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EFFECT OF NITROGEN FERTILIZER AND COMPOST RATES ON YIELD AND QUALITY OF SUGAR BEET GROWN IN SANDY SOIL UNDER DRIP IRRIGATION SYSTEM

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ABSTRACT

In order to investigate the effect of four nitrogen fertilizer rates *i.e.* 35, 70, 105 and 140 kg N/fad., and four compost rates *i.e.* 0, 2, 4 and 6 t/fad., and their interactions on yield and its attributes as well as quality of sugar beet (*Beta valgaris* L.) variety Top, grown in sandy soil under drip irrigation system. Two field experiments were conducted at the Agricultaral Researsh Station, Fac. Agric., Zagazig Univ., at El-Khattara Region, Sharkia Governorate, Egypt during the two successive winter seasons of 2011/2012 and 2012/2013. Regarding to the combined analysis of the both seasons, it could be noticed that increasing N fertilizer level from 35 to 140 kg N/fad., significantly increased root diameter, fresh top weight/plant, fresh root weight/plant, Na (%), K (%), alpha amino-N (%), top, root and recoverable sugar yields/fad. Root length and sugar loss in molasses percentage (SLM%) were responded only to 105 kg N/fad. The highest averages of sucrose and extractable sugar percentages were obtained by application of either 35 or 70 kg N/fad. Whereas, purity percentage significantly decreased with each increase in nitrogen fertilizer levels. Results clearly revealed that increasing compost rates up to 4 t/fad., significantly increased root length and diameter, fresh top weight/plant, fresh root weight/plant, Na (%) and SLM (%). The highest top, root and recoverable sugar yields as well as alpha amino-N (%) were achieved by application the highest rate of compost (6 t/fad.). The highest averages of sucrose, purity and extractable sugar percentages were obtained by the control treatment. In addition, the interaction between nitrogen fertilizer and compost rates significantly affected root length and diameter, fresh top weight/plant, fresh root weight/ plant, purity percentage, top, root and recoverable sugar yields/fad. It could be summarized that N-fertilizer level of 105 kg N/fad., with application of compost at 6 t/fad., could be applied for maximizing sugar production and minimizing soil pollution by reducing the application of N- fertilizer.

Key words: Sugar beet, N fertilizer, compost, drip irrigation system, sandy soil.

INTRODUCTION

Sugar beet (*Beta vulgaris*, L.) is one of the most important crops in Egypt, it has position in newly reclaimed sandy soils. Using organic and nitrogen fertilization in this soil are among factors that affect sugar beet yield and its quality. In this respect, nitrogen is the most important fertilizer element to be added under sandy soil conditions. Proper nitrogen nutrition in sugar beet production is crucial. Lack of nitrogen will result in significant reduction in root yields, while excess nitrogen will promote significant decrease in sucrose content of root and excessive leaf growth (Blumentbal, 1996). In this respect, Geweifel *et al.* (2006) revealed that, increasing nitrogen fertilizer level from 96 to 210 kg N/ha significantly increased sugar beet top, root and sugar yields and decreased sucrose percentage under sandy soil conditions in Egypt. Furthermore, many investigators reported that increasing nitrogen fertilizer levels up to 150 kg N/fad., resulted in significant increase in sugar beet yield and its components (Seadh, 2008; Abou-Shady *et al*., 2011; Osman, 2011; Abdou, 2013; Awad *et al*., 2013; El-Sayed, 2013), on

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the contrary, juice quality *i.e.* sucrose and purity percentages were significantly decreased due to increasing nitrogen fertilizer level. Nevertheless, Ramadan *et al.* (2003) and Gobarah *et al*. (2010) concluded that increasing N level from 60 to 150 kg/fad., significantly increased root yield, yield components and impurities (Na, K, and alpha amino nitrogen contents). Omar and Mohamed (2013) found that increasing N fertilizer levels from 50 to 125 kg/fad., caused significant increase in root length, root diameter, fresh top weigh/plant, fresh root weigh/plant, Na (%), k (%), sugar loss in molasses (%) and root yield/fad. Top and recoverable sugar yields were responded only to 100 kg N/fad. The highest averages of sugar (%), purity (%) and extractable sugar (%) were produced from using low nitrogen levels (either 50 or 75 kg N/fad.). Meanwhile, Mekdad (2015) stated that increasing nitrogen up to 140 kg N/fad., caused significant increase in root fresh weight, top fresh weight, root yield, gross sugar yield and lost sugar yield of sugar beet compared with 100 kg N/fad. Also, K, Na and alpha amino N percentages were significantly increased by increasing nitrogen fertilizer level, whereas nitrogen fertilizer level had no significant effect on purity (%). Recently, Abdou *et al*. (2014) and Ismail *et al*. (2016) recorded significant increment in top fresh weight, root fresh weight, root length, root diameter, root and sugar yields/fad., due to increasing nitrogen fertilizer level up to 120 kg N/fad.

Compost increases the organic matter content, especially in sandy soil which serves several advantages like conservation and slow release of nutrients, improvement of soil physical conditions and preservation of soil moisture, as well as application it in large quantities to soil systems with little danger of excess nutrient accumulation. In this regard, Mokadem (2000) reported that using farmyard manure (FYM) surpassed the check treatment (without adding farmyard manure) in fresh weight of root/plant and root, top and sugar yields/fad., while, percentage of sucrose was tended to be decreased with the addition of farmyard manure. El-Geddawy *et al*. (2003) reported that, organic compost with N mineral fertilizer significantly increased leaves fresh weight, root length, root diameter, root weight and root yield of sugar beet. Gomaa *et al.* (2007) showed that application of compost at rate of 2 t/fad., to sugar beet caused significant increase in Na, K, alpha amino-N and sugar loss to molasses percentages as compared to without compost application, while, sucrose (%) did not vary significantly by compost application (combined analysis). Abo El-Ftooh *et al.* (2012) revealed that poultry manure gave remarkable results in suppression in root, top and sugar yields as well as sucrose and purity (%) compared with cattle and sheep manures. Abou El-Magd *et al*. (2012) showed that, root yield of sugar beet and yield components (top yield, root diameter, root length, sucrose (%), juice purity (%), gross sugar yield and recoverable sugar %) significantly augmented by the application of FYM. They added that, raising FYM rate (0, 10 and 20 m^3/ fad.) gradually increased the quantity and quality of sugar beet. El-Ghareib *et al*. (2012) showed that increasing farmyard manure rate up to 30 m^3/fad., significantly increased root fresh weight, top yield/fad., root yield/fad., as well as sugar yield/fad., of sugar beet but, decreased sucrose (%) and purity (%) as compared to control (without added farmyard manure) in both seasons. Badawi *et al*. (2013) studied the effect of compost (0, 2, 4 and 6 t/fad.) on growth of sugar beet. They showed that, sugar beet plants furnished with 6 t compost/fad., produced the maximum averages of all growth characters at the period of 120 and 150 days from sowing in both seasons followed by those received 4 t compost/fad., then 2 t compost/fad., in both growing seasons. Hasanen *et al*. (2013) recorded significant increase in shoot fresh weight, root fresh weight, root length, root yield and sugar yield as well as the technological characters of sugar beet (sugar, purity, K, Na and Alfa-amino-N percentages) due to organic fertilization by farmyard manure (FYM) and poultry manure (PM). Recently, Soliman *et al*. (2014) studied the effect of nine treatments of compost produced from animal waste, town refuse and plant waste applied at three rates (10, 20 and 30 m^3/fad.) on growth and chemical composition of sugar beet plants. They indicated that the highest values of growth parameters as well as sugar, and purity percentages were recorded in plants treated with 30 m^3 compost/fad., produced from animal waste.

Therefore, this investigation was aimed to find out the effect of nitrogen fertilizer levels and compost rates on yield and its attributes and quality of sugar beet grown under the condition of sandy soil.

MATERIALS AND METHODS

Two field experiments were conducted at the Agricultaral Researsh Station, Faculty of Agriculture, Zagazig University at El-Khattara Region, Sharkia Governorate, Egypt during the two successive winter seasons of 2011/2012 and 2012/2013. The experiment aimed to find out the effect of four compost rates (0, 2, 4 and 6 t/fad.) and four nitrogen fertilizer levels (35, 70, 105 and 140 kg N/fad.) on yield and its attributes as well as quality of sugar beet (*Beta valgaris* L.) in sandy soil under drip irrigation system. Soil samples were collected from the experimental sites at the depth of 0-30 cm before planting to determine soil mechanical and chemical properties. The mechanical and chemical analyses of the experimental field soil and compost nutrient contents in the two seasons are presented in Table 1. A split-plot design with four replicates was followed, nitrogen fertilizer levels were randomly allocated in the main plots and compost rates were distributed in the sub-plots. Each experiment included 16 treatments which were the combinations of four rates of compost and four levels of nitrogen fertilizer. Each sub plot (15m^2) contained 5 drip lines, 5 m long, 60 cm apart. Compost was soil incorporated under drip lines before planting. Nitrogen fertilizer in the form of urea (46.5% N) was fertigated, each nitrogen fertilizer level was splited into five equal doses, the first was applied after thinning (35 days after sowing) and the others were applied at 14 days intervals after the first application. In both seasons, the preceding crop was corn (*Zea mays* L.). Seeds of sugar beet multi-germ variety TOP were planted at distance of 20 cm between hills on 16 and 28 of October in the first and the second seasons, respectively. Thinning at 4-leaf stage (35 days after planting) was done to obtain one plant/hill.

Phosphorus fertilizer at the rate of 31 kg P_2O_5/ fad., in the form of calcium super phosphate (15.5% P_2O_5) was drilled before planting under drip lines, while potassium fertilizer at the rate of 48 kg K_2O/fad., in the form of potassium sulphate (48% K_2O) was applied in two equal doses, the first was applied just after thinning, while the second was applied 15 days later. Drip irrigation system using underground water (around 900 ppm of total salts) and dripping time every 5 days was used. Plants were kept free from weeds by hand hoeing for three times. The other regular agronomic practices, except the studied factors were done as recommended during growing season.

Studied Characters

Root yield and its attributes

At harvest (195 days from planting) five plants were randomly taken from the second inner row of each plot to determine the yield attributes as following:

1- Root length (cm).

2- Root diameter (cm).

3- Top fresh weigh/plant (g).

4- Root fresh weight/plant (g).

All plants of the third and fourth central rows of each plot (6 m^2) were harvested to estimate.

5- Root yield (t/fad.)

6- Top yield (t/fad.)

7- Recoverable sugar yield (t/fad.) = Root yield x extractable sugar (%).

Quality parameters

All percentages 1-sucrose (%), 2- potassium (k %) 3- sodium (Na%) and 4- alpha-amino nitrogen (%) were determined in sugar company laboratories at El-Hamool District, Kafr El-Sheikh Governorate, Egypt. All studied quality parameters were calculated as follows:

5- Purity percentage (%) was calculated according to Devillers (1988) following this equation:

Purity=99.36–(14.27 (Na+K+a-amino nitrogen)/ sucrose %).

6- Sugar lost in molasses (SLM %) = 0.14 (Na + K) + 0.25 (a- amino nitrogen) + 0.50 was determined according to Devillers (1988).

Table 1. Soil mechanical and chemical analyses of experimental sites and compost nutrients content in the two seasons

Soil properties	2012	2013
Mechanical analyses		
Sand (%)	86.52	91.5
Silt (%)	3.06	1.71
Clay (%)	10.42	6.79
Organic matter (%)	0.47	0.29
Soil texture	Loamy sand	Sandy
Chemical analyses		
pH	7.96	8.09
EC mmhose/cm	0.93	1.34
Available N (ppm)	17.72	12.25
Available P (ppm)	18.47	12.02
Available K (ppm)	41.06	37.18
Soluble cations (meq/100 g)		
Na^{+}	0.68	1.04
K^{+}	0.19	0.14
Ca^{++}	43.21	22.80
Mg^{++}	0.18	0.0.13
Soluble anions (meq/100 g)		
Cl^{-}	0.64	0.79
CO_3^{--}	-	-
HCO_3^{-}	0.22	0.24
SO_4^{--}	0.57	0.41
Compost		
Total N (%)	0.67	0.64
Total P (ppm)	376	352
Total K (ppm)	7052	7171
Organic matter (%)	19.22	17.84
C/N ratio	15:1	16 : 1

Source: Central Laboratory, Faculty of Agriculture, Zagazig University, Egypt.

7- Extractable sugar percentage (%) was determined according to Dexter *et al*. (1967) following this equation:

Extractable sugar percentage (%) = (Sucrose % - SLM % - 0.60).

Statistical Analysis

Data of the two seasons and their combined analysis were statistically analyzed according to Gomez and Gomez (1984). Treatment means were compared using Least Significant Differences (LSD) test at 0.05 level of probability (Steel *et al*., 1997). Statistical analysis was performed by using analysis of variance technique of (MSTAT-C 1991) computer software package. The error mean squares of split-plot design were homogenous (Bartlett's test), therefore, the combined analysis was calculated for all the studied characters in both seasons. *, ** and NS denote to significant and highly significant differences among means at 0.05 and 0.01 levels of probability and insignificant variations, respectively. In the interaction Tables, capital and small letters were used to compare among columns and rows means, respectively.

RESULTS AND DISCUSSION

Effect of N Fertilizer Levels

Root yield attributes

Results presented in Table 2 clearly show that root performance in terms of root dimension *i.e.* length, diameter and fresh top and root weight/plant were highly significantly affected by nitrogen application through both growing seasons and their combined. Increasing N levels up to 140 kg N/fad., enhanced root growth and hence increased root parameters. Thus, the highest means of root diameter, fresh top and root weights/plant were achieved when 140 kg N/fad., were applied, concerning the combined results which ranged from 9.73 to 13.44 cm, 292.22 to 429.66 g and 1037.56 to 1396.72 g regarding root diameter, fresh top weight and fresh root weight/plant, respectively. While, root length was significantly responded to increasing nitrogen fertilizer rates up to 105 kg N/fad. The obtained results confirmed the role of nitrogen in division as well as building organic metabolites which in turn translocated to be stored in sugar beet roots as stated by Gobarah *et al*. (2010). These results are in agreement with those reported by Omar and Mohamed (2013), Abdou *et al*. (2014), Mekdad (2015) and Ismail *et al*. (2016).

Quality parameters

The obtained results in Tables 3 and 4 show that N-fertilizer levels had significant or highly significant effect on various juice quality traits (sucrose %, Na %, K %, alpha amino-N %, purity %, extractable sugar % and SLM %) throughout both growing seasons and their combined analysis. Meanwhile, higher levels of nitrogen (105 and 140 kg N/fad.) tended to increase impurity parameters (Na%, K%, alpha amino-N%) and SLM%, while it was decreased sucrose (%), purity (%) and extractable sugar (%) as compared with lower levels of nitrogen (35 and 70 kg N/fad). Such decrease in sucrose, purity and extractable sugar percentages with the increase in nitrogen fertilizer level from 70 to 105 or 140 kg N/fad., may be due to the role of nitrogen through the increase of cell size and its water content and thus the root content of those quality parameters became little through the dilution effect. In other words, increasing nitrogen fertilizer level significantly increased impurities parameters and decreased sucrose, purity and extractable sugar percentages which could be attributed to reasons that high levels of nitrogen fertilizer increased non-sugar substances such as protein, amino acids and other substances which lead to decreasing sucrose (%), purity (%) and extractable sugar (%) as explained by Gobarah *et al.* (2010). These results are in accordance with those reported by Ramadan *et al.* (2003), Geweifel *et al.* (2006), Abou-Shady *et al*. (2011), Osman (2011) and Omar and Mohamed (2013) who indicated that increasing N-levels had a significant negative effect on sugar beet quality. In addition, Mekdad (2015) stated that, increasing nitrogen fertilizer level up to 140 kg N/fad., significantly increased SLM, K, Na and alpha amino N percentages whereas nitrogen fertilizer level had no significant effect on purity (%). Otherwise, Ouda (2005) showed that increasing N-levels up to 110 kg N/fad., resulted in significant increase in sucrose (%), while purity (%) was not significantly affected by applied nitrogen.

Table 2. Root length (cm), root diameter (cm), fresh top weight/plant (g) and fresh root weight/ plant (g) of sugar beet as affected by nitrogen and compost rates during 2011-2012 and 2012-2013 seasons and their combined

Main effects and interactions	Root length (cm)			Root diameter (cm)			Fresh top weight/plant (g)			Fresh root weight/plant (g)		
	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Nitrogen rate (N)												
35 kg N/fad.	20.54 c	17.35 b	18.94 c	9.91 d	9.55 c	9.73 d	307.13 d	277.31c	292.22d	1110.62 d	964.50 c	1037.56 d
70 kg N/fad.	22.29 b	18.82 b	20.56 b	12.04 c	10.46 b	11.25 c	361.88 c	325.06b	343.47c	1265.00 c	1037.87b	1151.44 c
105 kg N/fad.	24.63 a	19.95 a	22.29 a	14.18 b	10.85ab	12.52 b	422.77 b	386.94a	404.66b	1447.19 b	1195.69b	1321.44 b
140 kg N/fad.	24.89 a	20.38 a	22.64 a	15.41 a	11.47 a	13.44 a	457.06 a	402.25a	429.66a	1544.69 a	1248.75 a	1396.72 a
F-test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	0.51	0.85	0.46	0.62	0.79	0.47	13.17	16.62	9.94	47.55	74.34	40.95
Compost rate (C)												
Without (control)	19.59 c	16.84 c	18.22 c	11.42 c	9.40 c	10.41 c	311.81 c	272.94c	292.37c	1040.62 c	886.25 c	963.44 c
2 t /fad.	22.50 b	18.91 b	20.70 b	12.81 b	10.35 b	11.58 b	354.44 b	323.31b	338.87b	1197.50 b	1014.56b	1106.03 b
4 t /fad.	25.04 a	20.24 a	22.64 a	13.54 a	11.18 a	12.36 a	434.25 a	390.44a	412.34 a	1547.19 a	1261.81 a	1404.50 a
6 t /fad.	25.22 a	20.51 a	22.86 a	13.76 a	11.40 a	12.59 a	447.94 a	404.88a	426.41 a	1582.19 a	1284.19 a	1433.19 a
F-test	**	**	**	**	**	**	**	**	**	**	**	**
LSD 0.05	0.58	0.71	0.45	0.60	0.60	0.35	19.11	17.93	16.92	56.1	60.22	0.42
Interaction												
N×C	*	NS	NS	NS	*	*	*	**	**	*	*	**

*, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

Table 3. Sucrose (%), Na (%), K (%) and Alpha amino-N (%) of sugar beet as affected by nitrogen and compost rates during 2011-2012 and 2012-2013 seasons and their combined

Main effects and interactions	Sucrose (%)			Na (%)			K (%)			Alpha amino N (%)		
	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Nitrogen rate (N)												
35 kg N/fad.	15.95 a	17.17 a	16.56 a	2.66 b	2.35 b	2.50 c	4.79 b	4.21 b	4.50 b	2.12 b	2.07 b	2.09 c
70 kg N/fad.	15.64 ab	17.00 a	16.32 a	2.74 ab	2.51 a	2.62 b	4.89 b	4.37 ab	4.63 b	2.22 b	2.16 b	2.19 c
105 kg N/fad.	15.08 b	16.26 b	15.67 b	2.90 a	2.56 a	2.73 ab	5.08 ab	4.44 a	4.76 ab	2.41 a	2.33 a	2.37 b
140 kg N/fad.	14.79 b	15.97 b	15.38 b	2.94 a	2.62 a	2.78 a	5.19 a	4.49 a	4.84 a	2.52 a	2.44 a	2.48 a
F-test	*	**	**	*	*	**	*	*	**	**	**	**
LSD 0.05	0.71	0.57	0.42	0.22	0.15	0.12	0.22	0.20	0.14	0.15	0.14	0.11
Compost rate (C)												
Without (control)	15.95 a	17.30 a	16.62 a	2.62 b	2.33 b	2.48 c	4.84 b	4.23 b	4.53 b	2.16 c	2.19 b	2.17 c
2 t/fad.	15.61 a	16.88 b	16.25 b	2.75 b	2.42 b	2.58 b	4.95 ab	4.39 a	4.67 a	2.34 b	2.18 b	2.26 b
4 t /fad	15.00 b	16.22 c	15.61 c	2.91 a	2.63 a	2.77 a	5.06 a	4.45 a	4.75 a	2.31 b	2.29 a	2.30 b
6 t /fad	14.91 b	15.99 c	15.45 c	2.96 a	2.66 a	2.81 a	5.10 a	4.43 a	4.77 a	2.45 a	2.34 a	2.39 a
F-test	**	**	**	**	**	**	**	*	**	**	**	**
L.S.D. 0.05	0.60	0.39	0.36	0.15	0.12	0.10	0.18	0.14	0.12	0.10	0.09	0.08/
Interaction												
NxC	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	NS	NS

*, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

Table 4. Purity (%), extractable sugar (%) and SLM (%) of sugar beet as affected by nitrogen and compost rates during 2011-2012 and 2012-2013 seasons and their combined

Main effects and interactions	Purity (%)			Extractable sugar (%)			SLM (%)		
	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Nitrogen rate (N)									
35 kg N/fad.	90.79 a	92.17 a	91.48 a	13.27 a	14.63 a	13.95 a	2.07 b	1.94 b	2.00 c
70 kg N/fad.	90.36 a	91.77 a	91.06 b	12.92 ab	14.40 a	13.66 a	2.12 b	2.00 b	2.06 b
105 kg N/fad.	89.52 b	91.14 b	90.33 c	12.27 b	13.59 b	12.93 b	2.22 a	2.06 ab	2.14 a
140 kg N/fad.	89.06 b	90.80 b	89.93 d	11.92 b	13.26 b	12.59 b	2.27 a	2.11 a	2.19 a
F-test	**	**	**	**	**	**	**	**	**
LSD 0.05	0.44	0.48	0.31	0.66	0.47	0.40	0.08	0.07	0.06
Compost rate (C)									
Without (control)	90.73 a	92.13 a	91.43 a	13.26 a	14.73 a	14.00 a	2.08 c	1.97 b	2.02 c
2 t /fad.	90.17 b	91.75 a	90.96 b	12.84 a	14.29 a	13.56 b	2.16 b	2.00 b	2.08 b
4 t /fad.	89.56 c	91.09 b	90.33 c	12.20 b	13.56 b	12.88 c	2.19 ab	2.06 a	2.13 a
6 t /fad.	89.27 c	90.91 b	90.09 c	12.07 b	13.31 b	12.69 c	2.24 a	2.08 a	2.16 a
F-test	**	**	**	**	**	**	**	**	**
LSD 0.05	0.40	0.42	0.26	0.57	0.45	0.39	0.07	0.06	0.05
Interaction									
N×C	NS	**	NS	NS	NS	NS	NS	NS	NS

*, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively.

Top yield (t/fad.)

The tabulated results in Table 5 show that N-fertilizer levels highly significantly affected top yield during both growing seasons and their combined analysis. Top yield (t/fad.) appeared to be significantly increased as N-fertilizes level was increased from 35 up to 105 Kg N/fad., during both growing seasons, however combined analysis results showed that top yield was gradually increased as N- fertilizer level was increased from 35 up to 140 kg N/fad., then, the highest top yield of 12.12 t/fad., was obtained by 140 kg N/fad., level. These results are attributed to the role of nitrogen in increase the vegetative growth through enhancing leaf initiation, increment chlorophyll concentration in leaves and photosynthesis process, consequently increase top yield/fad. In this manner, Abdou (2013) indicated that increasing nitrogen level up to 140 kg/fad., helps plants to elongate its vegetative growth and delay maturity. So great amounts of photosynthetic products pass through the new vegetative parts and consequently increase top yield/fad. The obtained results are in agreement with those reported by Abou-Shady *et al*. (2011), El-Sarag and Moselhy (2013), Omar and Mohamed (2013) and Abdou *et al.* (2014).

Root yield (t/fad.)

The results in Table 5 show that N fertilizer levels had highly significant effect on root yield of sugar beet during both succeeded seasons and their combined. Meanthrough, root yield (t/fad.) followed the same patterns of top yield (t/fad.) whereas it tended to be gradually increased as N- fertilizer levels increased from 35 to 140 kg N/fad. Then, root yield (t/fad.) significantly increased from 29.11 to 32.48, 37.61 and 39.83 (t/fad.) due to increasing N- levels from 35 to 70, 105 and 140 kg N/fad., for the same respective order. Concerning combined results increasing N levels from 35 to 70, 105 and 140 kg N/fad., gave relatively increases in root yield (t/fad.) amounted to 11.58%, 29.20% and 36.83% for the same following order. These favorable effects of nitrogen fertilizer application were rather expected since the soil of the experiment was sandy poor fertile one (Table 1). The positive effect of N application on yield attributes included root yield was also reported by several investigators (Ramadan *et al*., 2003; Geweifel *et al*., 2006; Abdou, 2013; Omar and Mohamed, 2013; Abdou *et al.*, 2014; Mekdad, 2015; Ismail *et al.*, 2016).

Table 5. Top yield (t/fad.), root yield (t/fad.) and recoverable sugar yield (t/fad.) of sugar beet as affected by nitrogen and compost rates during 2011-2012 and 2012-2013 seasons and their combined

Main effects and interactions	Top yield (t/fad.)			Root yield (t/fad.)			Recoverable sugar yield (t/fad.)		
	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
Nitrogen rate (N)									
35 kg N/fad.	9.03 c	7.41 c	8.22 d	32.53 d	25.68 d	29.11 d	4.24 c	3.72 c	3.98 d
70 kg N/fad.	10.37 b	8.87 b	9.62 c	36.55 c	28.41 c	32.48 c	4.69 b	4.07 b	4.38 c
105 kg N/fad.	12.05 a	10.80 a	11.42 b	41.67 b	33.54 b	37.61 b	5.08 a	4.52 a	4.80 b
140 kg N/fad.	12.84 a	11.39 a	12.12 a	44.00 a	35.66 a	39.83 a	5.21 a	4.69 a	4.95 a
F-test	**	**	**	**	**	**	**	**	**
LSD 0.05	0.81	0.63	0.48	1.98	1.32	1.06	0.25	0.21	0.13
Compost rate (C)									
Without (control)	9.14 d	7.56 c	8.35 d	30.79 d	24.49 d	27.64 d	4.01 d	3.56 c	3.79 d
2 t /fad.	10.35 c	8.81 b	9.58 c	35.35 c	27.96 c	31.66 c	4.52 c	3.98 b	4.25 c
4 t /fad.	11.83 b	10.63 a	11.23 b	42.44 b	34.45 b	38.44 b	5.15 b	4.64 a	4.90 b
6 t /fad.	12.97 a	11.47 a	12.22 a	46.17 a	36.39 a	41.28 a	5.53 a	4.81 a	5.17 a
F-test	**	**	**	**	**	**	**	**	**
LSD 0.05	0.87	0.93	0.62	1.73	1.68	1.19	0.22	0.18	0.16
Interaction									
N×C	*	*	**	**	*	**	**	NS	**

*, ** and NS indicate significant at 0.05, 0.01 and not significant, respectively. One faddan = 4200 m^2.

Recoverable sugar yield (t/fad.)

Results of recoverable sugar yield (t/fad.) as an economical yield of growing sugar beet as affected by N- fertilizers application levels are presented in Table 5 which reveal highly significant difference during both growing seasons and their combined analysis. Meanthrough, increasing N-fertilizes level from 35 up to 140 kg N/fad., tended to be significantly increased recoverable sugar yield (t/fad.) concerning the combined analysis, while the differences between the application of 105 and 140 kg N/fad., levels could not reach the level of significance during both growing seasons. Then, the combined analysis indicated that recoverable sugar yield (t/fad.) increased gradually from 3.98, 4.38, 4.80 and 4.95 t/fad., due to raising the application N- fertilizer level from 35 to 70, 105, and 140 kg N/fad., in the same respective following order. These results almost followed the same patterns of other yield components (top and root yields t/fad.), Table 5. The relative increase due to N-fertilizes application amounted to 10.05%, 20.60% and 24.37% for the increasing of N-fertilizer levels from 35 to 70, 105 and 140 kg N/fad., respectively, regarding the combined analysis. The increment in recoverable sugar yield/fad., which found with increasing nitrogen level up to 140 kg N/fad., may be due to the role of nitrogen in encourage of canopy growth that produced more photosynthetic products translocated to roots, then increased sugar production per unit area. Such favorable effects of N fertilizer application were rather expected since the soil of the experiment was sandy poor fertile one (Table 1). In this manner Mekdad (2015) indicated that, each increase in nitrogen fertilizer level from 100 to 140 kg N/fad., caused a gradual increase in sugar yield. Furthermore, several investigators showed that increasing N-fertilizer application significantly increased sugar yield of sugar beet/ fad., (Geweifel *et al.*, 2006; Seadh, 2008; Osman, 2011; Awad *et al.*, 2013; El-Sarag and Moselhy, 2013; Abdou *et al*,. 2014; Mekdad, 2015 ; Ismail *et al.*, 2016).

Effect of Compost Rates

Root yield attributes

Results presented in Table 2 clearly indicate that there were highly significant differences in root yield attributes (root length, diameter, top fresh and root fresh weights/plant) among the tested rates of compost during both growing seasons and their combined. Meanwhile, root yield attributes responded significantly to applied compost rates up to 4 t/fad. On the contrary, control treatment (without compost application) appeared to be recorded the lowest values, concerning root yield attributes evaluated during both seasons and the combined. Al-Labbody (1998) pointed out that applying FYM significantly increased root diameter, length and fresh weight. Furthermore, the obtained results are in accordance with those reported by El- Geddawy *et al*. (2003), Abou El-Magd *et al.* (2012), Hasanen *et al.* (2013) and Soliman *et al*. (2014).

Quality parameters

The results given in Tables 3 and 4 clearly showed that the application of compost tended to be significantly decreased sucrose, purity and extractable sugar percentages and such trend was confirmed during both growing seasons and their combined. Thus, the highest values of these quality parameters were achieved by control treatment (without compost application) which amounted to 16.62%, 91.43% and 14.00% for sucrose, purity and extractable sugar percentages, respectively, concerning the combined results. Otherwise, the application of compost significantly increased Na (%), K (%), alpha amino-N (%) and SLM (%) throughout the seasons and the combined results. But, the positive response of these traits to compost rates varied from trait to another, which it was responded up to 4 t/fad., for Na (%) and SLM (%), while K (%) increased with the application of low rate of compost (2 t/fad.) and alpha amino-N (%) increased significantly up to the application of the highest rate of compost (6 t/fad.). In general, Na, K and alpha amino-N are the serious impurities in beet juice and found much more than other elements. In addition, these three elements not removed during processing but contribute to losses of sugar to molasses and hence affected greatly the extracted sugar. The obtained results are in agreement with those reported by Gomaa *et al.* (2007) who indicated that application of compost at rate of 2 t/fad., to sugar beet resulted in significant increase in Na, K and alpha amino-N and sugar loss to molasses percentages as compared to without compost application. Furthermore, El-Ghareib *et al.*, (2012) stated that increasing farmyard manure rate up to 30 m^3/fad increased root yield attributes but, decreased sucrose (%) and purity (%) as compared to control (without added farmyard manure). On the other hand, Abou El-Magd *et al.* (2012); Hasanen *et al*. (2013) and Soliman *et al.* (2014) stated that sucrose and purity percentages were significantly augmented by the application of FYM.

Top yield (t/fad.)

With respecting to the influence of compost rates on top yield (t/fad.), the obtained results in Table 5 revealed highly significant differences during both growing seasons and their combined analysis. Meanwhile, the application of compost tended to be gradually significantly increased top yield from 8.35 to 9.58; 11.23 and 12.22 t/fad., for control (without compost application), 2, 4 and 6 t/fad., respectively regarding the combined results. These results could be attributed to the important role of compost and other organic manure in nutrient solubility as active physiological and biochemical processes in plant which leading to increase the plant growth and nutrient uptake as reported by Dahdouh *et al*. (1999) in wheat plants. The given results are in agreement with those reported by El-Geddawy *et al*. (2003); Abou-El-Magd *et al.* (2012) and El-Ghareib *et al.* (2012) in addition to Badawi *et al.* (2013) who found that all growth characters of sugar beet showed the maximum means with the application of 6 t compost/fad., followed by using 4 t, then 2 t compost/fad., during two growing seasons.

Root yield (t/fad.)

Results recorded in Table 5 clearly show that compost rates had highly significant effects on root yield (t/fad.) throughout both seasons and their combined. The results followed the same patterns of top yield/fad. Whereas root yield (t/fad.) appeased to be significantly increased as compost rates increased from 0 to 6 t/fad., root yield/fad., recorded gradually increase from 27.64 to 31.66, 38.44 and 41.28 t/fad., for control (without compost application), and the application of 2, 4 and 6 t/fad., respectively. The relative increases due to compost application amounted to 14.54%, 39.07% and 49.35% for increasing compost rates from 0 to 2, 4 and up to 6 t/fad., for the same following order, concerning the combined results. The increase in root yield caused by increasing compost rates may be attributed to the high of organic matters content of compost which serves several advantages like conservation and slow release of nutrients. These advantages lead to the increase in soil fertility which led in turn to increasing of the productivity of plants as illustrated by El-Ghareib *et al.* (2012). Furthermore, the obtained results are in agreement with those reported by El- Geddawy *et al.* (2003), Abo El-Ftooh *et al.* (2012), Abou El-Magd *et al.* (2012), Badawi *et al.* (2013) and Soliman *et al.* (2014).

Recoverable sugar yield (t/fad.)

Sugar yield (t/fad.) as affected by compost application rates is illustrated in Table 5. Meanwhile the results revealed highly significant differences during both growing seasons and its combined analysis, whereas sugar yield (t/fad.) increased gradually as compost rate was increased from 0 to 2, 4 and up to 6 t/fad., recorded 3.79, 4.25, 4.90 and 5.17 t sugar yield/fad., for the same followed order, respecting the combined results. Then, increasing compost rates from 0 to 2, 4 and up to 6 t/fad., resulted in relative increases in sugar yield/ fad., amounted to 12.14%, 29.29% and 36.41%, respectively, concerning the combined results. The increase in sugar yield of sugar beet caused by increasing compost rates may be attributed to its important role in nutrient solubility as activate physiological and biochemical process in plant which leading to increase the plant growth and nutrient uptake. In this manner, Hasanen *et al*. (2013) recorded a significant increase in sugar yield of sugar beet due to the applicant of organic fertilization. In addition, many other investigators reported similar results, from them Mokadem (2000), Abou El-Maged *et al.* (2012), El-Ghareib *et al.* (2012) and Hasanen *et al*. (2013).

Effect of Interaction

Root yield attributes

According to the combined analysis, the significant interaction between nitrogen fertilizer and compost rates on root diameter, fresh top weight/plant and fresh root weight/plant are presented in Table 2-a. It could be stated that, root diameter significantly and gradually increased by increasing nitrogen fertilizer levels up to 140 kg N/fad., under any rate of compost application (2, 4 and 6 t compost/ fad.). This effect of N-fertilizer was not observed under without compost application, where root diameter significantly increased when N-fertilizer increased only from 35 or 70 to 105 kg N/fad.

Concerning to the fresh top weight/plant, it is clear that, each increase in N-fertilizer levels caused significant and gradually increase in fresh top weight/plant when higher rates of compost (4 or 6 t/fad.) was applied. While, under without or application of 2 t compost/fad., fresh top weight/plant was responded to N-fertilizer increment up to 105 kg N/fad.

Fresh root weight/plant significantly and gradually increased due to increasing N-fertilizer levels up to 140 kg N/fad., when 6 t compost/fad., was applied. This effect of N-fertilizer was not observed under the lower rates of compost (0, 2 and 4 t/fad.) where fresh root weight/plant responded to N-fertilizer level up to 105 kg N/fad.

Top, root and recoverable sugar yields (t/fad.)

The significant interaction between N-fertilizer levels and compost rates on top, root and recoverable sugar yields/fad., are presented in Table 5-a. It was evident that under the application of 4 t compost/fad., top, root and recoverable sugar yields/fad. significantly and gradually increased with each increase in N-fertilizer levels up to 140 kg N/fad. While, under the lower (0 or 2 t/fad.) or higher (6 t/fad.) rates of compost, the three aforementioned traits significantly responded to N- fertilizer up to 105 kg N/fad. Furthermore, the lowest values of top, root and recoverable sugar yields/fad., were obtained when plants received either 35 or 70 kg N/fad., without compost application. The highest values of the three aforementioned were achieved by the application of N-fertilizer of 140 kg N/fad., under the application of 4 or 6 t compost/fad. However, the same results could be achieved by plants received only 105 kg N/fad., if 6 tons compost/fad., was applied.

Table 2-a. Root diameter (cm), fresh top weight /plant (g) and fresh root weight/plant (g) of sugar beet as affected by the interaction between nitrogen fertilizer levels and compost rates (combined analysis of the two growing seasons)

Compost rates	Nitrogen fertilizer levels			
	35 kg N/fad.	**70 kg N/fad.**	**105 kg N/fad.**	**140 kg N/fad.**
	Root diameter (cm)			
	B	B	A	A
Control	9.16 b	9.59 c	11.25 c	11.63 c
	D	C	B	A
2 tons/fad.	9.58 ab	11.24 b	12.29 b	13.22 b
	D	C	B	A
4 tons/fad.	10.05 a	11.65 b	13.20 a	14.54 a
	C	B	B	A
6 tons/fad.	10.13 a	12.53 a	13.33 a	14.37 a
	Fresh top weight/plant (g)			
	B	B	A	A
Control	250.88 b	256.00 c	323.25 c	339.38 c
	C	B	A	A
2 tons/fad.	275.75 b	316.63 b	372.88 b	390.25 b
	D	C	B	A
4 tons/fad.	316.63 a	392.88 a	450.38 a	489.50 a
	D	C	B	A
6 tons/fad.	325.63 a	408.75 a	472.13 a	499.50 a
	Fresh root weight/plant (g)			
	B	B	A	A
Control	837.88 c	856.00 c	1031.75 c	1092.13 c
	B	B	A	A
2 tons/fad.	971.63 b	1025.50 b	1185.38 b	1241.63 b
	C	B	A	A
4 tons/fad.	1142.50 a	1362.63 a	1520.87 a	1592.00 a
	D	C	B	A
6 tons/fad.	1162.25 a	1361.62 a	1547.75 a	1661.13 a

Table 5-a. Top yield (t/fad.), root yield (t/fad.) and recoverable sugar yield (t/fad.) of sugar beet as affected by the interaction between nitrogen fertilizer levels and compost rates (combined analysis of the two growing seasons)

Compost rates	Nitrogen fertilizer levels			
	35 kg N/fad.	**70 kg N/fad.**	**105 kg N/fad.**	**140 kg N/fad.**
	Top yield (t/fad.)			
	B	B	A	A
Control	7.07 c	7.64 d	9.16 d	9.53 c
	B	B	A	A
2 tons/fad.	7.95 b	8.80 c	10.49 c	11.08 b
	D	C	B	A
4 tons/fad.	8.86 a	10.33 b	12.03 b	13.70 a
	C	B	A	A
6 tons/fad.	8.99 a	11.71 a	14.2 a	14.16 a
	Root yield (t/fad.)			
	B	B	A	A
Control	24.74 c	25.39 d	29.42 d	31.01 d
	B	B	A	A
2 tons/fad.	27.89 b	29.06 c	33.77 c	35.90 c
	D	C	B	A
4 tons/fad.	31.63 a	36.08 b	41.07 b	45.01 b
	C	B	A	A
6 tons/fad.	32.16 a	39.39 a	46.16 a	47.40 a
	Recoverable sugar yield (t/fad.)			
	B	B	A	A
Control	3.42 c	3.61 d	4.00 d	4.12 c
	B	B	A	A
2 tons/fad.	3.92 b	4.00 c	4.45 c	4.63 b
	D	C	B	A
4 tons/fad.	4.28 a	4.75 b	5.04 b	5.51 a
	C	B	A	A
6 tons/fad.	4.30 a	5.15 a	5.71 a	5.53 a

Conclusion

It can be recommended that, maximizing growth characters, top, root and sugar yields/ fad., could be obtained by the application of N-fertilizer at levels of 140 kg N/fad., and compost at rate of 4 or 6 t/fad., under the environmental conditions of sandy soil at Sharkia Governorate. In addition, the significant interaction between both nitrogen and compost fertilizer rates indicated that N-fertilizer rate of 105 kg N/fad with compost rate of 6 tons/fad could be applied for maximizing top, root and sugar yields/fad., and minimizing the soil pollution by reducing the application of N- fertilizer. So, it is very important to mention that those results obtained when sugar beet grown under poor fertile sandy soil and drip irrigation practices which saved the amount of water used.

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تأثير معدلات السماد النيتروجيني والعضوي على محصول وجودة بنجر السكر المزروع في الأراضي الرملية تحت نظام الري بالتنقيط

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أقيمت تجربتان حقليتان في المزرعة التجريبية التابعة لكلية الزراعة - جامعة الزقازيق بمنطقة الخطارة – محافظة الشرقية – جمهورية مصر العربية خلال الموسمين المتتاليين ٢٠١٢/٢٠١١ ، ٢٠١٣/٢٠١٢ بهدف دراسة تأثير أربعة معدلات من السماد النيتروجيني (٣٥، ٧٠، ١٠٥ و١٤٠ كجم ن/فدان) وأربعة معدلات من السماد العضوى (صفر، ٢، ٤ و٦ طن كمبوست/فدان) على المحصول ومساهماته وصفات الجودة لبنجر السكر المزروع تحت نظام الرى بالتنقيط في الأراضي الرملية. وقد أظهرت نتائج التحليل المشترك لموسمى الدراسة ما يلى: أدت زيادة معدلات النيتروجين من ٣٥ كجم ن/فدان وحتى ١٤٠ كجم ن/فدان إلى حدوث زيادة معنوية فى طول وقطر الجذر، وزن العرش والجذر الغض/نبات، محتوى الجذور من الصوديوم والبوتاسيوم والألفا أمينونيتروجين ونسبة السكر المفقود في المولاس، محصول الفدان من العرش والجذور والسكر المستخلص، مع عدم وجود فرق معنوى بين معدلى الإضافة ١٠٥ و١٤٠ كجم ن/فدان بالنسبة لصفتى طول الجذر ونسبة السكر المفقود فى المولاس، نتج عن زيادة معدل السماد النيتروجينى عن ٧٠ كجم ن/فدان انخفاض معنوى لنسبتى السكروز والسكر المستخلص فى حين حدث إنخفاض تدريجى فى نسبة النقاوة مع كل زيادة من معدل السماد النيتروجينى، أوضحت النتائج أن زيادة معدل السماد العضوى حتى ٤ طن كمبوست/فدان إلى حدوث زيادة معنوية فى صفات: طول وقطر الجذر، الوزن الغض للعرش وللجذر/نبات، محتوى الجذور من الصوديوم ونسبة السكر المفقود فى المولاس. تم الحصول على أعلى القيم لكل من: محصول العرش، الجذور والسكر المستخلص وكذلك محتوى الجذور من الألفا أمينونيتروجين بإضافة أعلى معدل من السماد العضوي (٦ طن كمبوست/فدان)، بينما تم الحصول على أعلى القيم لكل من: نسبة السكروز، النقاوة والسكر المستخلص نتيجة لعدم إضافة السماد العضوى، كان للتفاعل بين معدلات السماد النيتروجيني ومعدلات السماد العضوى تأثيراً معنوياً موجباً على طول وقطر الجذر، الوزن الغض للعرش وللجذر/نبات، محصول الفدان من العرش والجذور والسكر المستخلص وكذلك نسبة النقاوة، جدير بالذكر أن إضافة السماد النيتروجينى بمعدل ١٤٠ كجم ن/فدان مع السماد العضوي بمعدل ٤ طن كمبوست/فدان أدى إلى الحصول على أعلى القيم لمحصول الفدان من العرش والجذور والسكر المستخلص، وفى نفس الوقت أمكن الحصول على نفس النتيجة من إضافة السماد النيتروجينى بمعدل ١٠٥ كجم ن/فدان مع السماد العضوي بمعدل ٦ طن كمبوست/فدان وهو الأفضل بهدف تقليل تلوث التربة عن طريق خفض معدل السماد النيتروجينى المستخدم، توصى هذه الدراسة بزيادة معدلات السماد النيتروجينى حتى ١٤٠ كجم نيتروجين للفدان وإضافة الكمبوست حتى ٤ أو ٦ طن للفدان لتعظيم إنتاجية محصول الجذور والسكر تحت ظروف الأراضي الرملية بمحافظة الشرقية.

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