6 *Egypt. J. Agron* . **Vol. 34,** No.1, pp.89-103 (2012)

Effect of Organic and Mineral Nitrogenous Fertilizers and Plant Density on Yield and Quality of Sugar Beet (*Beta vulgaris* L.)

E. A. Mahmoud, M. A. Hassanin and Eman I. R. Emara
Agronomy Department, Faculty of Agriculture, Cairo University, Cairo, Egypt.

TWO FIELD trials were conducted during 2008/2009 and 2009/2010 seasons in the Agricultural experiment and Research Center, Fac. Agric., Cairo Univ., Giza, Egypt, to study the response of sugar beet to mineral N rates (60, 80 and 100 kg/fed[1]), compost rates (0, 1 and 2 tons/fed of plant compost 15% N) and plant density (40 x 10^3 and 46 x 10^3 plants/fed). Results revealed that increasing N rate up to 100 kg significantly favored beet growth in terms of leaf area index (LAI) at 145 and 175 days from sowing as well as relative growth rate (RGR) and individual root weight. LAI decreased as plants advanced towards maturity. On the other hand, juice quality traits, sucrose, purity and sugar recovery were decreased as N rate increased, while sucrose loss to molasses was gradually increased as N rate increased. A substantial increase in root yield (24.9% and 21.5%) and recoverable sugar yield (16.7% and 11.3%) was recorded as N rate increased from 60 to 100 kg/fed in the first and second season, respectively .

Application of 2 tons of compost/fed significantly produced the highest LAI and RGR as well as the heaviest roots, and improved juice quality traits (sucrose, purity and recoverable sugar %). 1 and 2 tons of compost were significantly different in most of quality traits. Increasing compost rate from zero to 2 tons/fed increased root yield by 16.4 and 14.0% and sugar yield by 27.8 and 20.2% in the first and second seasons, respectively.

Increasing plant density from 40000 to 46000 plants/fed depressed beet growth in terms of LAI, RGR and root fresh weight, while sucrose, purity and recoverable sugar % were increased with increasing plant density. On the other hand, sucrose loss to molasses decreased as plant density increased. 46000 plants maximized root and sugar production per feddan. All interactions between the studied factors were significant with respect to the studied traits in both seasons. The highest root yield 41.57 and 41.02 ton/fed and sugar yield 6.30 and 5.87 ton/fed resulted from 100 kg N + 2 tons of compost with 46000 plants/fed .

Keywords: Sugar beet, Organic nitrogen, Mineral nitrogen, Plant density and quality.

[1]Feddan = 0.42 ha.

Nitrogen is the essential mineral element for sugar beet growth by the greatest influencing on root quality and sugar production. In Egypt, sugar beet growers intend to apply excess nitrogen in beet fields believing that high vegetative growth of beet plants must be reflecting on absolute high root yield. Widely ranging optimum rates of nitrogen have been reported in the literature. Strand & Vales (1987) recommended 120 kg/ha. Halverson & Hartman (1988) found that 150 kg/ha was the economic rate for maximum root production. Imura & Hayassaka (1987) found that raising N rates up to 200 kg/ha increased root and sugar yield. Halverson & Hartman (1980) reported optimum rates as high as 390kg/ha. In Egypt some researchers found that root yield significantly increased with rates up to 80 kg/fed (Mahmoud *et al.*, 1990 and Salama & Badawi, 1996). Others recommended 90 kg /fed for maximum root and sugar yield (El-Shafai, 2000), while Abd El-Aal *et al.* (2007) found that 100 kg/fed maximized yield productivity. El-Hennawy *et al.* (1998) recommended optimum rate as high as 120 kg/fed. Some workers have reported that higher nitrogen rates favored beet growth in terms of leaf area/plant, LAI, RGR and fresh and dry weight of the root (Mahmoud *et al.*, 1990; Besheit *et al.*, 1995 and Abd El-Aal *et al.*, 2007).

Some investigators found that sugar beets grown with inadequate N generally have a high sucrose percentage and low impurities (sodium, potassium and alpha amino N) but root and sucrose production was limited. Too much N dose increases root impurities and reduces sucrose percentage and consequently limits refined sucrose production (Carter & Traveller, 1981 and Ramadan, 1997).

The influence of soil fertilization on nutrient content in crops has been studied and different results have been recorded. Some authors show that the application of organic amendment improves soil nutrient content, but does not always increases plant nutrient concentration (Maareg *et al.*, 2008 and Kadar *et al.*, 2009). Nassar *et al.* (2000) found that raising farmyard manure rates from zero to 50 m^3/fed caused gradual increases of most growth traits, *i.e.* root length, root diameter, leaf area/plant, top/root ratio, root and top fresh weight/plant and root and sugar yields. El-Geddawy *et al.* (2003) and Kadar *et al.* (2009) found that adding farmyard manure increased the values of root fresh weight/plant as well as percentage of dry matter, sucrose percentage and root and sugar yields. Mohamed (2008) found that application of 2 tons of compost/fed to sugar beet increased size, fresh and dry weight of the roots as well as sucrose % and sugar yield compared to mineral N .

Plant density has a pronounced effect on beet productivity. Some workers reported that sucrose and purity percentages decreased linearly as population density decreased. On the other hand, increasing plant density reduced impurities in beet juice (Eckhoff *et al.*, 1991). Lauer (1995) reported that the highest sugar yield resulted from 70 to 100 thousand plants/ha. In Egypt the optimum plant density that could maximize sugar beet yield has received attention of some workers. Ramadan (1999) and Nassar (2001) found that sucrose, purity and recoverable sugar percentages were linearly reduced with the reduction in plant density, while root fresh weight, LAI, plant dry weight, Na, K, amino-N content and sucrose loss to molasses percentage were decreased with increasing plant density. Allam *et al.* (2005) reported that 25 cm surpassed 15 cm plant spacing in leaves dry weight, leaf area/plant, total soluble solids as well as top, root and sugar yields.

Materials and Methods

Two field experiments were carried out at Agricultural Experiment and Research Center of the faculty of Agriculture, Cairo University, Giza, Egypt during 2008 / 2009 and 2009 / 2010 seasons, to study the effect of mineral and organic nitrogen manures on growth, yield and quality of sugar beet under two plant densities. The variety used was Monte Bianko (from Germany) which was obtained by the Sugar Crops Research Institute, Agriculture Research Center, Egypt. Chemical analysis of the two experimental soils are presented in Table 1.

TABLE 1. Chemical analysis of the soil in 2008 and 2009 seasons.

Analysis	**1st season**	**2nd season**
Available N kg/fed	20.3	26.3
Available P (ppm)	1895	1987
Available K (ppm)	3200	3300
Organic matter (%)	1.7	1.9
pH	7.3	7.4
EC	0.9	0.8

Treatments

(1) Three nitrogen rates were used in the form of ammonium nitrates (33% N), *i.e.* 60, 80 and 100 kg N/ feddan. Nitrogen rates were divided into two equal doses, the first was applied after thinning (45 days from sowing) the second was applied 4 weeks later.

(2) Organic fertilizer (Plant compost): Three organic fertilizer rates (Zero, 1 and 2 tons/fed) were used in the form of compost (Nile Compost) which was added to the soil two weeks before planting. The analysis of the compost is shown in Table 2.

(3) Plant densities: Two plant densities 40000 and 46000 plants/feddan resulted from planting on 17.5 and 15cm between hills and 60 cm between rows. The preceding crop was corn in both seasons.

A split-split plot design with four replicates was used, nitrogen rates were arranged randomly in the main plots, compost rates in the sub plots and plant densities in the sub sub plots, the sub sub plot area was 15 m^2 and consisted of five ridges of 5 m in length and 60 cm apart. Sowing was on 19th and 13th of October in 2008/2009 and 2009/2010 seasons, respectively, and the field was irrigated immediately after planting. Seedlings were thinned at 4-6 leaf stage to ensure one plant per hill. Phosphorus fertilizer at a rate of 30 kg P_2O_5/fed in the form of superphosphate (15.5% P_2O_5) was added at sowing in both seasons. Potassium fertilizer at a rate of 48 kg K_2O/fed in the form of Potassium Sulphate (48 % K_2O) was added with the first dose of Nitrogen. Other cultural practices were carried out as usual. Harvest of sugar beet plants took place after 200 days from sowing in both seasons of experimentation.

TABLE 2. Some physical and chemical properties of the compost.

Character	Component
Weight of 1 m^3 (kgm)	625
Humidity percentage (%)	30
pH (extractable 1:5)	7.8
Ec(extractable 1:5) (mmol/com)	2.75
Total nitrogen %	15
Amonouim nitrogen(ppm)	160
Nitrate nitrogen (ppm)	125
Organic matter (%)	50
Organic carbon (%)	29
C/N ratio	17.5
Nacl (5)	1.21
Dobalic acids (%)	13
Total phosphorus (%)	0.7
Total potassium (%)	1.25
Fe (ppm)	1587
Mn (ppm)	162
Cu (ppm)	65
Zn (ppm)	21

Studied characters

Growth characters

1) Root, blades, petioles and plant dry weight were determined using a sample of 5 plants from each plot after drying in an oven at 70ºC till constant weight.

2) Leaf area index (LAT), relative growth rate (RGR) and net assimilation rate (NAR) were determined according to Watson (1958).

Juice quality characters

At harvest a random sample of 10 plants from each sub plot was taken and the following traits were determined at Delta Sugar Company, Kafrelsheikh, Egypt.

1) Sucrose percentage was determined polarimeterically .
2) Impurities percentage = [(K+Na) x 0.343) + (alpha amino N x 0.094 + 0.29)]
   where: K, Na and a-amino N (meq/100g sugar beet).
3) Purity percentage = [((sucrose% - impurities %) x 100) / sucrose %]
4) Recoverable sugar percentage (R.S %) was determined by using the following formula:
   RS % = [Pol% - 0.029 – 0.343 (Na+K) - 0.094 (alpha amion N)]

5) Sucrose loss to molasses (SLM) =
[0.343 (Na+K) + 0.094 (alpha amino N) - 0.31]

Yield and its components

Yields were determined from the middle three rows of each plot.

1) Number of plants at harvest
2) Root fresh weight/ plant
3) Root yield
4) Recoverable sugar yield (RSY) = Root yield (ton/fed)* Recoverable sugar % .

Statistical analysis

Data collected were subjected to the proper statistical analysis of variance of split-split plot design according to the procedures outlined by Snedecor & Cochran (1967) to compare treatment means; L.S.D. at 5% level of significance was used according to Steel & Torrie (1980). All statistical analysis was performed by using analysis of variance technique of (MSTAT) Computer software package.

Results and Discussion

Effect of nitrogen fertilizer

Growth traits

Data presented in Table 3 revealed that LAI, RGR and root fresh weight were significantly and gradually increased as N rate increased up to 100 kg/fed. LAI increased by 29.9 and 22.9% after 145 days and 19.7 and 29.2% after 175 days from sowing. RGR increased by 24.6 and 34.6% and root fresh weight by 15.5 and 12.1% as N rate increased from 60 to 100 kg/fed in the first and second seasons, respectively. Such obtained results insure the important role of nitrogen in stimulating and enhancing the photosynthetic and metabolic actives of plants which were reflected on the increase in the vegetative growth of beet plants. It is worth to mention that LAI decreased as plants advanced toward maturity as a result of leaf senescence. These results are in harmony with those of Mahmoud *et al.* (1990) Besheit *et al.* (1995) and Abd El-Aal *et al.* (2007).

Quality traits

Quality traits in terms of percentages of sucrose, purity, sugar recovery and sucrose loss to molasses were significantly affected by nitrogen application in both seasons (Table 4). The increase in N rate from 60 to 100 kg/fed gradually depressed sucrose, purity and sugar recovery %. The highest reduction resulted from the first increment (60-80 kg /fed). On the other hand, sucrose lose to molasses was gradually increased as N rate increased. Such effect might have been due to reduction in sucrose and sugar recovery accompanying high nitrogen rates. The depressive effect of high N rate on beet quality has been reported by Carter & Traveller (1981) and Abd El-Aal *et al.* (2007).

TABLE 3. Effect of mineral nitrogen on some growth traits of sugar beet plants.

N kg/fed	Leaf area index (LAI)			
	1st season		2nd season	
	145 days	175 days	145 days	175 days
60	4.25	3.41	4.02	3.08
80	5.11	3.83	4.50	3.48
100	5.52	4.19	4.81	3.89
L.S.D $_{5\%}$	0.84	0.77	0.52	0.67
N kg/fed	**RGR 145-175 days (g/g/week)**		**Root fresh weight (g)**	
	1st season	**2nd season**	**1st season**	**2nd season**
60	0.134	0.130	1068	1104
80	0.147	0.153	1180	1148
100	0.167	0.175	1234	1238
L.S.D $_{5\%}$	0.014	0.014	78	98

TABLE 4. Effect of mineral nitrogen on juice quality traits of sugar beet plants.

N kg/fed	Sucrose (%)		Purity (%)	
	1st season	2nd season	1st season	2nd season
60	17.02	18.32	87.40	83.42
80	16.61	17.20	84.35	82.32
100	16.49	16.48	83.95	82.01
L.S.D $_{5\%}$	0.38	0.45	0.69	0.64
N kg/fed	**Sugar recovery (%)**		**Sucrose loss (%)**	
	1st season	**2nd season**	**1st season**	**2nd season**
60	15.34	15.28	1.49	2.03
80	14.49	14.42	1.68	2.18
100	14.34	14.01	1.71	2.31
L.S.D $_{5\%}$	0.39	0.24	0.04	0.03

Root and recoverable sugar yields

Nitrogen exhibited significant effect on root and sugar yield in both seasons (Table 5). Increasing N rate from 60 to 80 kg/fed increased root yield by 11.1 and 7.2% and recoverable sugar yield by 4.9 and 2.7%, respectively. Whereas increasing N rate from 80 to 100 kg/fed increased root yield by 12.5 and 11.7% and recoverable sugar yield by 11.2 and 8.4% in the first and second seasons as compared to control treatment, respectively. It is worth to mention that the reduction in sucrose and sugar recovery was compensated by the increase in root yield and finally sugar yield increased. Similar results insuring the role of N in increasing root and sugar production were reported by Halverson & Hartman (1988), El-Hennawy *et al.* (1998) and El-Shafai (2000).

TABLE 5. Effect of mineral nitrogen fertilizer on yields of root and recoverable sugar of sugar beet plants.

N kg/fed	Root yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	1st season	2nd season	1st season	2nd season
60	30.37	31.14	4.66	4.76
80	33.73	33.88	4.89	4.89
100	37.94	37.85	5.44	5.30
L.S.D $_{5\%}$	1.63	2.07	0.28	0.30

Effect of compost fertilizer

Growth traits

Data presented in Table 6 revealed that compost application favored beet growth. Significant differences between compost rates were recorded in LAI at 145 and 175 days after sowing, as well as RGR and root fresh weight in both seasons.

TABLE 6. Effect of compost application on some growth traits of sugar beet plants.

Comp. ton/fed	Leaf area index (LAI)			
	1st season		2nd season	
	145 days	175 days	145 days	175 days
0	4.32	3.17	3.90	2.86
1	4.97	3.75	4.54	3.42
2	5.59	4.51	4.89	4.16
L.S.D $_{5\%}$	0.84	0.77	0.52	0.67
Comp. ton/fed	RGR 145-175 days (g/g/week)		Root fresh weight (g/plant)	
	1st season	2nd season	1st season	2nd season
0	0.134	0.550	1125	1103
1	0.148	0.650	1162	1171
2	0.166	0.700	1207	1207
L.S.D $_{5\%}$	0.014	0.014	78	98

Application of 2 tons of compost produced the highest LAI and RGR as well as the heaviest roots. Reflecting the important role of organic manure on releasing up most of essential elements for beet growth. Some authors show that the application of organic amendment improves soil nutrient content (Maareg *et al.,* 2008). In this connection, Nassar *et al.* (2000) and El-Geddawy *et al.* (2003) found that farmyard manure increased most of growth traits of sugar beet, *i.e.* root, top fresh, dry weight and leaf area/plant.

Quality traits

Data in Table 7 revealed a significant effect of compost application on juice quality traits in terms of sucrose, purity, sugar recovery in both seasons and sucrose loss to molasses only in the second season. These traits gradually increased as compost rate increased from zero to 2 tons/fed. A significant difference between 1 and 2 tons of compost/fed was recorded in most of quality traits. Such effect of compost might have been due to improving soil nutrient release and content in particular potassium which has an important role in moving and translocation of carbohydrates from tops to roots.

TABLE 7. Effect of compost application on juice quality traits of sugar beet plants.

Comp. ton/fed	Sucrose (%)		Purity (%)	
	1st season	2nd season	1st season	2nd season
0	15.84	16.18	84.15	81.75
1	16.62	16.61	85.42	82.69
2	17.03	16.67	86.12	83.30
L.S.D $_{5\%}$	0.38	0.45	0.69	0.64
Comp. ton/fed	**Sugar recovery (%)**		**Sucrose loss (%)**	
	1st season	**2nd season**	**1st season**	**2nd season**
0	13.99	14.21	1.65	2.17
1	14.82	14.54	1.62	2.19
2	15.36	14.97	1.62	2.16
L.S.D $_{5\%}$	0.39	0.24	Ns	0.03

These results are in harmony with those obtained by El-Geddawy *et al.* (2003) and Montemurro *et al.* (2007) who found that mixed organic and mineral N increased sucrose % and reduced alpha amino N in beet roots by 13.2% as compared with mineral N of 100 kg/ha.

Root and recoverable sugar yields

Differences among compost application in root and recoverable sugar yields were significant in both seasons (Table 8). Increasing compost rate from zero to

2 tons/fed resulted in a substantial increase in root and sugar production. The increase amounted to 16.4 and 14.0% for root yield and 27.8 and 20.2% for sugar yield in the first and second seasons, respectively reflecting the better growth traits in terms of LAI, RGR and root weight as well as the increase in quality traits accompanying compost application. Such results match with those of Nassar *et al.* (2000), El-Geddawy *et al.* (2003) and Kadar *et al.* (2009).

TABLE 8. Effect of compost application on yields of sugar beet plants.

Comp. ton/fed	**Root yield (ton/fed)**		**Recoverable sugar yield (ton/fed)**	
	1st season	**2nd season**	**1st season**	**2nd season**
0	31.85	32.04	4.46	4.55
1	33.11	34.31	4.91	4.99
2	37.08	36.52	5.70	5.47
L.S.D $_{5\%}$	1.63	2.07	0.28	0.30

Effect of plant density

Growth traits

Data presented in Table 9 revealed that increasing plant density from 40000 to 46000 plants/fed significantly decreased beet growth in terms of LAI, RGR and root fresh weight in both seasons. LAI decreased by 19.6 and 21.3% in the first season and by 19.7 and 27.7% in the second season after 145 and 175 days from sowing, respectively. RGR decreased by 13.8 and 17.4%, while root fresh weight decreased by 3.4 and 4.1% in the first and second seasons, respectively. Such effect might have been due to interplant competition for light and mineral nutrients. Similar results were reported by Mahmoud *et al.* (1990), Ramadan (1999) and Nassar (2001).

TABLE 9. Effect of plant density on some growth traits of sugar beet plants.

Pl.density plant/fed	**Leaf area index (LAI)**			
	1st season		**2nd season**	
	145 days	**175 days**	**145 days**	**175 days**
40000	5.50	4.27	4.93	4.04
46000	4.42	3.36	3.96	2.92
L.S.D $_{5\%}$	0.68	0.63	0.42	0.55
Pl.density plant/fed	**RGR 145-175 days (g/g/week)**		**Root fresh weight (g)**	
	1st season	**2nd season**	**1st season**	**2nd season**
40000	0.160	0.167	1185	1185
46000	0.138	0.138	1145	1136
L.S.D $_{5\%}$	0.017	0.014	30	32

Quality traits

A marked increase in sucrose %, purity % and sugar recovery % was recorded as plant density increased up to 46000 plants/fed (Table 10). On the other hand, sucrose loss to molasses was significantly decreased as plant density increased, reflecting the reduction in root weight and the small size roots are assumed to contain more sucrose, as reported by Eckhoff *et al.* (1991), Lauer (1995) and Ramadan (1999).

TABLE 10. Effect of plant density on juice quality traits of sugar beet plants.

Pl.density plant/fed	Sucrose (%)		Purity (%)	
	1st season	2nd season	1st season	2nd season
40000	16.40	17.23	85.15	82.11
46000	17.01	17.43	85.31	83.05
L.S.D $_{5\%}$	0.31	0.19	Ns	0.52
Pl.density plant/fed	**Sugar recovery (%)**		**Sucrose loss (%)**	
	1st season	2nd season	1st season	2nd season
40000	14.46	14.40	1.62	2.23
46000	14.99	14.74	1.64	2.12
L.S.D $_{5\%}$	0.32	0.19	Ns	0.11

Root and recoverable sugar yields

Plant density exhibited significant effect on root and sugar yield/fed (Table 11). Root yield increased by 7.6 and 5.8% and sugar yield by 11.4 and 8.3% as plant density increased up to 46 000 plants/fed in the first and second season, respectively. It is worth, mentioning, that the reduction in growth traits accompanying dense sowing was compensated by the increase in plant density and finally root and recoverable sugar yields were increased. These results are in harmony with those obtained by Mahmoud *et al.* (1990), Lauer (1995), Ramadan (1999), Nassar (2001) and Allam *et al.* (2005).

TABLE 11. Effect of plant density on yields of sugar beet plants.

Pl.density plant/fed	Root yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	1st season	2nd season	1st season	2nd season
40000	32.77	33.33	4.74	4.80
46000	35.26	35.25	5.28	5.20
L.S.D $_{5\%}$	1.33	1.69	0.23	0.25

Interaction effects

Results in Table 12 revealed that all interactions between the studied factors were significant in both seasons. The highest values of LAI 6.73 and 5.86 in the first season and 5.91 and 5.04 in the second season, as well as RGR 0.191 and 0.215, root fresh weight 1297 and 1365 (g), sucrose 17.67% and 18.52%, purity 88.31% and 84.24% resulted from 100 kg N + 2 tons of compost + 40000 plants/ fed in the first and second seasons, respectively. While the highest percentages of sugar recovery 16.07% and 15.83% and sucrose loss to molasses 1.78% and 2.50% resulted from application of 60 kg N + 1 ton of compost + 40000 plants / fed. The highest root yield 41.57 ton and 41.02 ton and sugar yield 6.30 ton and 5.87 ton/fed was obtained from 100 kg N + 2 tons of compost + 46000 plants/fed.

TABLE 12. Highest values of the interactions between the studied factors.

Interactions	Leaf area index (LAI)			
	1st season		2nd season	
	145 days	175 days	145 days	175 days
N x C	6.10 (N_3 x C_3)*	5.16 (N_3 x C_3)*	5.41 (N_3 x C_3)*	4.45 (N_3 x C_3)*
N x P	6.03 (N_3 x P_1)*	4.67 (N_3 x P_1)*	5.26 (N_3 x P_1)*	4.52 (N_3 x P_1)*
C x P	6.31 (C_3 x P_1)*	5.18 (C_3 x P_1)*	5.43 (C_3 x P_1)*	4.82 (C_3 x P_1)*
N x C x P	6.73 (N_3 x C_3 x P_1)*	5.86 (N_3 x C_3 x P_1)*	5.91 (N_3 x C_3x P_1)*	5.04 (N_3 x C_3 x P_1)*
Interactions	RGR 145-175 days (g/g/week)		Root fresh weight (g)	
	1st season	2nd season	1st season	2nd season
N x C	0.180 (N_3 x C_3) *	0.198 (N_3 x C_3) *	1286 (N_3 x C_3) *	1293 (N_3 x C_3) *
N x P	0.175 (N_3 x P_1) *	0.201 (N_3 x P_1) *	1248 (N_3 x P_1) *	1267 (N_3 x P_1) *
C x P	0.171 (C_3 x P_1) *	0.182 (C_3 x P_1) *	1229 (C_3 x P_1) *	1252 (C_3 x P_1) *
N x C x P	0.191 (N_3x C_3x P_1)*	0.215 (N_3 x C_3x P_1) *	1297 (N_3 x C_3x P_1) *	1365 (N_3 x C_3x P_1)*
Interactions	Sucrose Purity			
	1st season	2nd season	1st season	2nd season
N x C	17.61 (N_1 x C_3) *	18.57 (N_1 x C_3) *	87.89 (N_1 x C_3) *	84.01 (N_1 x C_3) *
N x P	17.18 (N_1 x P_2) *	18.41 (N_1 x P_2) *	87.41 (N_1 x P_1) *	83.48 (N_1 x P_1) *
C x P	17.47 (C_3x P_2) *	17.74 (C_3 x P_1) *	86.14 (C_3 x P_2) *	83.55 (C_3 x P_2) *
N x C x P	17.67 (N_1 x C_3x P_1) *	18.52 (N_1 x C_3x P_1) *	88.31 (N_1 x C_3x P_1) *	84.24 (N_1 x C_3xP_1) *

TABLE 12. Cont.

Interactions	Sugar recovery (%)		Sucrose loss (%)	
	1st season	2nd season	1st season	2nd season
N x C	15.68 (N_1x C_2) *	15.47 (N_1x C_1) *	1.75 (N_3x C_1) *	2.35 (N_3x C_3) *
N x P	15.48 (N_1 x P_1) *	15.55 (N_1 x P_2) *	1.74 (N_3x P_2) *	2.43 (N_3x P_1) *
C x P	15.24 (C_2 x P_1) *	14.95 (C_3 x P_1) *	1.65 (C_1x P_1) ^{ns}	2.31 (C_2 x P_1) *
N x C x P	16.07 (N_1x C_2x P_1) *	15.83 (N_1x C_2 x P_1) *	1.78 (N_3x C_2 x P_1) *	2.50 (N_3x C_2 x P_1) *

Interactions	Root yield (ton/fed)		Recoverable sugar yield (ton/fed)	
	1st season	2nd season	1st season	2nd season
N x C	40.60 (N_3 x C_3) *	39.32 (N_3 x C_3) *	6.07 (N_3 x C_3) *	5.60 (N_3 x C_3) *
N x P	38.72 (N_3 x P_2) *	38.73 (N_3 x P_2) *	5.64 (N_3 x P_2) *	5.45 (N_3 x P_2) *
C x P	38.58 (C_3 x P_2) *	37.92 (C_3 x P_2) *	5.98 (C_3 x P_2) *	5.68 (C_3 x P_2) *
N x C x P	41.57 (N_3 x C_3 x P_2) *	41.02 (N_3 x C_3x P_2) *	6.30 (N_3 x C_3 x P_2) *	5.87 (N_3 x C_3 x P_2) *

N_1= 60 kg N/fed C_1 = 0 ton comp. /fed P_1 = 40000 plant/fed

N_2= 80 kg N/fed C_2 = 1 ton comp. /fed P_2 = 46000 plant/fed

N_3= 100 kg N/fed C_3 = 2 ton comp. /fed

*Denote significant at 5% level of probability.
^{ns}Denote nonsignificant at 5% level of probability.

Conclusion

Increasing N rate up to 100 kg/fed enhanced beet growth in terms of LAI, RGR and fresh and dry weight of tops and roots, but excess nitrogen depressed juice beet quality in terms of sucrose, purity and recoverable sugar percentages. Application of 100 kg N + 2 tons of compost + 46000 plants/fed maximized root and sugar yields.

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(*Received* 30/4/2012;
accepted 1 /7/2012)

تأثير الأسمدة الآزوتية العضوية والمعدنية والكثافة النباتية على محصول وجودة بنجر السكر

السيد عبد العزيز محمود، محمود عبد الرحيم حسانين و إيمان إبراهيم رفاعى عمارة
قسم المحاصيل - كلية الزراعة - جامعة القاهرة - القاهرة - مصر.

أجريت تجربتان حقليتان فى موسمى الزراعة ٢٠٠٩/٢٠٠٨ و ٢٠١٠/٢٠٠٩ بمحطة التجارب الزراعية- كلية الزراعة- جامعة القاهرة- الجيزة- مصر، لدراسة إستجابة بنجر السكر لمعدلات التسميد النيتروجين المعدنى (٦٠، ٨٠ و ١٠٠ كجم/ف) و معدلات إضافة الكمبوست النباتى (صفر ، ١ و ٢ طن/ف) وكثافات نباتية (٤٠ و ٤٦ ألف نبات/ف). أوضحت النتائج أن زيادة معدلات الآزوت حتى ١٠٠كجم/ف أدى لزيادة معنوية فى دليل مساحة الأوراق عند عمر ١٤٥ و ١٧٥ يوم من الزراعة كذلك معدل النمو النسبى ووزن الجذر الواحد وانخفض دليل مساحة الأوراق كلما تقدم النبات فى العمر. على الجانب الآخر انخفضت صفات الجودة المتمثلة فى نسبة السكروز، النقاوة و عائد السكر بزيادة معدل الآزوت. فى حين زادت نسبة السكروز المفقود فى المولاس تدريجيا كلما زاد معدل الآزوت. وكانت هناك زيادة معنوية فى محصول الجذور (٢٤،٩ و٢١،٥%) ومحصول السكر (١٦،٧ و ١١،٣%) عند زيادة معدل التسميد الآزوتى من ٦٠ إلى ١٠٠ كجم ن/ف فى الموسم الأول والثاني على التوالى.

إضافة ٢ طن من الكومبوست للفدان أعطى أعلى دليل مساحة الأوراق ومعدل النمو النسبي وكذلك أكبر الجذور وزنا، كما أدى إلى تحسين صفات الجودة (السكروز، النقاوة ونسبة عائد السكر)، كما أدى إلى زيادة محصول الجذور بنسبة ١٦،٤% و ١٤% ومحصول السكر ٢٧،٨ % و ٢٠،٢ % فى الموسم الاول والثانى على التوالى.

زيادة الكثافة النباتية من ٤٠ إلى ٤٦ ألف نبات / ف أدى إلى إنخفاض دليل مساحة الأوراق ، معدل النمو النسبي ووزن الجذر الطازج على الرغم من أن نسبة السكروز والنقاوة وعائد السكر زادت مع زيادة الكثافة النباتية. ونتج أعلى محصول من الجذور والسكر من زراعة ٤٦ ألف نبات / ف. كانت التفاعلات بين العوامل الدراسية معنوية لجميع الصفات المدروسة في الموسمين، ونتج أعلى محصول جذور ٤١،٥٧ و ٤١،٠٢ طن / ف ومحصول سكر ٦،٣٠ و ٥،٨٧ طن / ف من إضافة ١٠٠ كجم نيتروجين + ٢ طن كمبوست + ٤٦ ألف نبات / ف.