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Effect of Nitrogen Level and Planting Density on Sugar Beet Yield and its Attributes

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TWO FIELD experiments were carried out at EL-Fayoum Governorate, Egypt during 2006/2008 seasons to evaluate the effect of different plant populations (35000, 40000, 46000 plants fed^{-1}) and nitrogen levels (90, 120, 150 kg N fed^{-1}) on sugar yield and some of its attributes. Seeds of Kawemera variety were sown on 15^{th} of October in both seasons. A split plot in a randomized complete block design with three replications was used. Main plots were devoted for N levels and sub plots were devoted for planting densities. Results showed that beet sugar yield and all of its attributes were significantly affected by N level in both seasons except number of plants at harvest. Root fresh weight and root yield were linearly increased with increasing N level. Application N at 120 kg N fed^{-1} was recommended for sucrose content, purity, extractable sucrose and sugar yield in both seasons. Increasing planting density from 35000 to 40000 plants fed^{-1} and from 40000 to 46000 plants fed^{-1} significantly decreased individual root fresh weight by 16.35 and 16.09% in the first season and by 18.09 and 11.69% in the second season, respectively. The same trend was observed for root yield where it decreased by 2.8 and 3.6% in the first season with no significant difference between 35000 and 40000 plant, while in the second season, planting density had no effect on root yield. On the other hand, increasing plant density from 35000 to 40000 plants significantly increased sucrose content by 3.8 and 5.3%, purity by 6.0 and 5.4%, extractable sucrose by 20.9 and 22.8% and sugar yield by 18.2 and 24.3% in the first and second season, respectively. All quality measurements and sugar yield were decreased at planting density of 46000 plants compared with 400000 plants, but without significant differences except for sucrose content in the second season and sugar yield in the first season. At each plant density root yield was increased with each N increment but this increase was more pronounced under high than at low planting density. Application of 120 kg N fed^{-1} with 40000 plants was recommended for sucrose content (22.03, 22.33%) and extractable sucrose (18.39, 17.70%) in the first and second season, respectively. Plant population of 40000 plants fed^{-1} was recommended for sugar yield, but with 120 and 150 kg N fed^{-1} in the first and second season, respectively. Over seasons, a maximum sugar yield of 4.85, 5.80, and 6.72 ton fed^{-1} could be obtained at predictable N levels of 112, 141, and 228 kg N fed^{-1} with plant densities of 35000, 40000, and 46000 plants fed^{-1}, respectively.

Keywords: Sugarbeet (*Beta vulgaris* L.), Predictable N levels, Plant population, Root yield, Quality measurements .

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Nitrogen fertilization and plant population density have the greatest influence of all agronomic variables on yield and quality of sugar beet (*Beta vulgaris* L.). Although N is an essential element for plant growth, low N fertility levels result in low root yields, whereas excessive N additions adversely affect quality of sugar beet particularly at low planting densities (Smith & Martin, 1977; Hofer *et al.*, 1979; Lauer, 1995; Kemp *et al.*, 1996 and EL- Geddawy *et al.*, 2006). However, nitrogen rate recommendations are location–specific and usually range from 56 to 179 kg N ha^{-1}, although rates up to 364 kg N ha^{-1} are suggested for some locations (Hills & Ulrich, 1971). Increasing nitrogen rate up to 90 kg N fed^{-1} (fed = 0.42 ha) (Mahmoud *et al.*, 1999), 105 kg N fed^{-1} (Leilah *et al.*, 2005), and 120 kg N fed^{-1} (EL- Hennawy *et al.*, 1998) significantly increased root and sugar yields, but it resulted in marked reduction in juice purity and sucrose percentage.

Many investigations have been conducted to determine the optimum plant population densities for high root yields with good qualities. These studies were mainly directed toward the effect of spacing between and /or within sugar beet rows on root yield and recoverable sugar. However, Mahmoud *et al.* (1999) found that widening the distance between hills from 15 to 20 cm in row width of 60cm significantly increased weight of individual root, root yield, sucrose content and sugar yield. Sultan *et al.* (1996) evaluated the effect of four population densities (35000, 46500, 52500 and 70000 plants fed^{-1}) on sugar beet in North Delta region. They observed that the highest yield of roots and sugar were obtained with the planting density of 46500 plants fed^{-1}. Lauer (1995) found that planting density had no significant effect on root yield, while sucrose content was increased by 5g kg^{-1} as plant density was increased from 42000 to 112000 plants ha^{-1}, and recoverable sucrose was increased from 7.40 Mg ha^{-1} at 42000 plants ha^{-1} to a maximum of 7.79 Mg ha^{-1} at 88600 plants ha^{-1}. However sowing sugar beet at 28000 and 42000 plants fed^{-1} gave high values of yield and quality traits, respectively (Ismail & Allam, 2007). The lower plant populations and presence of many missed hills in the field reduced the quality mainly of sugar content and white sugar yield as a result of increased impurities content (Minx, 1993 and Lauer, 1995).

This study was undertaken in order to determine the optimum nitrogen level at different population densities for maximization of yield and quality of sugar beet grown in newly reclaimed soils.

Materials and Methods

Two field experiments were established in Howara location, EL-Fayoum Governorate (Latitude 29° N, Longitude 30° N and high tide 30 m) during 2006/2008 seasons to evaluate the effect of different plant population densities and nitrogen levels on sugar yield and some of its attributes in Kawemera sugar beet variety. Soil characteristics are listed in Table 1. Seeds were sown on 15th of October in both seasons.

TABLE 1. Preceding crops and soil characteristics of sugar beet experimental fields during 2006/07 and 2007/08 seasons .

	2006/ 2007	2007/ 2008
Preceding crop	Sun flower	Corn
Soil sample date	15 Oct.	15 Oct.
Soil texture	Sandy loam	Sandy loam
pH	8.70	9.50
E.C (m/cm)	0.37	0.40
Na (mq/l)	1.29	1.95
Cl (mq/l)	0.50	0.50
$CaCO_3$ %	7.00	11.50
N (mg kg^{-1})	30.00	40.00
P (mg kg^{-1})	22.00	30.00
K (mg kg^{-1})	288.00	184.00
Fe (mg kg^{-1})	9.12	10.50
Zn (mg kg^{-1})	0.22	0.22
Mn (mg kg^{-1})	7.70	9.60

The experimental design was a randomized complete block in a split-plot arrangement with three replications. N application levels of 90, 120 and 150 kg N fed^{-1} were allocated in main plots. Sub-plots were devoted for planting densities of 35000, 40000 and 46000 plants fed^{-1} resulting from using three plant spacing within ridges of 15, 17.5 and 20cm, respectively. Sub-plot included five ridges 4m long and 0.6m apart. Thinning took place to one plant/hill at 4-leaf stage (25 days from planting).

Nitrogen was added in the form of ammonium nitrates (33.5% N) in three equal splits, the first was applied after thinning and other splits were added at one and two months later. Moreover, 15 kg P_2O_5 (superphosphate 15.5% P_2O_5) was added at seed bed preparation and 24 kg K_2O (potassium solephate 48% K_2O) was applied with the first split of nitrogen fertilizer. The other agronomic practices were carried out as recommended.

Sugar beet was topped and harvested by hand on May 15^{th} (210 days old). Roots were harvested from the central three ridges. Weight per plot was obtained and used to calculate root yield on a per-feddan basis. Sucrose and purity percentages were determined on a ten root pulp sample using standard methods as outlined in A.O.A.C. (1975). Extractable sucrose% was calculated using the following equation from Dexter *et al.* (1967):

$$\text{Extractable sucrose \%} = [\text{sucrose \%} - 0.3]\ [1 - (\ 1.667 \times \frac{100 - \text{Purity}}{\text{Purity}}\ )]$$

Sugar yield was calculated according the following equation:

$$\text{Sugar yield ton fed}^{-1} = \text{root yield ton fed}^{-1} \times \text{Extractable sucrose \%}$$

Collected data were subjected to normal statistical analysis and treatment mean comparisons were made using least significant difference at 5% level of probability. Orthogonal polynomial coefficients (linear and quadratic) were sequentially added to the model and included when they contributed significantly to the variation in the dependent variable (Gomez & Gomez. 1984).

Results and Discussion

Effect of nitrogen level

Sugar beet yield and all of its attributes were significantly affected by nitrogen level in both seasons with the exception of harvest plant density (Table 2). The effect of N level on mean root weight and root yield was linear, while its effect on total soluble solids (TSS), sucrose %, purity %, extractable sucrose % and sugar yield was quadratic in both seasons. For data averaged over plant densities (Table 3) results showed that the effect of N level on each studied trait nearly follow the same trend in both seasons but with different linear and quadratic magnitudes for each season. The response of root yield was diminishing in the first season but nondiminishing in the second season. Also, the magnitude of response was higher in the second than in the first season as judged from the greater measures in the former than in the later. This probably could be attributed to the effect of preceding crop on this response, where it was maize in the second season and sunflower in the first one. The higher $CaCO_3$ content in the second (11.5%) than in the first (7.0%) season might have played a role in this respect. However increasing nitrogen level up to 150 kg N fed^{-1} resulted in significant increasing in root yield in both seasons, which can be explained by the role of nitrogen in enhancing growth, chlorophyll formation, photosynthesis process and hence increasing root yield and its attributing variables such as mean root weight as observed herein. Similar results were reported by many investigators in other sugar beet production areas (Kemp *et al.*, 1996; El-Hinnawy *et al.*, 1998; Leilah *et al.*, 2005 and El- Geddawy *et al.*, 2006), though some studies (Reuss & Rao, 1971; Carter *et al.*, 1976 and Lauer, 1995) showed that sugar beet root yield was increased by adding N fertilizer when N is limiting, and some times the yield may be decreased when excessive N is used, which was probably caused by the increased top growth. However, quality traits are increased by increasing N rate from 90 to 120 kg N fed^{-1}. Application N at 120 kg N fed^{-1} seems to be the optimum level for quality traits (Sucrose %, purity % and extractable sucrose %) and sugar yield in both seasons. The increasing in quality traits might be due to the role of nitrogen in stimulation the growth of new leaves in which are the vehichle for sucrose production by photosynthesis, while too much N increase root impurities which are negatively correlated with quality traits (Carter *et al.*, 1976; Smith & Martin, 1977 and Lauer, 1995), also excessive nitrogen application tends to increase crown tissue production which is lower in quality than the rest root tissue (Zielke, 1973 and Halvorson *et al.*, 1978).

Effect of planting density

Significant differences among planting densities were found for all studied characters except total soluble solids in both seasons and root yield in the second season (Table 2). Harvest plant density and root yield responded linearly to increasing the plant density in both seasons and first season, respectively, while quadratic effect was significant for root fresh weight, sucrose%, purity %, extractable sucrose % and sugar yield in each season.

This study aimed to establish harvest plant density of 35000, 40000 and 46000 plants fed^{-1}, but because of the harmful effect of insects on sugar beet seedlings, the tried densities were not obtained for all populations (Table 4). Over nitrogen rates, increasing plant density from 35000 to 40000 plants fed^{-1} and from 4000 to 46000 plants fed^{-1} significantly decreased root fresh weight by 16.35 and 16.09 % in the first season and by 18.09 and 11.69% in the second season, respectively. The same trend was observed for root yield hence it decreased by 2.8 and 3.6% with increasing plant density in the first season with no significant difference between 35000 and 40000 plant, while in the second season, plant density had no effect on root yield, since the root yield under the three plant densities was almost the same. This is because the reduction in fresh root weight was somewhat compensated by increasing root number. This result is in agreement with those reported by Lauer (1995), Arita *et al.* (1998), EL- Geddawy *et al.* (2006) and Ismail & Allam (2007).

On the other hand increasing plant density from 35000 to 40000 plants fed^{-1} significantly increased sucrose content by 3.8 and 5.3%, purity by 6.0 and 5.4 %, extractable sucrose by 20.9 and 22.8% and sugar yield by 18.2 and 24.3% in the first and second season, respectively. Quality traits in terms of sucrose content, purity and extractable sucrose as well as sugar yield were decreased at plant density of 46000 plant compared to 40000 plant fed^{-1}. However, differences were insignificant except for sucrose content in the second season and sugar yield in the first season which could be explained by significant reduction in root yield at plant density of 46000 plants in the first season. Therefore, under this experimental condition or at least under similar conditions, sowing sugar beet at 17.5 cm plant spacing seems to be the optimum treatment for sugar beet yield and quality traits. However, under different environmental conditions and with different varieties Smit *et al.* (1995) mentioned that the model based on German trials suggests an optimum of about 90000 plants ha^{-1} (37500 plant fed^{-1}) for yield and quality of sugarbeet, though the yield differences between 75000 and 90000 plant ha^{-1} suggested by the model is no more than about 1% .

TABLE 2. Mean squares from analysis of variance with orthogonal polynomial partitioning of nitrogen and plant density treatments as well as their interaction for sugarbeet yield and some of its attributes during 2006/ 2007 and 2007/ 2008 seasons.

S.O.V	d.f	Harvest plant density/fed x10^3	Root fresh weight(kg)	Root yield (ton fed^{-1})	TSS	Sucrose%	Purity%	Extractable sucrose%	Sugar yield (ton fed^{-1})
2006 / 2007									
Nitrogen (N)	2	1.74	0.049**	39.75**	7.53**	7.47**	23.66**	13.48**	2.71**
Linear	1	3.41	0.097**	79**	13.94**	8.57**	1.61	2.35*	3.11**
Quadratic	1	0.07	0.002	0.51	1.11**	6.37**	45.71**	24.60**	2.28**
Density (D)	2	216.36**	0.227**	8.19**	0.72	1.32*	57.91**	19.14**	1.34**
Linear	1	432**	0.443**	16.25**	0.79	0.61	37.30*	12.5*	0.37
Quadratic	1	0.65	0.01*	0.13	0.66	2.04*	78.51**	25.71**	2.32**
N x D	4	1.84	0.002	5.95**	0.71*	6.16**	61.56**	29.27**	3.96**
2007 / 2008									
Nitrogen (N)	2	2.51	0.099**	129.61**	22.34**	19.91**	30.33*	24.39**	5.71**
Linear	1	1.36	0.197**	258.60**	38.37**	24.01**	2.25	7.45	9.20**
Quadratic	1	3.64	0.002	0.40	6.22*	15.82**	58.32**	41.33**	2.22*
Density (D)	2	272.84**	0.160**	0.20	0.40	2.56**	49.77**	20.83**	1.84**
Linear	1	544.5**	0.305**	0.02	0.72	1.36*	53.26**	20.23**	2.27**
Quadratic	1	1.16	0.01**	0.38	0.08	3.70**	46.24**	21.43**	1.41**
N x D	4	0.50	0.001	3.11*	0.88*	7.19**	66.58**	32.93**	3.59**

*, ** significant at the 0.05 and 0.01 probability levels, respectively.

TABLE 3. Sugar beet yield and some of its attributes as affected by nitrogen level in 2006/ 2007 and 2007/ 2008 seasons.

Nitrogen level (kg/fed)	Harvest plant density/fed x 10^3	Root fresh weight(kg)	Root yield (ton/fed)	TSS	Sucrose %	Purity%	Extractable sucrose%	Sugar yield (ton/fed)
2006 / 2007								
90	34.42	0.80	27.12	22.74	19.67	86.49	14.32	3.91
120	33.83	0.89	29.57	24.05	21.39	88.96	16.72	4.94
150	33.55	0.95	31.31	24.50	21.05	85.91	15.07	4.74
LSD at 0.05	n.s	0.08	1.28	0.27	0.11	1.04	0.45	0.27
2007 / 2008								
90	33.89	0.70	23.22	22.13	18.82	85.03	13.10	3.05
120	34.94	0.78	26.79	24.60	21.60	87.80	16.37	4.38
150	34.44	0.91	30.80	25.05	21.13	84.34	14.39	4.48
LSD at 0.05	n.s	0.04	1.57	0.73	0.51	2.98	1.70	0.68

n.s = non significant

TABLE 4. Sugar beet yield and some of its attributes as affected by planting density in 2006/ 2007 and 2007/ 2008 seasons.

Target plant density/fed	Harvest plant density/fed x 10^3	Root fresh weight(kg)	Root yield (ton/fed)	TSS	Sucrose %	Purity%	Extractable sucrose%	Sugar yield (ton/fed)
2006 / 2007								
35000	29.00	1.04	30.25	24.08	20.32	84.47	13.85	4.18
40000	34.00	0.87	29.40	23.54	21.09	89.53	16.75	4.94
46000	38.81	0.73	28.35	23.66	20.69	87.35	15.51	4.46
LSD at 5%	0.80	0.05	0.94	n.s	0.58	2.58	1.41	0.41
2007 / 2008								
35000	28.78	0.94	27.05	24.09	19.98	83.08	12.93	3.45
40000	34.72	0.77	26.77	24.01	21.04	87.57	15.88	4.29
46000	39.78	0.68	26.99	23.69	20.53	86.52	15.05	4.16
LSD at 0.05	0.63	0.03	n.s	n.s	0.48	1.85	1.06	0.37

Effect of interaction

The interaction of nitrogen level x planting density was significant for all yield and quality measurements in both seasons, with the exception of harvested plant density and root fresh weight (Table 2). The consistent nitrogen x planting density interaction suggests that adjustments in nitrogen level were needed for each plant density. At each plant density, root yield was increased with increasing nitrogen level, but this increase was notable under high plant density rather than low plant density (Table 5). Total soluble solids (TSS), sucrose content, purity and extractable sucrose were decreased with increasing plant density from 35000 to 46000 plant under the low level of nitrogen (90 kg N fed^{-1}). This effect may be due to decreasing growth rate of plants under the low level of nitrogen particularly at high planting density and lower residual soil N (Table 1). While with high level of nitrogen (150 kg fed.$^{-1}$), all quality measurements were increased with increasing planting density in both season. This increase in quality readings may be due to decreasing in brei juice impurities (Lauer, 1995; Kemp *et al.*, 1996; El- Geddawy *et al.*, 2006 and Ismail & Allam, 2007). However, application of 120 kg N fed^{-1} with 40000 plant fed^{-1} was recommended for sucrose content (22.03, 22.33%) and extractable sucrose (18.39, 17.70%) in the first and second season, respectively. Data averaged over season indicated that root yield increased linearly with increasing N levels at each plant density (Fig.1). A maximum extractable sucrose of 16.53, 18.14 and 19.52 % could be obtained at predictable nitrogen levels of 107, 128 and 174 kg N fed^{-1} with planting density of 35000, 40000 and 46000 plants fed^{-1}, respectively (Fig. 2). Plant population of 40000 plants fed^{-1} was recommended for sugar yields in both season, but with nitrogen level of 120 and 150 kg N fed^{-1} in the first and second season, respectively (Table 5). Over seasons, a maximum sugar yield of 4.85, 5.80 and 6.72 ton fed^{-1} could be obtained at predictable nitrogen levels of about 112, 141 and 228 kg N fed^{-1} with plant population of 35000, 40000 and 46000 plants fed^{-1}, respectively (Fig. 3). Therefore optimum amounts of nitrogen fertilizer should be defined for each planting density for having the maximum balanced top and root growth, and hence maintaining sufficiently high sucrose percentage and purity for profitable sucrose extraction and yield.

TABLE 5. Effect of the interaction of nitrogen level and plant density on sugar beet yield and some of its components in 2006/ 2007 and 2007/ 2008 seasons.

Nitrogen level (kg/fed)	Target plant density/fed	Harvest plant density/fed x 10^3		Root fresh weight(kg)		Root yield (ton/fed)		TSS	
		2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08
90	35000	30.33	28.33	0.97	0.85	29.49	24.03	23.52	22.80
	40000	34.50	34.50	0.78	0.67	26.91	23.11	22.53	22.12
	46000	38.42	38.83	0.65	0.58	24.97	22.51	22.17	21.47
120	35000	28.33	29.00	1.08	0.95	30.60	27.39	24.20	24.67
	40000	34.17	35.33	0.87	0.75	29.73	26.53	24.07	24.97
	46000	39.00	40.50	0.73	0.65	28.38	26.46	23.88	24.17
150	35000	28.33	29.00	1.08	1.03	30.67	29.74	24.53	24.80
	40000	33.33	34.33	0.95	0.89	31.56	30.67	24.03	24.93
	46000	39.00	40.00	0.81	0.80	31.69	31.99	24.93	25.43
LSD at 0.05		n.s	n.s	n.s	n.s	1.63	1.51	1.21	0.99

TABLE 5. Cont.

Nitrogen level (kg/fed)	Target plant density/fed	Sucrose%		Purity%		Extractable sucrose%		Sugar yield (ton/fed)	
		2006/07	2007/08	2006/07	2007/08	2006/07	2007/08	2006/07	2007/08
90	35000	20.70	19.87	88.11	87.14	15.77	14.75	4.65	3.55
	40000	19.67	18.80	87.30	85.00	14.66	13.06	3.94	3.02
	46000	18.63	17.80	84.06	82.95	12.54	11.49	3.13	2.59
120	35000	21.20	21.27	87.62	86.23	15.97	15.38	4.89	4.21
	40000	22.03	22.33	91.55	89.45	18.39	17.70	5.46	4.69
	46000	20.93	21.20	87.71	87.73	15.79	16.03	4.47	4.24
150	35000	19.07	18.80	77.69	75.86	9.80	8.66	3.01	2.60
	40000	21.57	22.00	89.74	88.27	17.21	16.88	5.43	5.17
	46000	22.50	22.60	90.29	88.88	18.20	17.64	5.77	5.66
LSD at 0.05		1.01	0.83	4.47	3.20	2.44	1.84	0.70	0.64

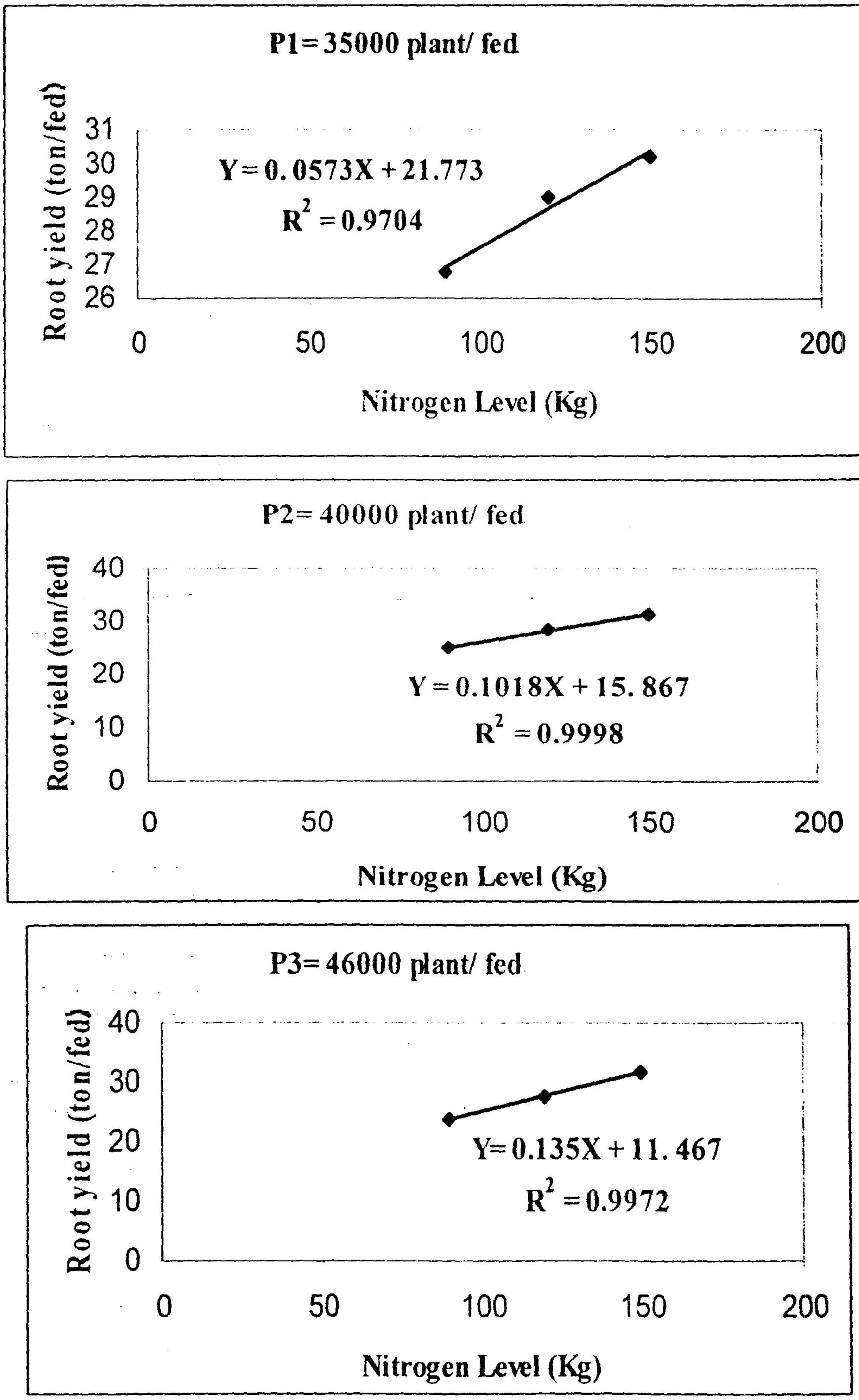

Fig. 1. Relationship between nitrogen level and root yield at each plant density (Pi) when data are combined over years.

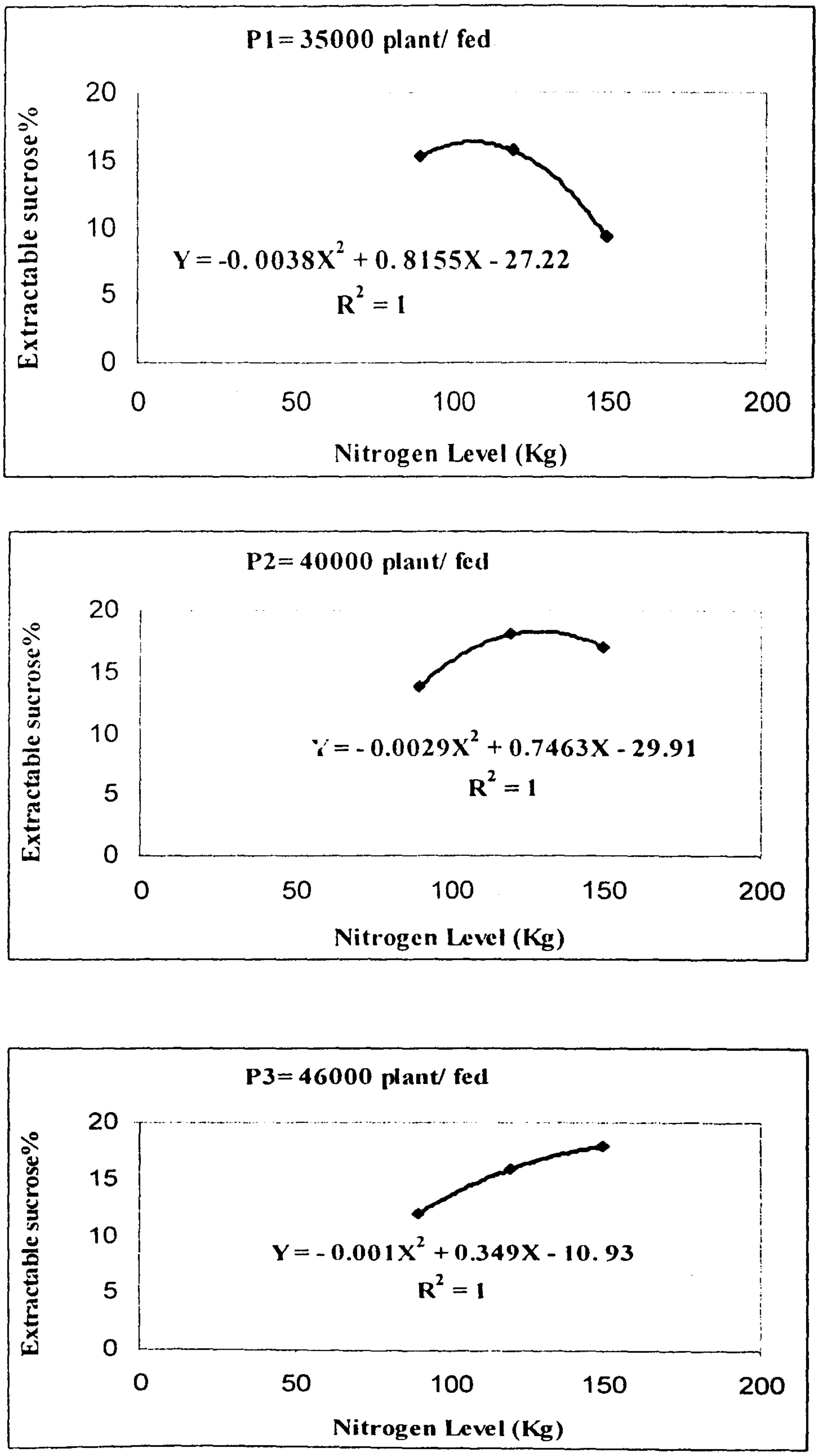

Fig. 2. Relationship between nitrogen level and extractable sucrose at each plant density (Pi) when data are combined over years.

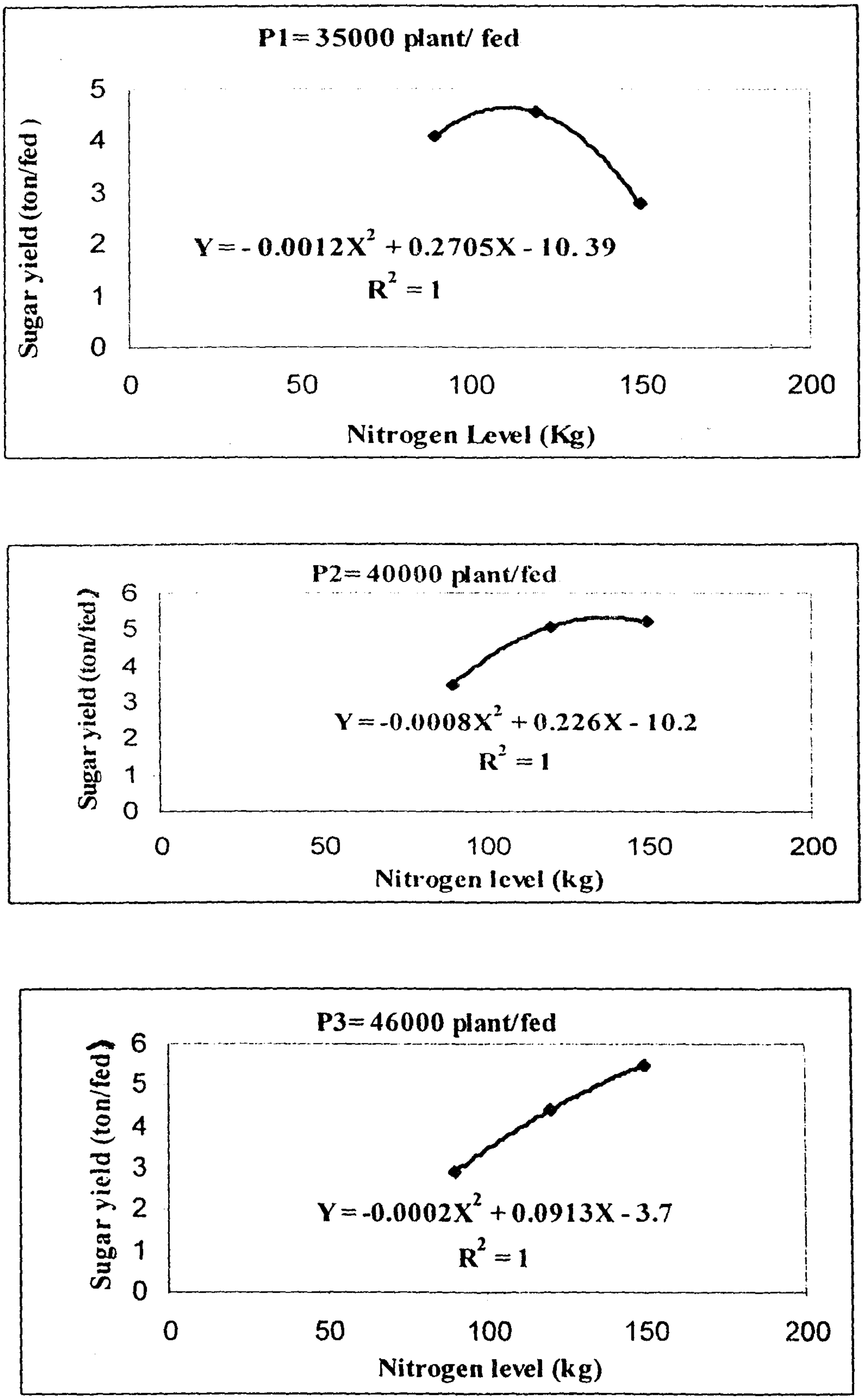

Fig. 3. Relationship between nitrogen level and sugar yield at each plant density (Pi) when data are combined over years.

References

Arita, T., Kajiyama, T. and Tezuka, M. (1998) Effect of increased plant population by narrow row width (50cm) on directly sown sugarbeet. *Bull. Hokkaido Prefectural Agric. Exp. Stat.* 77, 23-26.

Association of Official Analytical Chemists (1975) *"Official Methods of Analysis"*. 12[th] ed. Washington, D.C.

Carter, J. N., Westermann, D. T. and Jensen, M. E. (1976) Sugar beet yield and quality as affected by nitrogen level. *Argon J.* **68**, 49 –55.

Dexter, S. T., Frankes, M. G. and Snyder, F.W. (1967) A rapid and practical method of determining of extractable white sugars as may be applied to the evaluation of agronomic practices and grower deliveries in the sugar beet industry. *J. Am. Soc. Sugar Beet Technol.* **14**, 433 – 454.

EL-Geddawy, I. H., EL-Shafai, A. M. A. and Azzazy, A.B. (2006) Yield and quality of some sugar beet varieties as affected by planting densities and nitrogen fertilization. *J. Agric. Sci. Mansoura Univ.* **31** (1). 43 – 54.

EL- Hinnawy, H.H., Ramadan, B. S. H. and Mahmoud, E.A. (1998) Response of sugar beet to nitrogen fertilization levels and its time of application. *J. Agric. Sci. Mansoura Univ.* **23** (3), 969 – 978.

Gomez, K.A. and Gomez, A.A. (1984) *"Statistical Procedures for Agricultural Research"*. 2[nd] ed. John Wiley & Sons. New York.

Halvorson, A. D., Hartman, G. P., Cole, D. F., Haby, V. A. and Baldridge, D. E. (1978) Effect of N fertilization on sugarbeet crown tissue production and processing quality. *Agron. J.* **70**, 876-880.

Hills, F.J. and Ulrich, A. (1971) Nitrogen nutrition. In: *"Advances in Sugar Beet Production : Principles and Practices"*. p. 111- 135. Iowa State Univ. Press, Ames, Iowa, USA.

Hofer, H., Vullioud, P. and Walther, U. (1979) The infuence of nitrogen fertilization on yield and quality of sugar beet at different stand densities. (In German.) *Mitt. Schweiz. Landwirtsch.* **27**, 113 – 128.

Ismail, A. M. A., and Allam, S. M. (2007) Yield and technological traits of sugar Beet as affected by planting density, phosphorus and potassium fertilization. *Proc. the 3[rd] Conf. of Sustain.* Agric. Develop. Fac. Agric. Fayoum Univ., pp.15- 28.

Kemp, P. D., Khani, A. M. and Millner, J. P. (1996) The effect of plant population and nitrogen level on sugar yield and juice purity of sugar beet (*Beta vulgaris* L.) *Proc. Annl Conf. Agron. Soc.* New Zealand., **24**, pp. 131 – 134.

Lauer, J. G. (1995) Plant density and nitrogen rate effects on sugar beet yield and quality early in harvest. *Agron. J.* **87**, 586 – 591.

Leilah, A. A., Badawi, M. A. and Said, E. M. (2005) Effect of planting dates, plant population and nitrogen fertilization on sugar beet productivdity under the newly reclaimed sandy soils in Egypt. *Scientific J. of King Faisal (Basic and Appl. Sci.).* **6**, 95 – 110.

Mahmoud, E. A., El-Metwally, M. A. and Gobarh, M. E. M. (1999) Yield and quality of some multigerm sugar beet as affected by plant densities and nitrogen levels. *J. Agric. Sci. Mansoura Univ.* **24** (9), 4499- 4516.

Minx, L. (1993) The effect of row spacing on the productive utilization of distances between plants by the sugar beet stand. *Rostlinna Vyroba.* **39** (b), 531 – 541.

Reuss, J. O. and Rao, P. S. C. (1971) Soil nitrate nitrogen levels as an index of nitrogen fertilizer needs of sugarbeet. *J. Am. Soc. Sugar Beet Technol.* **16**, 461-470.

Smit, A. B., Struik, P. C. and Van Niejenhuis, J. H. (1995) Modelling the influence of plant density on yield, sugar content and extractability of sugar beet. *Proc. 58th IIRB Winter Congress.* pp. 403 – 412.

Smith, G. A. and Martin, S.S. (1977) Effects of plant density and nitrogen fertility on purity components of sugar beet. *Crop Sci.* **17**, 469 – 472.

Sultan, M.S., Attia, A.N., Sharief, A. E., Ibrahim, M.A. M. and Emara, T.K. (1996) Role of plant population and water quality on productivity of sugar beet in North Nile Delta. *Proc.* 7th. *Conf. Agron.* Mansoura. 9 – 10 Sept., **2**, pp. 525 – 529.

Zielke, R. C. (1973) Yield, quality, and sucrose recovery from sugarbeet root and crown. *J. Am. Soc. Sugar Beet Technol.* **17**, 332-344.

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تأثير مستوى النيتروجين والكثافة النباتية على المحصول ومكوناته فى بنجر السكر

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أجريت تجربتان حقليتان فى منطقة هوارة بمحافظة الفيوم خلال موسمى ٢٠٠٦ / ٢٠٠٨ لدراسة تأثير ثلاث كثافات زراعية هى: ٣٥٠٠٠، ٤٠٠٠٠ و ٤٦٠٠٠ نبات/ فدان نتجت من ترك مسافة ٢٠، ١٧,٥ و ١٥ سم بين الجور على خطوط متباعدة ٦٠ سم على التوالى مع ثلاث مستويات أزوت هى: ٩٠، ١٢٠ و١٥٠ كجم ن/ فدان على محصول الجذور والسكر وبعض مكوناتهما فى بنجر السكر. وقد استخدم الصنف كاوميرا والذى تمت زراعته فى ١٥ أكتوبر فى موسمى الدراسة. وتم الحصاد بعد ٢١٠ يوم من الزراعة وقد استخدم تصميم القطع المنشقة فى ثلاث مكررات بحيث شغلت مستويات الأزوت القطع الرئيسية بينما شغلت الكثافة النباتية القطع المنشقة والمكونة من ٥ خطوط بطول الخط ٤ م ومتباعدة ٠,٦ م.

أظهرت نتائج الدراسة أن جميع الصفات تحت الدراسة فيما عدا عدد النباتات عند الحصاد قد تأثرت معنويا بزيادة مستوى الأزوت في كلا الموسمين . وقد استجاب كل من متوسط وزن الجذر ومحصول الجذور للفدان استجابة خطية بالزيادة مع زيادة معـدل الازوت. وأوضحت النتائج أن اضافة الأزوت بمعدل ١٢٠ كجم/ فدان يعتبر المستوى المثالى لصفات نسبة السكر فى العصير، النقاوة، نسبة السكر المستخلص، محصول السكر للفدان فى كلا الموسمين. ومن ناحية أخرى أدت زيادة الكثافة الزراعية من ٣٥٠٠٠ إلى ٤٠٠٠٠ نبات ومن ٤٠٠٠٠ إلى ٤٦٠٠٠ نبات إلى حدوث انخفاض معنوى فى متوسط وزن الجذر بنسبة ١٦,٣٥٪ ، ١٦,٠٩٪ فى الموسم الأول و بنسبة ١٨,٠٩٪ ، ١١,٦٩٪ فى الموسم الثانى على التوالى. وقد لوحظ نفس الأتجاه مع محصول الجذور للفدان حيث انخفض بنسبة ٢,٨٪ ، ٣,٦٪ فى الموسم الأول مع ملاحظة عدم وجود فرق معنوى بين ٣٥٠٠٠ و ٤٠٠٠٠ نبات بينما لم يكن للكثافة الزراعية أى تأثير معنوى على محصول الجذور فى الموسم الثانى. من ناحية أخرى أدت زيادة الكثافة الزراعية من ٣٥٠٠٠ إلى ٤٠٠٠٠ نبات إلى حدوث زيادة معنوية فى كل من نسبة السكر فى العصير بنسبة ٣,٨٪ والنقاوة بنسبة ٦٪ و نسبة السكر المستخلص بنسبة ٢٠,٩٪ و محصول السكر للفدان بنسبة ١٨,٢٪ فى الموسم الأول بينما كانت هذه النسب ٥,٣٪ ، ٥,٤٪، ٢٢,٨٪ و١٤,٣٪ فى الموسم الثانى بنفس الترتيب ، وعلى العكس أدى ارتفاع الكثافة الزراعية إلى ٤٦٠٠٠ نبات إلى حدوث انخفاض غير معنوى فى صفات الجودة ومحصول السكر مقارنة بالكثافة الزراعية ٤٠٠٠٠ فيما عدا نسبة السكر فى الموسم الثانى ومحصول السكر فى الموسم الأول حيث كان الأنخفاض معنويا. وقد أدى زيادة معدل الأزوت عند كل كثافة زراعية إلى حدوث زيادة فى محصول الجذور ولكن هذه الزيادة كانت

ملحوظة أكثر عند الكثافة الزراعية العالية. وتبين أن اضافة الأزوت بمعدل ١٢٠ كجم/ فدان يعتبر المستوى المثالى لصفات نسبة السكر فى العصير (٢٢,٠٣٪، ٢٢,٣٣٪) و نسبة السكر المستخلص (١٨,٣٩ ٪ و ١٧,٧٠٪) فى الموسم الأول والثانى على التوالى. ويمكن اعتبار أن الكثافة الزراعية ٤٠٠٠٠ نبات مع ١٢٠ كجم وحدة أزوت فى الموسم الأول ومع ١٥٠ كجم وحدة أزوت فى الموسم الثانى هى المعاملة المثلى بالنسبة لمحصول السكر للفدان . وبغض النظر عن المواسم فأن أقصى محصول متوقع من السكر يمكن الحصول عليه تحت مستويات أزوت ١١٢ ، ١٤١ ، ٢٢٨ كجم ن/ فدان عند كثافة زراعية ٣٥٠٠٠ ، ٤٠٠٠٠ و ٤٦٠٠٠ هو: ٤,٨٥، ٥,٨٠ و ٦,٧٢ طن/ فدان على التوالى.