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Response of Two Sugar Beet Cultivars to the Application level and Time of Nitrogen fertilizer

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Abstract:

Two field experiments were carried out at Agronomy Department Exp. Farm, Faculty of Agricultural, Assiut University, Assiut, Egypt 2010/2011 and 2011/2012 seasons to investigate the response of two sugar beet cultivars to nitrogen application level and time. A randomized complete block design (RCBD) using a split-plot arrangement with three replications was used. Two sugar beet cultivars were assigned to the main plots while, seven the nitrogen combination were randomly arranged in the sub-plots.

The obtained results showed that the N fertilizer application level and time had a significant effect on the root and top fresh weights and yields of sugar beet plants. Increasing the N applied level up to 120 kg fed.$^{-1}$ decreased the sugar percentage and juice purity of roots. On the other hand, the early application of N at 30 days after planting using 90 kg N fed.$^{-1}$ splitting into three doses was ranked to be the best treatment for improving the root quality and increasing the root gross and extractable sugar yields. The purity of root juice that combined with a good sugar yield quality was obtained from applying the three equal doses of N fertilizer in compared with two equal doses. It can be concluded that the N applied level at three times of plant growth stages lead to raise the yield and quality of the tops and roots of sugar beet.

Keywords: *Sugar beet, N application time, chlorophyll, leaf area and sugar yield.*

Introduction

The fertilization level for an optimum economic yield of sugar beet (*Beta vulgais*, L.,) is usually considered less than that level required for the maximum growth of tops and roots (Allison *et al*., 1996). Nitrogen (N) is an important nutrient for sugar beet crop. To obtain a maximum sucrose accumulation in the beet roots, the amount of N supplied to the plants should be reduced just prior to harvest to avoid vigorous top growth. An over-abundant uptake of N at this stage would decrease the sugar percentage and increase the presence of "α-amino N" compounds, which make sugar extraction difficult within the storage roots (Pocock *et al*., 1990). It significantly reduces the proportion of the sugar which can be crystallized (Dutton and Huijbregts, 2006). Deficient soil N negatively affects the plant growth and N surplus can also negatively impact the environmental quality and human welfare (Sutton *et al*., 2011 a, b). So, optimizing the use of N through a better understanding of the crop requirement is an important goal to obtain roots of high quality, to guarantee the highest net income for the farmers and to minimize the groundwater pollution due to nitrate leaching (Draycott, 1993). Research results have shown that various plants have different preference to nitrate and ammonium N absorption. There is strong evidence that the role of N in the generation of the foliage canopy is a central mechanism governing the yield of healthy and disease-free sugar beet crops (Malnou *et al*., 2006).

Supplies of N to sugar beet must be readily available during the early and mid-season in order to promote the root and top growth. However, sugar beet must be deficient in nitrogen prior to harvest to attain the maximum sucrose concentration (Osman, 2011 and Abd El-Rahman and Mohamed 2013). The late N fertilizer dose increases both the N concentration in the plants and canopy size, but the canopy size still declines throughout the late growth season (Carter and Traveller 1981). Late N application increases top dry weight at the final harvest but it fails to have a positive effect on sugar yield (El-Sayed 2013).

Zalat and Saif (1997) found that the highest root and sugar yields were obtained when N was applied at 80 days after planting (DAP), while the highest sucrose percentage was recorded from applying N at 100 days after planting. The late N application (140 DAP) gave the highest top yield. Abdou (2000) and Leilah *et al*., (2005) indicated that the highest values of root length and diameter, number of plants at harvest, root fresh weight and purity as well as top, root and sugar yields were associated with the early N application in two equal portions at 45 and 60 days of planting recorded the highest values of sucrose content and total soluble solids (T.S.S. %). The dramatic increase of the used fertilizers requires more attention from producers to reduce the environmental pollution and production cost. This reduction can be obtained by selecting the proper applied fertilizer level that is suitable for the soil and plant species as well as the beneficial application time to obtain a real increase in the crop yield, and quality and in turn, thus has a high economic return. The present study aims to investigate the impact of the application level and time of nitrogen fertilizer on the growth and quality of two sugar beet cultivars.

Materials and Methods

Two field experiments were carried out at Agronomy Department Farm, Faculty of Agricultural, Assiut University, Assiut, Egypt during 2010/2011 and 2011/2012 growth seasons to investigate the response of two sugar beet cultivars (Gollia and Top) to the application level and time of nitrogen fertilizer. Some physical and chemical properties of the experimental soil that were determined according to the methods described by Jackson (1967) before sowing are present in Table 1. A randomized complete block design (RCBD) using a split-plot arrangement with three replications were used.

Two sugar beet cultivars were assigned to the main plots. Seven nitrogen combinations were randomly arranged in the sub-plots.

Table 1: Some physical and chemical properties of representative soil samples of the experimental site before sowing (0-30 cm depth) for the two growth seasons.

Soil property		2010/2011 season*	2011/2012 season*
Particle - size distribution			
Silt	(%)	27.4	27.3
Sand	(%)	24.3	25.2
Clay	(%)	48.3	47.5
Texture		Clay	Clay
Organic matter	(%)	1.75	1.72
Field capacity	(%)	42.8	43.2
EC (1:1 extract)	(dS m^{-1})	0.74	0.77
pH (1:1 suspension)		8.2	8.1
Total nitrogen	(%)	0.72	0.69
$CaCO_3$	(%)	3.4	3.5
KCl-extractable N	(mg kg^{-1})	41.23	40.26
$NaHCO_3$-extractable P	(mg kg^{-1})	4.36	4.65
NH_4OAC-extractable K	(mg kg^{-1})	49.24	50.86

* Each value represents the mean of three replications.

Three nitrogen fertilizer levels were applied at 60, 90 and 120 kg N fed.$^{-1}$ as ammonium nitrate (33.3% N). Doses and time of N application are presented in Table (2). The soil was treated with 31 kg P_2O_5 fed.$^{-1}$ as calcium superphosphate (15.5% P_2O_5) during soil preparation. The potassium fertilization was applied at a level of 50 kg K fed.$^{-1}$ as potassium sulphate (48% K_2O) in one dose after thinning. The area of each plot was 10.5 m^2 (3.5 m length x 3 m width) with six ridges of 50 cm apart and 3.5 m in length.

Sugar beet seed balls of multigerm (Gollia (C_1) and Top (C_2) cv.) were sown in hills of 20 cm apart at a rate of 2-3 balls hill^{-1} on the 9th and 10th of October in first and second seasons, respectively. The plants were thinned to one plant hill^{-1} after 21 days from sowing (at the 4 true leaf stage).

Table 2: Nitrogen application level and time.

Treatment	N level (kg fed.$^{-1}$)	30 days	60 days	90 days
T_1		-	30 kg	30 kg
T_2		30 kg	30 kg	-
T_3	60	20 kg	20 kg	20 kg
T_4		30 kg	30 kg	30 kg
T_5		-	45 kg	45 kg
T_6	90	45 kg	45 kg	-
T_7	120	40 kg	40 kg	40 kg

All recommended cultural practices were applied for sugar beet production in Upper Egypt except the treatments under investigation. The preceding crop was wheat in both seasons. Two weeks before harvest, the irrigation of sugar beet was stopped in both seasons. At maturity (190 days from sowing), a sample of ten guarded plants from each plot was randomly taken to record the data of top and root fresh weights (g plant^{-1}).

At harvest (190 days from sowing), the plants of each sub plot were harvested to determine the top and root yields (ton fed.$^{-1}$). A sample of 25 kg of roots was randomly taken from each plot and sent to the beet laboratory at Abo-Korkas sugar factory to determine root quality parameters including:

1- Alpha amino nitrogen (α-amino-N) as well as sodium (Na) and potassium (K) concentrations were determined using an autoanalyzer as described by A.O.A.C. (1995). These concentrations were calculated as mmol 100 g^{-1} beet paste.

2- Sucrose content was estimated in fresh samples of sugar beet roots using the Saccharometer according to the method descried by Le-Docte (1927).

3- Sugar loss percentage was calculated using the following formula according to Reinefeld *et al.* (1974):

Sugar loss percentage = 0.29 + 0.343 (K+Na) + 0.094 α-amino-N

4- Sugar recovery (S.R. %) was calculated using the following equation according to Cooke and Scott (1993):

Sugar recovery (S.R. %) = sucrose % - Sugar loss %

5- Recoverable sugar yield (R.S.Y.) was calculated using the following equation:

Recoverable sugar yield (ton fed.$^{-1}$) = root yield (ton fed.$^{-1}$) x sugar recovery %

6- Quality index % = (Sugar recovery % x 100)/Sucrose %.

7- Sugar loss yield (ton fed.$^{-1}$) = Root yield (ton fed.$^{-1}$) x Sugar loss %.

8- Leaf area plant^{-1} was determined in the characteristic phenostages of sugar beet (vegetation stage) by using the leaf area meter (model Planix 5000).

9- A chlorophyll meter (model SPAD-502) was used for chlorophyll measurement. The chlorophyll content was measured on middle-aged leaves considering 3 replications at 100 days of planting (Mohammadian *et al*., 2003).

The analysis of variance was carried out according to Gomez and Gomez (1984) using MSTAT computer software. The means of the different treatments were compared using the least significant difference (LSD) test at 0.05 level of probability.

Results and Discussion

Cultivars Effect

There were significant differences in some growth and quality traits between the two studied cultivars (Tables 3, 4 and 5). Significant mean values of root fresh weight of 894.04 and 1000.62 g plant^{-1}, top fresh weight of 282.16 and 292.04 g plant^{-1}, root fresh weight of 31.29 and 35.02 ton fed.$^{-1}$ and S.R.Y. of 2.78 and 2.89 ton fed.$^{-1}$ were obtained from C_1 and C_2 respectively, in the first season. The respective mean values of these traits for C_1 and C_2 in the second season were 928.56 and 1025.42 g plant^{-1}, 297.1 and 312.17 g plant^{-1}, 32.5 and 35.89 ton fed.$^{-1}$ and 2.89 and 2.93 ton fed.$^{-1}$. Significant mean values of the sucrose percentage 17.98 and 18.28 % were also recorded in the first season in the roots of C_1 and C_2 respectively, Differences in leaf area plant^{-1} were also recorded between the two cultivars due to the differences in dry matter accumulation, photosynthesis products and nitrogen uptake. Differences in growth, root yield and sugar yield among sugar beet cultivars were indicated by Ebrahim *et al*., (1988). On the other hand, Sobh *et al*. (1992) found no significant differences in the root length, TSS %, sucrose % and purity % among three sugar beet cultivars.

Nitrogen Application Time Effect

The proper management of N fertilization is a major factor in maximizing the production of sugar beet. The effects of the N fertilizer level, splitting and time of application on the biomass parameters, yield and sucrose production of sugar beet are present in Tables 3 and 4. The results clearly demonstrated that the highest level of N fertilizer produced an appreciable induction in the root and top yield of each cultivar. Highest mean values of root fresh weight of 1171.0 and 1270.8 g plant^{-1}, top fresh weight of 355.19 and 368.82 g plant^{-1}, root fresh weight of 40.99 and 44.48 ton fed.$^{-1}$, top fresh yield of 12.43 and 12.91 ton fed.$^{-1}$, leaf area of 2949 and 3030 cm^2 plant^{-1} and total chlorophyll content of 55.95 and 53.27 were recorded using the T_7 seasons, respectively. The application of nitrogen treatment in the first and second N at the level of 90 kg fed.$^{-1}$ in three equal doses (30 kg fed.$^{-1}$ at 30 days after planting (DAP), 30 kg fed.$^{-1}$ at 60 DAP and 30 kg fed.$^{-1}$ at 90 DAP) produced the highest mean values of sugar beet, while the lowest mean values were obtained when N was applied at 60 kg fed.$^{-1}$ the level in two equal doses (30 kg fed.$^{-1}$ at 60 DAP and 30 kg fed.$^{-1}$ at 90 DAP) in both seasons. These results are in an agreement with those obtained by Sharief, *et al.*, (1997), Abdel-Motagallay and Attia (2009), Abdou (2000), Leilah *et al*., (2005), Osman and Shehata (2010) and Safina and Abdel Fatah (2011).

The impurities (K, Na and α-amino-N concentrations) are recorded to be accumulated in beet roots under the excess of N fertilization. The presence of N fertilizer provoked α-amino-N accumulation in the roots of sugar beet cultivars in the two seasons (Table 5). The highest mean values of α-amino-N content in roots were consistently found in the plants grown in the highest N treated soil (T_7) and having a late N dose (T_5), at 90 DAP. Similarly, the high N level (T_7) and the late N dose at 90 DAP stimulated the accumulation of Na in sugar beet roots of both cultivars. However, no significant differences in K accumulation in sugar beet roots of both cultivars in both seasons could be observed among the different N treatments.

Nitrogen splitting time exhibited a significant effect on juice quality traits in both seasons. Splitting the N treatment of 90 kg fed.$^{-1}$ into three equal doses could improve sucrose content of sugar beet cultivars at the two seasons compared to other N treatments. The early application of N also improved the beet quality. Highest mean values of sucrose of 19.83 and 20.25 %, S.R. of 17.27 and 17.66 %, S.R.Y. of 3.43 and 3.58 ton fed.$^{-1}$, gross sugar yield of 0.922 and 0.965, quality index of 87.08 and 87.20 % and K concentration of 4.70 and 4.85 mmol 100 g^{-1} beet paste resulted from the application of the T_4 nitrogen treatment in the first and second seasons, respectively. However, highest mean values of sugar loss of 2.70 and

2.59 % and Na concentration of 2.50 and 2.36 mmol 100 g^{-1} beet paste were obtained from the application of T_7 nitrogen treatment in the first and second season, respectively.

Nitrogen has a role in building up plant organs through the synthesis of proteins. It is an integral part of the chlorophyll molecule. In addition, it is important in the synthesis of sucrose and in the reactions involving the utilization of sucrose as an energy source for plant growth and cell maintenance (El-Harriri and Gobarh, 2001). It is worth to mention that the reduction in juice quality traits accompanying the late N application is compensated for the increase in the root yield $fed.^{-1}$ and finally sugar yield is increased. Similar results were obtained by Leilah *et al*. (2005). Ismail and Abo El-Ghit (2005) showed that the application of 155 kg N $fed.^{-1}$ significantly increased the root fresh weight $plant^{-1}$ and root yield, while the sucrose content was reduced. Moreover, Masi (2008) indicated that the application of 120 kg N $fed.^{-1}$ was recommended for high values of sucrose content, purity, extractable sucrose and sugar yield. Also, Nemeat-Alla *et al*. (2007) reported that the application of 120 kg N $fed.^{-1}$ significantly increased the root diameter, dry matter $plant^{-1}$, root/top ratio, sucrose % as well as the root, top and sugar yield $fed.^{-1}$ in the first season only; no significant effects were found on the root length, T.S.S. % and purity % in both seasons due to the nitrogen fertilization.

Sugar beet yield and quality are dramatically influenced by the level of available N. Residual and fertilizer N levels that will allow adequate top growth and maximize the root growth and extractable sucrose concentration are desired. However, sucrose yield are decreased by the over fertilization of sugar beet with more N than it is needed for the maximum sucrose production. Therefore, an adequate supply of N is essential for optimum the yield but excess N may result in an increase in the root yield with lower values of sucrose content and juice purity.

Interaction Effect

Special emphasis was laid on the influence of N treatments on the quality of sugar produced from the test cultivars. The data herein clearly demonstrate that the quality of sugar was substantially affected by N treatments and the response of the test cultivars depends on the applied level, time and split of the N fertilizer (Table 4). Splitting the N treatment of 90 kg $fed.^{-1}$ into three equal doses (T_4) significantly increased the sugar purity of sugar juice of both sugar beet cultivars more than the other treatments in both seasons. Table 4 also reveals that, the percentage of sugar loss of both sugar beet cultivars in both seasons increased with increasing the N applied level, except T_6 which it was as the lowest level (60 kg $fed.^{-1}$). With respect to the percentage of sugar recovery, T_4 clearly improved the sugar recovery of both cultivars in the two seasons compared to the treatments. Similarly, T_4 markedly increased the sugar recovery yield of both cultivars over other treatments. On the other hand, both T_4 and T_7 were the most effective N treatments in increasing the gross sugar yield of both cultivars in the two seasons.

Highest mean values of root fresh weight of 1213.67 and 1307.00 g plant^{-1}, top fresh weight of 362.13 and 373.42 g plant^{-1}, root fresh weight of 42.48 and 45.75 ton fed.$^{-1}$, top fresh weight of 12.67 and 13.07 ton fed.$^{-1}$, leaf area of 2984 and 3113.0 cm^2 plant^{-1} and chlorophyll content of 57.30 and 54.47 were obtained by applying T_7 treatment to Top cultivar (C_2) in the first and second season, respectively. However, highest mean values of sucrose of 19.95 and 20.41 %, sugar recovery of 17.40 and 17.83 %, S.R.Y. of 3.47 and 3.64 ton fed.$^{-1}$, quality index of 87.22 and 87.35 %, and K concentration of 4.72 and 4.87 mmol 100 g^{-1} beet paste were obtained by treating Top cultivar (C_2) with T_4 treatment in the first and second season, respectively.

The results show that, applying 90 kg N fed.$^{-1}$ in three equal doses (T_4) could resulted in a higher sucrose content than the other N treatments of sugar beet cultivars in both seasons. Increased N levels probably enhanced more leaf area resulting in higher photo assimilates and thereby more dry matter accumulation. These findings are supported by the resulted of Mandal *et al*. (1992). Fresh weights of roots and tops increased with increasing the N applied level to both sugar beet cultivars in the two growth seasons (Table 3). This increase was clearer with treating both cultivars with T_7 (120 kg fed.$^{-1}$). Also, the results of Table 3 clearly demonstrate that the highest N level induced appreciable increases in root and top yields of each cultivar.

Applying the highest level of nitrogen caused significant increases in top and root weights and sugar yield compared to the lower N level in both seasons. Nitrogen has an important role as an essential structural nutrient in building up plant organic substances. The increase in the root weight is mainly due to the role of N in stimulating the meristematic growth activity which contributes to the increase in number of cells and cell enlargement. These results are in agreements with Nemeat-Alla (2001) and Assey *et al*. (2005). Mousa (2004), Ismail and Abo El-Ghit (2005) and Kafaga *et al*. (2007) also found that increasing the nitrogen fertilizer level from 30 to 60 kg N fed.$^{-1}$ significantly increased the root length, root diameter, root and top fresh weights as well as top and root yields in both seasons and sugar yield in the second season, but it decreased the sucrose % and purity % in second season. In the stage of inflorescence stalk appearance, the cultivars do not have any statistically significant influence on the leaf area plant^{-1} in the both seasons. In this stage, the leaf area was significantly influenced by nitrogen treatment that was applied early or at a high level. A significantly largest leaf area plant^{-1} was obtained by applying 120 kg N fed.$^{-1}$ compared to 60 kg N fed.$^{-1}$.

In soils of different fertility status, increasing N inputs causes increases in the root yield. The effect of N on the quality and sugar production is more complex because the plant with an increased N supply diverts more energy from the stored sugar to be used in root growth. Thus, N can have opposite effects on both concentration and accumulation of α-amino-N compounds which determine the extractability of sugar during processing (El-Sayed, Safaa, 2013). (Telep *et al*. 2008) reported that increasing the N level up to 140 kg N fed.$^{-1}$ increased the root yield, sugar yield, T.S.S. %, α-amino-N and potassium content in the juice, while the sucrose content, purity % and Na content decreased. Sodium concentration increased rapidly as the available N increased, while K and α-amino-N concentrations were significantly greater when N was applied than when no N was applied. Carter (1986) indicated that both Na and K uptakes were associated with N uptake, with major concentrations of these impurities located in the sugar beet tops and crowns.

Conclusions

It can be concluded that applying the N application of 90 kg fed.$^{-1}$ splitting into three equal doses at 30, 60 and 90 days after planting (DAP) compared to its two equal doses was the best treatment increasing the sugar yield by improving the root juice quality and extractable sugar yields. On the other hand, increasing the N level up to 120 kg fed.$^{-1}$ decreased the sugar content and juice purity of sugar beet roots.

Table 3: Effect of nitrogen application levels and time on yield and its traits of two sugar beet cultivars (C) grown in 2010/2011 and 2011/2012 seasons.

N treatment	Root fresh weight (g plant^{-1})			Top fresh weight (g plant^{-1})			Root fresh yield (ton fed.$^{-1}$)			Top fresh yield (ton fed.$^{-1}$)			Leaf area (cm^2 plant^{-1})		
	2010/2011														
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	724.34	864.25	794.3	207.24	213.46	210.35	25.35	30.25	27.8	7.25	7.47	7.36	2232	2265	2249
T_2	826.65	1062.23	944.44	262.24	275.36	268.8	28.93	37.18	33.06	9.18	9.64	9.41	2346	2368	2357
T_3	888.42	968.42	928.42	287.16	295.25	291.21	31.09	33.89	32.49	10.05	10.33	10.19	2573	2597	2585
T_4	1086.16	1146.62	1116.4	326.42	332.15	329.29	38.02	40.13	39.08	11.42	11.63	11.53	2867	2894	2881
T_5	746.25	886.45	816.35	238.65	253.45	246.05	26.12	31.03	28.58	8.35	8.87	8.61	2257	2286	2272
T_6	858.23	862.67	860.45	305.14	312.45	308.80	30.04	30.19	30.12	10.68	10.94	10.81	2698	2726	2712
T_7	1128.24	1213.67	1171.0	348.25	362.13	355.19	39.49	42.48	40.99	12.19	12.67	12.43	2913	2984	2949
Mean	894.04	1000.62	947.33	282.16	292.04	287.10	31.29	35.02	33.16	9.87	10.22	10.05	2555.1	2607.0	2581
F values for C.	**	**		**	**		**	*		N.S.	N.S.		N.S.	N.S.	
LSD 0.05 N	34.65	21.46		36.45	32.57		3.27	2.86		2.14	1.88		87.26	94.26	
LSD 0.05 C X N	56.24	64.21		38.72	41.56		3.24	3.12		1.87	1.92		124.46	112.62	
	2011/2012														
T_1	768.35	872.45	820.4	215.62	226.14	220.88	26.89	30.54	28.72	7.55	7.91	7.73	2285	2297	2291
T_2	846.27	1002.42	924.35	274.35	295.42	284.89	29.62	35.08	32.35	9.60	10.34	9.97	2435	2457	2446
T_3	895.14	1008.14	951.64	293.41	300.35	296.88	31.33	35.28	33.31	10.27	10.51	10.39	2644	2664	2654
T_4	1118.42	1228.62	1173.5	342.14	367.35	354.75	39.14	43.00	41.07	11.97	12.86	12.42	2867	2913	2890
T_5	763.12	874.25	818.69	262.72	285.16	273.94	26.71	30.60	28.66	9.20	9.98	9.59	2362	2387	2375
T_6	874.17	885.24	879.71	327.24	337.32	332.28	30.60	30.98	30.79	11.45	11.81	11.63	2767	2817	2792
T_7	1234.42	1307.23	1270.8	364.22	373.42	368.82	43.20	45.75	44.48	12.75	13.07	12.91	2947	3113	3030
Mean	928.56	1025.48	977.02	297.1	312.17	304.64	32.50	35.89	34.20	10.4	10.93	10.67	2615.3	2645.6	2630
F values for C.	**	**		**	**		*	**		N.S.	N.S.		N.S.	N.S.	
LSD 0.05 N	34.65	18.64		30.15	28.54		3.12	2.78		2.23	1.94		98.25	89.15	
LSD 0.05 C X N	56.24	55.32		39.24	34.12		3.17	2.91		2.18	1.87		116.43	104.42	

*and ** significant and highly significant, respectively. N.S. = Not significant. C_1= Gloria C_2 = Top

Table 4: Effect of nitrogen application levels and time on some quality traits of two sugar beet cultivars (C) grown in 2010/2011 and 2011/2012 seasons.

N treatment	Sucrose %			Sugar loss (%)			Sugar recovery (S.R. %)			R.S.Y. (ton fed.$^{-1}$)			Gross sugar yield (ton fed.$^{-1}$)		
	2010/2011														
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	17.32	17.77	17.55	2.40	2.37	2.39	14.92	15.40	15.16	2.58	2.74	2.66	0.609	0.716	0.663
T_2	17.44	17.38	17.41	2.38	2.45	2.42	15.06	14.93	15.00	2.63	2.59	2.61	0.687	0.741	0.714
T_3	18.64	18.18	18.41	2.44	2.47	2.46	16.20	15.71	15.96	3.02	2.86	2.94	0.759	0.920	0.840
T_4	19.71	19.95	19.83	2.58	2.55	2.57	17.13	17.40	17.27	3.38	3.47	3.43	0.979	0.864	0.922
T_5	17.18	18.26	17.72	2.72	2.70	2.71	14.46	15.56	15.01	2.48	2.84	2.66	0.711	1.084	0.898
T_6	18.37	18.56	18.47	2.49	2.48	2.49	15.88	16.08	15.98	2.92	2.98	2.95	0.747	0.769	0.758
T_7	17.18	17.84	17.51	2.74	2.66	2.70	14.44	15.18	14.81	2.48	2.71	2.60	1.082	0.803	0.943
Mean	17.98	18.28	18.13	2.53	2.54	2.54	15.44	15.75	15.60	2.78	2.89	2.84	0.8	0.83	0.815
F values for C.	*	*		N.S.	N.S.		N.S.	N.S.		*	**		N.S.	N.S.	
LSD N	0.44	0.36		N.S.	N.S.		0.46	0.38		0.18	0.24		0.15	0.14	
0.05 C X N	0.52	0.37		N.S.	N.S.		0.54	0.42		0.21	0.19		0.18	0.12	
	2011/2012														
T_1	17.48	17.14	17.31	2.32	2.26	2.29	15.16	14.88	15.02	2.65	2.55	2.60	0.623	0.692	0.658
T_2	17.84	17.42	17.63	2.51	2.52	2.52	15.33	14.90	15.12	2.74	2.60	2.67	0.743	0.770	0.757
T_3	18.84	18.27	18.56	2.51	2.42	2.47	16.33	15.85	16.09	3.08	2.90	2.99	0.787	0.850	0.819
T_4	20.08	20.41	20.25	2.60	2.58	2.59	17.48	17.83	17.66	3.51	3.64	3.58	1.018	0.911	0.965
T_5	17.82	18.88	18.35	2.68	2.71	2.70	15.14	16.17	15.66	2.70	3.05	2.88	0.715	1.164	0.940
T_6	18.73	18.48	18.61	2.52	2.46	2.49	16.21	16.02	16.12	3.04	2.96	3.00	0.771	0.753	0.762
T_7	17.22	18.14	17.68	2.62	2.55	2.59	14.60	15.59	15.10	2.51	2.83	2.67	1.134	0.789	0.962
Mean	18.29	18.39	18.34	2.54	2.50	2.52	15.75	15.89	15.82	2.89	2.93	2.91	0.83	0.85	0.840
F values for C.	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		*	**		N.S.	N.S.	
LSD N	0.42	0.24		N.S.	N.S.		0.32	0.22		0.16	0.18		0.13	0.12	
0.05 C X N	0.39	0.28		N.S.	N.S.		0.39	0.28		0.21	0.23		0.17	0.21	

*and ** significant and highly significant, respectively. N.S. = Not significant. C_1= Gloria C_2 = Top

Table 5: Effect of nitrogen application levels and time on some quality traits of two sugar beet cultivars (C) grown in 2010/2011 and 2011/2012 seasons.

N treatment	Quality index (%)			α- amino-N			K			Na			Total chlorophyll content		
				concentration (mmol 100 g^{-1} beet paste)											
	2010/2011														
	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean	C_1	C_2	Mean
T_1	86.14	86.69	86.42	1.73	1.76	1.75	4.15	4.08	4.12	1.53	1.49	1.51	31.07	30.27	30.67
T_2	86.38	85.90	86.14	1.43	1.52	1.48	4.26	4.34	4.30	1.43	1.54	1.49	42.40	43.97	43.19
T_3	86.91	86.39	86.65	1.57	1.52	1.55	4.26	4.43	4.35	1.58	1.52	1.55	47.73	49.30	48.52
T_4	86.93	87.22	87.08	1.66	1.64	1.65	4.67	4.72	4.70	1.54	1.42	1.48	43.17	49.87	46.52
T_5	84.15	85.21	84.68	2.89	2.84	2.87	4.05	4.03	4.04	2.25	2.22	2.24	38.47	36.47	37.47
T_6	86.47	86.64	86.56	2.16	2.23	2.20	3.86	3.95	3.91	1.95	1.82	1.89	48.87	48.30	48.59
T_7	84.05	85.10	84.58	2.79	2.57	2.68	3.85	3.74	3.80	2.53	2.46	2.50	54.60	57.30	55.95
Mean	85.86	86.17	86.02	2.03	2.01	2.02	4.16	4.18	4.17	1.83	1.78	1.81	43.76	45.07	44.42
F values for C.	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
LSD N	0.34	0.29		0.07	0.06		0.02	0.02		0.05	0.04		1.77	1.12	
0.05 C X N	0.28	0.35		0.08	0.09		0.03	0.04		0.07	0.06		2.12	1.98	
	2011/2012														
T_1	86.74	86.79	86.77	1.72	1.67	1.70	3.98	3.92	3.95	1.46	1.38	1.42	26.47	21.33	23.90
T_2	85.93	85.53	85.73	1.46	1.54	1.50	4.53	4.62	4.58	1.54	1.46	1.50	31.77	30.23	31.00
T_3	86.66	86.74	86.70	1.54	1.53	1.54	4.53	4.27	4.40	1.53	1.53	1.53	34.87	35.57	35.22
T_4	87.05	87.35	87.20	1.62	1.57	1.60	4.83	4.87	4.85	1.46	1.38	1.42	40.90	45.27	43.09
T_5	84.97	85.67	85.32	2.63	2.57	2.60	4.11	4.07	4.09	2.13	2.27	2.20	29.30	29.33	29.32
T_6	86.55	86.69	86.62	2.26	2.14	2.20	3.92	3.87	3.90	1.96	1.87	1.92	52.07	45.10	48.59
T_7	84.76	85.96	85.36	2.76	2.49	2.63	3.67	3.57	3.62	2.38	2.33	2.36	52.07	54.47	53.27
Mean	86.10	86.39	86.25	2.00	1.93	1.97	4.22	4.17	4.20	1.78	1.75	1.77	38.21	37.33	37.77
F values for C.	N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.	
LSD N	0.27	0.19		0.05	0.04		0.02	0.01		0.04	0.03		1.21	1.19	
0.05 C X N	0.32	0.26		0.07	0.05		0.01	0.02		0.05	0.06		1.34	1.32	

*and ** significant and highly significant, respectively. N.S.= Not significant. C_1= Gloria C_2= Top

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أستجابة صنفين من بنجر السكر لمستوى ووقت أضافة السماد النيتروجينى

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الملخص

أجريت هذه الدراسة بمزرعه قسم المحاصيل – كلية الزراعة – جامعة أسيوط خلال موسمي ٢٠١٠/٢٠١١ ، ٢٠١١/٢٠١٢ لدراسة أستجابه صنفين من بنجر السكر لمستوى ووقت اضافه السماد النيتروجينى وتم استخدام القطاعات كاملة العشوائية في تصميم القطع المنشقة مرة واحدة في ثلاث مكررات حيث وزع صنفي بنجر السكر في القطع الرئيسية في حين وزعت ٧معاملات السماد النيتروجينى (T_7:T_1) عشوائياً في القطع المنشقة.

كانت أهم النتائج المتحصل عليها:

١- زيادة مستويات السماد النيتروجينى إلي ٩٠ كجم نيتروجين للفدان أثرت معنويا فى صفات الوزن الأخضر والجاف لكل من العرش والجذور ومحصول السكر بالطن/فدان فى حين لا توجد فروق معنويه في نسبة الشوائب (الصوديوم ، البوتاسيوم ، الألفا أمينو نيتروجين) بين مستويات الأضافه في موسمي الزراعة.

٢- أدى تسميد بنجر السكر باستخدام ١٢٠ كجم نيتروجين للفدان الى زيادة فى نمو الجذوروالعرش بينما أدى الى انحفاض محصول السكر وصفات الجوده في موسمي الزراعة.

٣- أدت الأضافه المبكره فى عمر ٣٠ يوم من الزراعة وباستخدام ٩٠ كجم نيتروجين للفدان مع تجزئه السماد النيتروجينى الى ٣ جرعات متساويه الى تحسين جوده الجذوربالمقارنه بأضافته على جرعتين.

من نتائج هذه الدراسة يمكن التوصية بتسميد محصول بنجر السكر ب ٩٠ كجم نيتروجين للفدان مع تقسيم السماد الى ٣ جرعات متساويه وأضافتها بدايه من عمر ٣٠ يوم من الزراعة للحصول علي أعلي ناتج من محصول الجذور السكروأعلى صفات جودة لمحصول بنجر السكر.