Effect of Nitrogen and Compost Fertilization on Yield and Quality of Sugar Beet

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ABSTRACT: The present field experiment was conducted at Km 71 West Nubaryia, Alex. Cairo Desert Road, El- Behiera Governorate, Egypt during the two successive seasons, 2015/ 16 and 2016/ 17 to study the effect of nitrogen and compost fertilization on yield and quality of sugar beet (*Beta vulgaris,*L.) cultivar polygerm (cv. MK4016), which was obtained from Sugar Crop Research Institute Agricultural Research Center, Giza. The experimental design was randomized complete blocks in three replicates. The nitrogen and compost fertilization treatments were applied as follows: T_1(100kgN/ fed),T_2(50 kgN/ fed + 3.5 ton plant compost/ fed),T_3(50kgN/ fed + 3.5 ton mixed compost/ fed),T_4(7 ton plant compost/ fed) and T_5(7 ton mixed compost/ fed) where mixture of compost includes both 60% plant and 40% animal composts.The main results could be summarized as follows: All characters of yield and quality were significantly affected by the previous mentioned treatments. The treatment of (50kg N/ fed + 3.5 ton mixed compost/fed), gave the highest values of root fresh weight,leaves fresh weight and total fresh weight. Also the same treatment gave the highest values of root, top and sugar yields/ fed , sucrose% and T.S.S% of sugar beet during the two growing seasons. However, the treatment (50kg N/fed+3.5ton plant compost/fed) achieved the highest value of purity % in the first season, meanwhile the treatment (7 ton mixed compost/fed) recorded the highest one in the second season.

Key words: Sugar beet, Mineral and Organic fertilization, yields, Quality.

INTRODUCTION

Sugar beet is a specially type of *Beta vulgaris,* L. grown for sugar production and is considered the second important sugar crop in many countries all over the world after sugar cane (*Sacchurum officinarum,* L.) (Sugar Crops Council 2017). The importance of sugar beet to agriculture is not only confined to sugar production, but also to its by products which are used for alcohol production and considered as an important source of food for livestock. Also, it has a wide adaptability to be grown in poor, saline and alkaline soils (Sugar Crops Council 2017).Thus, it can be economically grown in the newly reclaimed lands at the Northern parts of Egypt, and makes the soil in good conditions for the benefit of the following cereal crops.

Now, Egypt faces many problems that affects the productivity of crops in general and sugar crops in particular, including sugar beet, which became the first source for the production of sugar in Egypt, where the production of sugar from beets has 57.61% (1.266 Million tons) of sugar production in Egypt (Sugar Crops Council 2017). While the sugar cane production was 42.39% (0.931 Million tons) (Sugar Crops Council, 2017).

Thereby, using organic fertilization (compost) and nitrogen fertilization 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 Stumpe *et al.* (2000). Compost additions to soil help create organic reserves that release nutrients incrementally over many years, Zawislak and Rycheik (1999). Compost can therefore be applied in large

quantities to soil systems with little danger of excess nutrient accumulation, Karlamyshev *et al.* (1998). Therefore, this study aimed to determine the effect of nitrogen and compost fertilization on yield and quality of sugar beet under the environmental conditions of EL- Bhira Governorate.

MATERIALS AND METHODS

The present field experiment was conducted at Km 71 West Nubaryia, Alex. Cairo Desert Road, El- Behiera Governorate, Egypt during the two successive seasons, 2015/ 16 and 2016/ 17, to study the effects of nitrogen and compost fertilization on yield and quality of sugar beet (*Beta vulgaris,* L.) cultivar polygerm (cv. MK4016). This cultivar obtained from Sugar Crop Research Institute, Agricultural Research Center, Giza.

The preceding summer crop was maize (*Zea mays*, L.) in both seasons. Plants were kept free from weeds, which were manually controlled by hand hoeing at three times. The common agricultural practices for growing sugar beet according to the recommendations of Ministry of Agriculture were followed, except the factors under study. The treatments of nitrogen and compost fertilization were as follows: T_1(100kgN/ fed),T_2(50 kgN/ fed + 3.5 ton plant compost/ fed),T_3(50kgN/ fed + 3.5 ton mixed compost/ fed),T_4(7 ton plant compost/ fed) and T_5(7 ton mixed compost/ fed) where: mixture of compost includes both 60% plant and 40% animal composts which producted by Egyptian Italian company for the production of organic fertilizers and their derivatives(Egyptly Compost).

Experimental design:

All treatments were arranged in a randomized complete blocks design in three replicates. T_1(100kgN/ fed),T_2(50 kg N/ fed + 3.5 ton plant compost/ fed),T_3(50kgN/ fed + 3.5 ton mixed compost/ fed),T_4(7 ton plant compost/ fed) and T_5(7 ton mixed compost/ fed). Nitrogen fertilizer was added in the form of Urea (46%N) as a side dressing at the rate of 100 kg N/ fed, in two equal doses a half after thinning (before the first irrigation) and the other half before the second irrigation.

Soil samples before soil preparation, were taken at a depth of 0-30 cm from different experimental sites to determine physical and chemical properties of soil according to Page *et al*. (1982) as shown in Table (1).

The soil of field experiments well prepared through two ploughing and leveling, Calcium super phosphate (15.5% P_2O_5) was applied during tillage operation at rate of 100 kg/ fed. Potassium sulfate (48 % K_2O) was also applied at the rate of 50 kg K_2O/ fed.

Seeds ball were hand sown as the usual dry sowing on one side of the ridge in hills 20 cm apart at the rate of 4- 5 seed ball per hill and sown on 13th and 21st September and harvested after 7 months for the 2015/ 16 and 2016/ 17 seasons, respectively. The experimental basic unit area was 10.5 m^2 (1/ 400 fed) included 6 ridges, each of which 50 cm width and 3.5 meters long. The plants were thinned once at 35 days old to one plant/hill.

Table (1). Some physical and chemical properties of the experimental soil in 2015/ 16 and 2016/ 17 seasons

Soil properties	Season	
	2015/ 2016	2016/ 2017
Mechanical analysis		
Sand%	88.23	87.41
Clay%	4.80	5.72
Silt%	6.97	6.87
Soil texture	sandy	sandy
pH 1:1	7.35	7.15
EC (dS/m)	1.14	1.04
Soluble cations (1:2) (Cmo1/kg soil)		
K^+	1.20	1.30
Ca^{++}	3.10	3.20
Mg^{++}	2.30	2.40
Na^+	4.65	4.55
Soluble anions (1:2) (Cmo1/kg soil)		
CO^{--}_3+ HCO^-_3	2.72	2.70
CL^-	7.09	7.29
SO^{--}_4	0.98	0.80
Calcium carbonate (%)	28	23
Total nitrogen (mg/kg)	23.00	23.10
Available Phosphorus (mg/kg)	3.14	3.19
Organic matter %	0.83	0.93

Data Recorded:

In each plot, the outer two ridges (1st and 6th) were considered as a border, while, the 2*nd* and 5th ridges were devoted for plant growth sampling, the two central ridges to determine roots and top yields at harvesting time. The collected data in the two experiments involved the following traits:

I- Growth characters:

Five guarded plants were randomly taken from each plot at 150, 180 and 210 days from sowing to determine the following growth parameters:

I-1- Root fresh weight (g/ plant).

I-2- Leaves fresh weight (g/ plant).

I-3- Plant fresh weight (g/ plant).

II- Yield components:

II-1- Roots yield (tons/ fed).

II-2- Top yield (tons/ fed).

II-3- Sugar yield (tons/ fed) = Roots yield/ fed × Sucrose%

III- Quality characters:

III-1- Total soluble solids content (T.S.S %).

It was measured in juice of fresh roots by using Hand Refractometer according to Me Ginnis (1982).

III-2- Sucrose content%.

III-3- Purity percentage (QZ%).

Sucrose%, soluble non sugar (Na, K and α-amino-N in meq/ 100 g beet roots

and juice purity% were determined in Sugar Delta Company according to Harvey and Dutton (1993).

Table (2). Some chemical properties of both composts

Property	Plant Compost	Mixed Compost
Total N%	1.70	1.51
Total K%	3.43	1.49
Total P%	2.25	1.15
pH	7.61	7.71
EC	5.07	5.26
HCO_3(Cmo1/kg compost)	1	2
Organic Carbon	26	22.62
C/N	1:15	1:15

Statistical analysis:

The obtained data were statistically analyzed according to the randomized complete block design (Snedecore and Cochran, 1990). Mean separations were done by using a MSTAT-C computer program v.4 according to Duncan (1955).

RESULTS AND DISCUSSION

I- Growth characters:

The effect of nitrogen and compost fertilization treatments on vegetative characters of sugar beet during 2015/16 and 2016/17 seasons are presented in Table (3). It could be noticed that fresh weight of root, fresh weight of leaves and total fresh weight of plant were affected significantly by nitrogen and compost fertilization rates. The highest values of root fresh weight, leaves fresh weight and total fresh weight (g/ plant) of sugar beet plants (897.50, 434.00 and 1331.50 g/ plant) and (1054.67, 593.67 and 1648.33 g/ plant) were obtained from the treatment T_3 (50kg N/ fed + 3.5 ton mixed compost/fed) in the first and second seasons, respectively. However, the lowest ones of root fresh weight, leaves fresh weight and total fresh weight (g/ plant) of sugar beet plants (579.17, 320.92 and 900.08 g/ plant) and (624.92, 321.08 and 946.00 g/ plant) were obtained from the treatment T_4 (7 ton plant compost/fed) in the first and second seasons, respectively.

The results indicated that the increases in root fresh weight, leaves fresh weight and total fresh weight/ plant (g/ plant) of sugar beet were significantly influenced by the combination between nitrogen and compost fertilization might be due to improve the growth characters and increasing cells size and division, consequently growth. Mixed compost better than plant compost because it consisted of material were completed dissolving than plant compost that plant can take it easily Hasanen *et al* (2013) and Margo *et al*. (2015) showed that the compost fertilization increased markedly the shoot growth, average weight of sugar beet plants. Also, Maareg *et al.* (1999) indicated that the application of compost with mineral nitrogen fertilizer to sugar beet plants significantly increased root, leaves and plant weight.

Also, Yussef (2016) found that application of 60 kg K_2O/ fed and 10 m^3/ fed of farmyard manure, gave the maximum value for the fresh root weight of sugar beet.Agami (2005), Nemeat- Alla and El-Geddawy (2008), Abd El-Rahman and Agami (2009) and El- Safy (2014) found that increasing N fertilization level to 67.5kg N/fed significantly increased root and leaf fresh weights of sugar beet.

Table (3). Effect of nitrogen and compost fertilization on characters of sugar beet plant during 2015/ 16 and 2016/ 17 seasons

Treatments	Season 2015/ 16			Season2016/ 17		
	Fresh weight of root (g/plant)	Fresh weight of leaves (g/plant)	Total fresh weight of plant (g/plant)	Fresh weight of root (g/plant)	Fresh weight of leaves (g/plant)	Total fresh weight of plant (g/plant)
100kgN/fed	629.58bc	375.08ab	1004.66bc	794.67bc	467.58b	1262.25b
50 kg N/ fed + 3.5 ton plant compost /fed	820.00ab	410.33ab	1230.33ab	892.83b	506.58b	1399.41b
50 kg N/ fed + 3.5 ton mixed compost /fed	897.50a	434.00a	1331.50a	1054.67a	593.67a	1648.34a
7 ton plant compost/fed	579.17c	320.92b	900.09c	624.92c	321.08c	946.00c
7 ton mixed compost/fed	781.67ab	399.00ab	1180.67ab	806.00bc	484.17b	1290.17b

II- Yield components:

The data in Table (4) revealed that compost fertilization rates significantly affected root, top and sugar yield (ton/ fed) in the two seasons of 2015/16 and 2016/17. The treatment of T_3 (50kg N/ fed + 3.5 ton mixed compost/fed) recorded the highest values of root yield, top yield and sugar yield (20.538, 8.074 and 3.610 ton/ fed) and (21.799, 10.941 and 4.029 ton/ fed) in the first and second seasons, respectively.

The treatment of T_4 (7 ton plant compost/fed) achieved the lowest values of root yield, top yield and sugar yield (14.426, 5.768 and 2.460 ton/ fed) and (17.743, 5.589 and 3.250 ton/ fed) in the first and second seasons, respectively. The increases in root yield, top yield and sugar yield due to applying (T_3), treatment were about (31.84, 16.93 and 37.26 %) and (15.58, 65.92 and 19.27%) in the first and second seasons, respectively as compared with the treatment (T_1), (100 kg N/ fed).

Table (4). Effect of nitrogen and compost fertilization on yield and yield components of sugar beet plant during 2015/ 16 and 2016/ 17 seasons

Treatments	Season 2015/ 16			Season2016/ 17		
	Root yield (ton/fed)	Top yield (ton/fed)	Sugar yield (ton/fed)	Root yield (ton/ fed)	Top yield (ton/fed)	Sugar yield (ton/fed)
100kgN/fed	15.578bc	6.905ab	2.630bc	18.860ab	6.594bc	3.378ab
50 kg N/ fed + 3.5 ton plant compost /fed	18.885a	7.459ab	3.253a	20.710ab	8.793b	3.824ab
50 kg N/ fed + 3.5 ton mixed compost /fed	20.538a	8.074a	3.610a	21.799a	10.941a	4.029a
7 ton plant compost/fed	14.426c	5.768b	2.460c	17.743b	5.589c	3.250b
7 ton mixed compost/fed	18.064ab	7.246ab	3.092ab	20.326ab	8.001b	3.806ab

The increase in root yield, top yield and sugar yield (ton/ fed) due to the application of both nitrogen and compost fertilization rates(there includes N.P.K) might be due to the increase in fresh weight of root and leaves (g/ plant) as shown in Table (3). Maareg *et al.* (1999) indicated that the application of compost with mineral nitrogen fertilizer to sugar beet plants significantly increased sugar yield. Also, Margo *et al*. (2015) showed that the aplication of five rates (0, 20, 40, 60 and 80 t ha^{-1}) of compost applied at planting increased markedly yields of sugar beet plants. Also, Abd- EL- Hady *et al*. (2002), Yussef (2016) studied the effect of the combinations between the nitrogen fertilizers and organic application which gave the maximum values for root, top and sugar yield per feddan of sugarbeet plants (ton/ fed). Abo Shady *et al*. (2008), El- Hilal *et al*. (2008), Nemeat- Alla and El-Geddawy (2008), Abd- El- Rahman and Agami (2009), Shaban *et al*. (2014) and Mekdad (2015) indicated that increasing the level of nitrogen fertilizer application led to increasing root, top and sugar yields/ fed of sugar beet plants.

III- Quality characters:

The results in Table (5) showed that sucrose%, purity (QZ%), total soluble solids content (T.S.S%) were significantly affected by application of both nitrogen and compost fertilizations in the two seasons. The highest values of sucrose% and total soluble solids content (T.S.S%), (17.51 and 21.05%) and (18.46 and 22.45%) were obtained from the treatment of T_3 (50kg N/ fed + 3.5 ton mixed compost/fed) in first and second seasons, respectively. On the other hand, the treatment of T_1 (100 kg N/ fed) recorded the lowest values for sucrose% and total soluble solids content (T.S.S%), (16.80 and 20.31%) and (17.80 and 21.95%) in the first and second seasons, respectively.

Table (5). Effect of nitrogen and compost fertilization on quality characters of sugar beet during 2015/ 16 and 2016/ 17 seasons

Treatments	Season 2015/ 16			Season 2016/ 17		
	Sucrose %	Purity %	T.S.S %	Sucrose %	Purity %	T.S.S %
100kgN/fed	16.80b	82.59b	20.31b	17.80b	81.30c	21.95ab
50 kg N/ fed + 3.5 ton plant compost /fed	17.08ab	83.86a	20.34b	18.31a	82.50b	22.19ab
50 kg N/ fed + 3.5 ton mixed compost /fed	17.51a	83.16ab	21.05a	18.46a	82.29b	22.45a
7 ton plant compost/fed	16.86b	82.90ab	20.31b	18.09ab	82.38b	21.95ab
7 ton mixed compost/fed	17.05ab	83.03ab	20.52b	18.11ab	83.78a	21.61b

The highest values of purity (QZ%), (83.86 and 83.78%) were achieved from the treatments T_2 (50kg N/ fed + 3.5 ton plant compost/fed) and T_5 (7 ton mixed compost/fed) in the first and second seasons, respectively.These increases in some quality characters of sugar beet when organic fertilization was used might be due to encouragement of canopy growth, which produced more photosynthesis which translocate to roots.

Maareg *et al.* (1999) indicated that the application of compost with nitrogen fertilizer to sugar beet plants significantly increased quality percentage. As well as, Margo *et al*. (2015) reported that application of compost at planting, reduced the physicochemical quality of roots and soluble solid content. Yussef (2016) found that application of farmyard manure, gave the maximum value of T.S.S% and sucrose percentage in both seasons. Also, Ibrahim *et al*. (2005) and El- Manhaly (2007) reported that increasing nitrogen rate increased T.S.S and sucrose percentages while, juice purity percentage was decreased. Similarly, Ramadan and Nassar (2004), Kanany *et al*.(2005), Ramadan (2005), Nemeat- Alla and El-Geddawy (2008) and Abdou *et al*. (2009) found that increasing N fertilization rate significantly decreased total soluble solids%, sucrose% and juice purity%.

CONCLUSION

From the finding of the present study, it could be concluded that, sugar beet cultivar polygerm (cv. MK4016) can produce an acceptable yield with fertilization of 50kg N/ fed + 3.5 ton mixed compost/fed under sandy soil.

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الملخص العربي

تأثير التسميد بالنتروجين والسماد العضوي الصناعي (الكمبوست) على نمو ومحصول وجودة بنجر السكر

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أجريت تجربتان حقليتان عند الكيلو 71 غرب الطريق الصحراوى إسكندرية – القاهرة – محافظة البحيرة خلال موسمي الزراعة 2015/ 16 و2016/ 17 وذلك لدراسة تأثير التسميد بعنصرالنتروجين والكمبوست على محصول وجودة بنجر السكر صنف (م ك 4016) عديد الأجنة وقد استخدم في تنفيذ التجربة تصميم القطاعات الكاملة العشوائية في ثلاث مكررات وكانت مستويات التسميد الخمسة كالتالى:

(T_1) 100كجم نيتروجين معدني/ فدان، (T_2) 50كجم نيتروجين + 3,5 طن كومبوست نباتي/فدان، (T_3) 50 كجم نيتروجين + 3,5 طن كومبوست خليط/ فدان، (T_4) 7طن كومبوست نباتي/ للفدان ,(T_5) 7طن كومبوست خليط/ فدان. الكمبوست الخليط يتكون من خليط من (60% كمبوست نباتى + 40% كمبوست حيوانى) وهذا الكمبوست من إنتاج المصريه إلايطاليه لإنتاج الأسمدة العضوية ومشتقاتها (إيجيبتلى كمبوست) وكانت أهم النتائج كالًاتى:–

– يوجد تأثير معنوى بأستخدام معاملات التسميد المختلفة على كل صفات المحصول وصفات الجودة فى بنجر السكر.

– سجلت المعاملة (50 كجم نيتروجين + 3,5 طن كومبوست خليط/ فدان) أعلى قيمة لكل من الوزن الغض للجذر و وزن الأوراق والوزن الكلى/ نبات وأيضا أعطت نفس المعاملة أعلى القيم لكل من محصول الجذور والعرش ومحصول السكر/فدان ونسبة السكروز ونسبة المواد الصلبة الذائبة الكلية فى كلا الموسمين 2016/15،2017/16 .

– تم الحصول علي أعلى قيمة لنسبة النقاوة عند إستخدام كل من المعاملة (50 كجم نيتروجين + 3.5 طن كومبوست نباتى/ فدان) فى الموسم الأول2015/16 وعند إستخدام المعاملة (7 طن كومبوست خليط/ فدان) فى الموسم الثانى2016/17 .

الخلاصة

من هذه الدراسه يتضح أن نبات بنجر السكر صنف عديد الأجنة يعطى اعلى إنتاجية مع المعامله 50 كجم نيتروجين + 3.5 طن كومبوست خليط/ فدان فى الأراضى الرملية .