

EFFECT OF NITROGEN FERTILIZATION AND LAST IRRIGATION ON YIELD AND QUALITY OF SUGAR BEET (*Beta vulgaris* L.) IN NORTHERN DELTA

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ABSTRACT

Two field experiments were carried out at the Experimental Farm of EL-Serw Agricultural Station, Dommia Governorate, Agricultural Research Center, Egypt during the two successive seasons of 2006/07 and 2007/08. The aim of this investigation was to study the effect of nitrogen levels at rates of (80, 100 and 120 kg N/fed) and three withholding irrigation dates of the last irrigation (3, 4 and 5 weeks before harvest) on yield and quality of sugar beet.

The results showed that:

- 1- There is a significant effect of nitrogen fertilizer levels on root diameter, root fresh weight, purity %, root and sugar yields (t/fed) in both seasons and significant for sucrose percentage in the second season, TSS% in the first season while it is an insignificant effect for root length in both seasons. The treatment of 120 kg N/fed increased root yield by 64.157% and 25.78% and sugar yield by 53.23% and 21.25% compared by addition of 80 kg N/fed in both seasons.
- 2- Effect of withholding last irrigation was significant for root length, sucrose percentage, sugar yields in both seasons and significant effect on root fresh weight in the second season and root yield in the first season and insignificant effect on purity percentage in both seasons. Applying the irrigation 5 weeks before harvest gave the lowest root length, root fresh weight and the lowest root and sugar yields while it gave the highest sucrose and purity percentages in both seasons.
- 3- The interaction between nitrogen fertilizer levels and withholding of last irrigation was significant for root length and root fresh weight in the second season, TSS% in the first season and sucrose percentage in both seasons, but it was an insignificant effect on root diameter, root and sugar yields in both seasons.
- 4- From this study we can advise to use nitrogen fertilization at a rate of 120 kg/fed and date of last irrigation 4 weeks before harvest to obtain the maximum yield and quality of sugar beet in East Northern Delta.

INTRODUCTION

Recently sugar beet has become an important source for sugar in Egypt. Sugar beet is the second sugar crop in Egypt after sugarcane, meeting the increase in sugar consumption in Egypt and difficulty in extending area under sugar cane in upper Egypt. In addition sugar beet can be grown in northern part of the country in the new cultivated area.

Nitrogen appears to have the most pronounced effect on plant growth and development. It usually increases root yield but decreases sucrose percentage. Thus management strategies must aim to an optimization of maximum sugar yield. Ibrahim, *et al.* (2005) found that increasing nitrogen levels from 60 up to 120 kg N/ fed resulted in significant increases in root length, root diameter, root weight as well as root and sugar yields per feddan,

total soluble solids (TSS%), sucrose and purity in both seasons. Ramadan (2005) found that the highest root yield (30.4ton/fed) resulted from adding 120 kg N/fed. while The highest recoverable sugar yield (3.73 and 3.80 ton/fed) resulted from 90kg N/fed) In both seasons, respectively .

Shalaby (1998) found that withholding irrigation periods (10,17,24 and 31 days) before harvest had no significant effect on root length ,the highest values of top fresh weight /plant was obtained in case of stopping irrigation 17 days before harvest .Root fresh weight showed gradual decrease as the period of no irrigation was prolonged from 0 to 17, 24 or 31 days before harvest ,sucrose and total soluble solids percentage were increased significantly as the period of withholding irrigation was prolonged from 10 to 31 days before harvest . Purity percentage had the same trend with no significant difference between 10 and 17 days of stopping irrigation on this trait. Period of no irrigation 10 days before harvest recorded the highest root yield t/fed compared by 17 and 31 days. With holding irrigation periods (21 or 31 days before harvest produced The maximum sugar yield. Bailey (1990) and Rayan *et al.* (1999) found that preventing irrigation 2-week before harvest resulted in a significant increase in root yield in both seasons. The highest values of sucrose % were obtained from beets received the last irrigation 4 weeks before harvest in both seasons. Meanwhile, withholding irrigation 2 weeks before harvest resulted in producing beets contained the lowest sucrose %,the highest values of TSS% was obtained by applying last irrigation 6 weeks before harvest ,the maximum root yield was found when sugar beet received last irrigation two weeks before harvest . Applying the last irrigation 4 weeks before harvest insignificantly produced higher sugar yield compared with 2 weeks before harvest.

The aim of this investigation to study the effect of nitrogen levels and withholding irrigation dates of the last irrigation before harvest on yield and quality of sugar beet cv .Sultany.

MATERIALS AND METHODS

Two field experiments were carried out at Al-Serw Agricultural Research Station, Agricultural Research Center ,Egypt during 2006/2007 and 2007/2008 seasons to study the effect of nitrogen fertilizer levels (80,100 and 120 kg N/fed) and three withholding irrigation dates of the last irrigation (3,4 and 5weeks before harvest) and their interaction on yield and quality of sugar beet cv. Sultan. A split plot design with four replications was adopted . The main plots were occupied by nitrogen fertilizer levels (80,100and 120 kg N/fed) while the sub plots were occupied with three withholding irrigation dates of the last irrigation (3,4 and 5weeks before harvest)

Each experimental basic unit (sub-plot) included 5 ridges, each of 60 cm width and 3.5 m length, resulted an area of 10.5 m² (1/400 fed). The preceding summer crop was Rice (*Oryza sativa* L.) in both seasons.

The soil of the experimental site was clay loam and its physical and chemical properties which measured by using the method described by Jackson (1967) and the results shown in table 1.

Table 1: Mechanical and chemical analysis of the experimental site for

Mechanical and chemical analysis	Seasons	
	2006/2007	2007/2008
Clay%	63.2	63.1
Silt%	21.7	21.6
Sand%	13.3	13.5
Organic matter%	1.8	1.8
Available N(ppm)	52.0	50.3
Available P(ppm)	16.3	15.2
AvailableK (ppm)	37.7	36.7
CaCO ₃ %	1.9	2.5
pH	8.0	8.1

Seed –balls were hand sown as the usual dry method of sowing on one side of the ridges 20cm between hills at the first week of November in both seasons. Plants were thinned to one plant /hill after 5 weeks from planting.

Calcium super phosphate (15.5 % P₂O₅) at the rate of 100kg/fed was added before last tillage and potassium in the form of potassium sulphate (48%K₂O) at the rate of 100 kg/fed was added at the first irrigation .Nitrogen in the form of Urea (46%N) at the above mentioned rates was added in the two equal portions, before the second and third irrigations. The recommendations of ARC for sugar beet production (except the studied factors) were performed.

At maturity ,ten guarded plants were taken at random from each sub-plot to estimate the following characteristics :-

- 1- Root diameter (cm)
- 2- Root length (cm)
- 3- Root fresh weight/plant (g)
- 4- TSS %: Total soluble solids was determined by hand refractometer .
- 5- Sucrose %:It was determined plorametricaly on lead acetate extract of fresh macerated root according to the method as described by Le Docte (1927) .
- 6- Purity percentage: It was calculated according to the following equation:

$$\text{Purity \%} = \text{Sucrose\%} \times 100/\text{T.S.S\%}$$
- 7- Root yield (t/fad) was estimated on the hole plot basis.
- 8- Sugar yield (t/ fad) was calculated according to the following equation :

$$\text{Sugar yield} = \text{Root yield} \times \text{Sucrose \%}$$

Data were subjected to analysis of variance (Anova) for the split –plot design as described by Gomez and Gomez (1984): Least significant difference (LSD) method was used to test the differences between treatment means at 5% .level of probability as described by Waller and Duncan (1969)

RESULTS AND DISCUSSION

The obtained results of yield and its components as well as sugar quality as influenced by N-fertilizer level ,last irrigation and their interaction in 2006/07 and 2007/08 seasons could be discussed as follows:

Effect of nitrogen fertilization levels :

Means of root diameter and length (cm) as well as root fresh weight (g) of sugar beet plants as affected by nitrogen fertilization levels are presented in Table 2. Raising nitrogen levels from 80 to 120 kg N/fed significantly increased root diameter by 5.81 and 22.43%, root fresh weight by 57.61 and 55.87% as compared with 80 kg N/fed in both seasons, however there were insignificant effect due to application of nitrogen fertilization on root length of sugar beet plants in both seasons .

Table 2: Effect of nitrogen levels and dates of last irrigation on root diameter, root length and root fresh weight of sugar beet during 2006/07 and 2007/08 seasons.

Characters		Root diameter cm		Root length cm		Root fresh weight g/plant	
		2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008
Nitrogen fertilization	A1 80 kgN/fed	10.33	7.40	22.82	22.91	531.69	604.42
	A2 100 kgN/fed	10.29	9.97	22.73	22.83	747.44	880.00
	A3 120 kgN/fed	10.93	9.06	24.25	24.34	837.98	942.12
F.Test		*	*	NS	NS	*	*
LSD 0.05		0.55	1.51	—	—	10.25	12.45
Withholding irrigation	B1: 3 weeks	10.88	9.02	24.00	24.10	635.61	872.69
	B2 : 4 weeks	10.85	8.78	23.23	23.24	760.62	803.72
	B3 : 5 weeks	9.82	8.63	22.57	22.74	720.88	750.13
F.Test		NS	NS	*	*	NS	*
LSD 0.05%		—	—	0.93	0.90	—	13.52
A X B Interaction		NS	NS	NS	*	NS	*

Data tabulated in Table 3 show that raising nitrogen levels from 80 to 120 kg N/fed recorded a decrease in sucrose percentage.

Table 3: Effect of nitrogen levels and dates of last irrigation on sucrose %, Total soluble solids % and Purity % of sugar beet during 2006/07 and 2007/08 seasons

Characters		Sucrose %		Total soluble solids%		Purity%	
		2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008	2006/ 2007	2007/ 2008
Nitrogen fertilization	A1 80 kg N/fed	17.26	17.14	20.17	21.43	85.57	79.98
	A2 100 kgN/fed	17.37	16.59	20.73	21.80	83.79	76.10
	A3 120 kg N/fed	16.28	16.52	21.47	22.04	80.34	74.95
F.Test		NS	*	*	NS	*	*
LSD0.05		—	0.17	0.69	—	3.59	2.52
Withholding irrigation	B1: 3 weeks	16.25	16.72	20.54	21.34	83.69	78.35
	B2 : 4 weeks	17.19	16.89	20.90	21.96	82.54	76.91
	B3 : 5weeks	17.47	16.64	20.93	21.97	83.47	75.74
F.Test		*	*	NS	*	NS	NS
LSD0.05%		0.10	0.08	—	0.55	—	—
A X B interaction		*	*	*	NS	NS	NS

Treatment of 120 kg N/fed decreased sucrose% by 3.62% as compared with treatment of 80 kg N/fed in the second season, while there is insignificant effect of this trait in the first season. Addition of 120 kg N/fed significantly decreased TSS% by 21.47 % as compared with 80 kg N/fed in the first season, there is significant effect due to nitrogen fertilization on purity percentage in both seasons. The highest purity % was obtained with using of 80 kg N/fed, the results were 85.57% and 79.98% in both seasons.

Raising nitrogen levels from 80 to 120 kg N/fed increased root yield by 64.16 and 25.78% as compared with addition 80 kg N/fed in both seasons as shown in Table 8. This can be easily described to the role of nitrogen in activating growth of sugar beet plants and increasing root weight. Similar observation were reported by Shalaby (1998), Ismail (2002) and Nemeat Alla *et al.* (2002). Also increasing nitrogen levels from 80 to 120 kg N/fed increased sugar yield with 53.23% and 21.25% compared by addition 80 kg N/fed in both seasons. This can be easily described to the role of nitrogen in activating of growth of sugar beet plants and increasing root yield Shalaby (1998), Ismail (2002), Nemeat Alla *et al.* (2002) Ramadan (2005) found that The highest recoverable sugar yield (3.73 and 3.80 ton/fed) resulted from 90kg N/fed. This can be easily described to the role of nitrogen in activating of growth of sugar beet plants and increasing root weight This may be attributed to the favourable effect of nitrogen fertilizer levels on the metabolic processes and physiological activities of meristemic tissues, which are responsible for cell division and elongation in addition to the formation of plant organs. This leads to more growth and consequently accumulation of more photosynthesis assimilates. Similar observation were reported by Shalaby (1998), Ismail (2002) and Nemeat Alla, *et al.* (2002).

Effect of date of last irrigation on sugar beet:

Data listed in Table 2 show that date of last irrigation significantly affected root length in both seasons, root fresh weight in the second season. The highest values of root length 24.00 and 24.10 cm were obtained with last irrigation at 3 weeks before harvest. However, the lowest values 22.57 and 22.74cm were found at last irrigation 5 weeks before harvest. Similar results were found by Bailey (1990) and Rayan *et al.* (1999). The highest values of root fresh weight 872.69 g were obtained with last irrigation at 3 weeks before harvest where the lowest root fresh weight 750.13 g were obtained with the last irrigation at 5 weeks before harvest.

The date of last irrigation significantly affected sucrose percentage. The highest sucrose percentages 17.47 % was obtained with last irrigation at 5 weeks before harvest ,while the lowest ones 17.19% was found at 3 weeks before harvest in the first season . Shalaby (1998), Bailey (1990) and Rayan *et al.* (1999) found that the highest values of sucrose % were obtained from beets received the last irrigation 4 weeks before harvest .Table 3 show that the date of last irrigation significantly affected Total soluble solids percentage .The highest total soluble solids percentage 21.97 % was obtained with last irrigation at 5 weeks before harvest ,while the lowest ones 21.34% was found at 3 weeks before harvest. Data listed in Table 3 show that the date of last irrigation insignificantly affected purity percentage in both seasons.

Table 4 show that date of last irrigation significantly affected root yield, the highest values of root yield(27.34 t/fed was obtained with last irrigation at 3 weeks before harvest however the lowest ones.(25.14) was found at 5 weeks before harvesting both seasons. Shalaby (1998) attained these results.The date of last irrigation significantly affected sugar yield, the highest values of sugar yield 4.69 t/fed were obtained with last irrigation at 3 weeks before harvest in the first season . Shalaby (1998) attained these results.

Table 4: Effect of nitrogen levels and dates of last irrigation on root and sugar yields of sugar beet during 2006/07and 2007/08 seasons

Characters		Root yield t/ fed		Sugar yield t/ fed	
Treatments		2006/2007	2007/2008	2006/2007	2007/2008
Nitrogen fertilization	A1: 80 kgN/fed	18.62	19.98	3.25	3.42
	A2: 100 kgN/fed	29.79	24.52	5.17	4.07
	A3: 120 kgn/fed	30.57	25.13	4.98	4.15
F.Test		**	*	**	*
LSD 0.05		2.54	1.58	0.48	0.32
Withholding last irrigation	B1: 3 weeks	27.34	28.33	4.69	3.32
	B2 : 4 weeks	26.50	25.18	4.57	4.25
	B3 : 5weeks	25.14	16.12	4.39	4.07
F. Test		**	NS	**	*
LSD 0.05%		0.80	—	0.15	0.25
A X B Interaction		NS	NS	NS	NS

Table 5: Effect of the interaction between nitrogen levels and dates of last irrigation on root length during 2007/2008 season.

Treatment	2007/2008		
	Date of last irrigation		
	3 weeks	4 weeks	5weeks
80kgN/fed	23.03	23.30	22.40
100 kgN/fed	21.53	23.07	23.90
120kgN/fed	24.67	23.37	24.97
F.test	*		
LSD5%	1.56		

3-Interactions effect:

The interaction between nitrogen fertilization and date of last irrigation on root fresh weight was significant in the second season. The highest values of root fresh weight was 986.300 g was obtained as interaction between nitrogen fertilizer at rate of 120 kg N/fed and withholding of last irrigation at 3 weeks before harvest (Table 6).

The highest values of sucrose% 17.23% and 17.14% were obtained from the interaction between treatment of nitrogen fertilizer at rate of 80kgN/fed and withholding of last irrigation at 5 weeks before harvest (Table 7).

The maximum TSS% was 21.70 % was resulted from interaction between 120kg /fed and withholding and last irrigation 5 weeks before harvest (Table 8).

Table 6: Effect of the interaction between nitrogen levels and dates of last irrigation on root fresh weight during 2007/2008 season.

Treatment	2007/2008		
	Date of last irrigation		
	3 weeks	4 weeks	5weeks
80 kgN/fed	489.70	553.37	770.20
100 kgN/fed	884.40	894.03	861.57
120 kgN/fed	986.30	963.77	876.30
F.test	*		
LSD5%	16.21		

Table 7: Effect of the interaction between nitrogen levels and dates of last irrigation on sucrose percentage of sugar beet during 2006/2007 and 2007/2008 seasons.

Treatment	2006/2007			2007/2008		
	3 weeks	4 weeks	5weeks	3 weeks	4 weeks	5weeks
80kgN/fed	16.20	16.16	17.47	16.60	17.20	17.07
100 kgN/fed	17.17	16.70	17.50	16.50	16.80	16.47
120kgN/fed	17.23	17.10	17.20	17.14	16.67	16.30
F. test	*			*		
LSD 5%	0.17			0.14		

Table 8: Effect of the interaction between nitrogen levels and dates of last irrigation on total soluble solids of sugar beet during 2006/2007 season.

Treatments	2006/2007		
	Date of last irrigation		
	3 weeks	4 weeks	5 weeks
80kgN/fed	20.37	19.80	20.33
100 kgN/fed	19.93	21.20	21.04
120kgN/fed	21.31	21.43	21.70
F.test	*		
LSD 5%	0.62		

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تأثير التسميد النيتروجيني وميعاد الريه الأخيرة قبل الحصاد على محصول وجودة
بنجر السكر
السيد حسن حسن سليم ، محمد علي الدسوقي عبده ، حازم محمود سرحان و
داليا ابراهيم حنفي الجداوي
قسم بحوث المعاملات- معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية- الجيزة- مصر

أقيمت تجربتان حقليتان في محطة بحوث السرو بمحافظة دمياط في الموسمين
٢٠٠٦/٢٠٠٧ و ٢٠٠٧/٢٠٠٨ لدراسة تأثير معدلات التسميد النيتروجيني (٨٠، ١٠٠ و ١٢٠ كجم
نيتروجين / فدان) وثلاث مواعيد لآخر رية قبل الحصاد (٣، ٤، ٥ أسابيع) على المحصول والجودة في
بنجر السكر الصنف سلطاني
وكانت النتائج المتحصل عليها:

- ١- كان هناك تأثير معنوي للتسميد النيتروجيني على قطر الجذر ووزن الجذر غرض والنسبة المئوية
للنقاوة ومحصول الجذور والسكر (طن/فدان) في كلا الموسمين والنسبة المئوية للمواد الصلبة
الذائبة في الموسم الأول وغير معنوي لطول الجذر في كلا الموسمين.
- ٢- أديا إضافة ١٢٠ كجم نيتروجين للفدان إلى زيادة محصل الجذور /فدان بحوالي ١٦، ٦٤،
٧٨٢، ٢٥% ومحصول السكر بحوالي (٢٣، ٥٣ و ٢١، ٢٣٢%) بالمقارنة بالمعاملة ٨٠ كجم
ازوت للفدان في كلا الموسمين.
- ٣- كان تأثير ميعاد آخر رية قبل الحصاد معنويا لطول الجذر ونسبة السكر ووزن الجذر ومحصول السكر في
كلا الموسمين ومعنويا لوزن الجذر غرض في الموسم الثاني ومحصول الجذور في الموسم الأول
وغير معنوي لنسبة النقاوة في كلا الموسمين.
- ٤- منع الري قبل الحصاد لمدة ٥ أسابيع أعطى أقل القيم لطول الجذر ووزن الجذر غرض واقل
محصول جذور وسكر بينما أعطى أعلى القيم لنسبة السكر ونسبة النقاوة % في كلا الموسمين.
- ٥- كان التفاعل بين معدل التسميد النيتروجيني وميعاد الريه الأخيرة قبل الحصاد معنوي لطول
الجذر ووزن الجذر غرض في الموسم الثاني ونسبة المواد الصلبة الذائبة في الموسم الأول
ونسبة السكر ووزن الجذر ووزن الجذور ومحصول الجذور والسكر في كلا
الموسمين.
- ٦- من هذه الدراسة نوصي باستخدام التسميد الأزوتي بمعدل من ١٢٠ كجم للفدان وأن يكون ميعاد
الريه الأخيرة ٤ أسابيع قبل الحصاد للحصول على أعلى محصول وجودة من بنجر السكر في
شمال شرق الدلتا .