بدون تسميد عضوى كمبوست أو حمض هيومك والتسميد المعدنى بـ 80 كجم نيتروجين/فدان) وأيضاً لتقليل التلوث البيئى.

قام بتحكيم البحث

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