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EFFECT OF SOURCE , RATE AND APPLICATION TIME OF NITROGEN FERTILIZER ON SUGAR BEET

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ABSTRACT

The present investigation was conducted at El-Hamoul area, Kafr El-Sheikh Governorate, Egypt during 2000/2001 and 2001/2002 seasons, to study the effect of three nitrogen sources (urea 46% N, ammonium nitrate 33.3%N and ammonium sulphate 20%N), two rates (60 and 90 kgN/fed) and three application time of nitrogen (All nitrogen rates of the three sources were applied at 40 or at 70 days from sowing and splitted into two equal half the first applied at 40 and the second at70 days after sowing)on growth, yield and quality of sugar beet, cultivar Top poly.The experiments were carried out in randomize complete block design in factorial arrangement with three replications.

The obtained results showed that the effect of nitrogen sources was significant on root length , root fresh weight, sucrose %, root yield/ fed and sugar yield /fed in both seasons. Ammonium nitrate gave the highest values of all previously mentioned traits as compared with other studied sources in both seasons.

The obtained results showed that the effect of nitrogen rates was significant on all studied traits in both seasons. Applied nitrogen fertilizer at the rate of 90 kgN/fed surpassed 60kgN/fed in all studied characters in both seasons.

The obtained results indicated that the effect of nitrogen application time was significant on all studied traits in both seasons, except sucrose% in 2001/2002 season. Splited nitrogen fertilizer into two equals half an added at 40 and 70 days from sowing gave the highest values of all studied traits in both seasons.

The results presented exhibited that all the interaction effects between the three studied factors were significant on root fresh weight in both seasons. The interaction effect among sources and application time of nitrogen and the interaction effect among rates and application time of nitrogen were significant on root and sugar yield/fed in both seasons.

INTRODUCTION

Sugar beet (*Beta vulgaris*, L.) ranks the second important sugar crop after sugar cane, producing annually 45% of sugar production all over the world. Recently, sugar beet has an important position in Egyptian crop rotation as a winter crop not only in the fertile soils, but also in poor, saline, alkaline and calcareous soils. The great importance of sugar beet crop is not only from it's ability to grown in the newly reclaimed areas as economic crop, but also for production higher of sugar under these conditions as compared with sugar cane, also it's productivity make it a good cash crop at this situation. The Egyptian Government encourages sugar beet growers to increase the cultivated area for decreasing the gap between sugar production and consumption. These increase is likely to be obtained by growing sugar beet crop in newly reclaimed soils. Most of these areas face some stress

problems ,i.e. salinity and unbalance nutrient elements. Attempts are made to increasing sugar beet productivity in newly reclaimed soils, one of these is to be applying the adequate fertilization. Nitrogen source , rate and time of application plays prominent role in raising sugar beet production.

Source of nitrogen application is important management tools in this respect because maximum nitrogen efficiency is obtained when nitrogen is applied in the form which is available for uptake by plant needed. Khedr and Nemeat_Alla (2006),El-Sheref (2007), Leilah *et al*. (2007), Abou-Shady *et al.* (2008) Allam (2009), El-Sarag (2009), and Nemat-Alla (2009), they reported that fertilized sugar beet by all nitrogen sources (ammonium nitrate , urea and sulphate ammonium) gave the highest values of root length, root fresh weight ,sucrose percentage , root yield / feddan and sugar yield /feddan.

Nitrogen is a major nutrient element and its needed in large amount for high yield of sugar beet and it considered the most factor affecting the growth and productivity of sugar beet. El-Hawary (1999), El-Geddawy *et al*. (2006), Stevens *et al.* (2008)and El-Sarag (2009), reprted that raising nitrogen fertilizer rate up to 120 kgN/fed increased of root length, root fresh weight ,sucrose percentage as well as root and sugar yield.

Mousa (2004), found that applying N fertilizer in three equal portions (before the first, second and third irrigation) increased sucrose %, root and, top yield/fed. Leilah *et al*. (2007), showed that sugar beet yield and quality (root fresh weight , root and sugar yield and sucrose%) were markedly affected by timing of N application.

The aim of the present investigation is to study the effect of nitrogen sources, nitrogen rate and time of application on sugar beet productivity at El-Hamoul area, Kafr El-Sheikh governorate, Egypt.

MATERIALS AND METHODS

The present investigation was conducted at El-Hamoul area, Kafr El-Sheikh Governorate, Egypt during 2000/2001 and 2001/2002 seasons, to study the effect of three nitrogen sources (urea 46% N, ammonium nitrate 33.3%N and ammonium sulphate 20%N), two rates (60 and 90 kgN/fed) and three application time of nitrogen (All nitrogen rates of the three sources were applied at 40 or at 70 days from sowing and splitted into two equal half the first applied at 40 and the second at70 days after sowing)on growth, yield and quality of sugar beet, cv. Top poly.

The experiments were carried out in randomized complete block design in factorial arrangement with three replications. The area of plot was 25.2 m^2 (6 rows x 0.6 m width x 7 m length). Soil samples were randomly taken from the experimental sites at depth of 0 to 30 cm from soil surface and were prepared for physical and chemical properties in 2000/2001 and 2001/2002 seasons. Physical and chemical properties of soil at the experimental sites in seasons are shown in Table (1). Sowing took place on 10 and 25 October in 2000/2001 and 2001/2002 seasons, respectively. The preceding crop was corn in both seasons. Seeds of multigerm sugar beet cultivar "Top Poly" were hand sown in hills with approximately 3-4 seed

balls/hill. Plants were thinned to one plants/hill after 35 days from sowing. Other cultural practices were done as recommended for sugar beet crop.
The collected data in the experiment involved the following traits:

Data recorded

1-Root length (cm)
2-Root fresh weight per plant (kg)
3-Sucrose percentage
4-Root yield per feddan (ton)
5-Sugar yield per feddan (ton), it was calculated from root yield /feddan multiplied by white sugar percentage.

Statistical Analysis

The analysis of variance was carried out according to Gomez and Gomez (1984). Treatment means were compared by Duncan's Multiply Rang Test (Duncan, 1955). All statistical analysis was performed using analysis of variance technique by means of "IRRISTAT" computer software package.

Table 1: Physical and chemical analysis of soil at the experimental sites in 2000/2001 and 2001/2002 seasons.

Variable	Seasons	
	2000/2001	2001/2002
Physical analysis		
Sand %	25.68	23.32
Silt %	23.74	23.99
Clay %	50.58	52.69
Texture class	Clayey	Clayey
Chemical analysis		
Soil reactions pH (1:7.5)	8.02	8.13
EC dS/m in soil paste	3.36	3.46
Organic matter%	2.01	2.22
Available N ppm	18.92	18.61
Available P ppm	7.05	7.14
Available K ppm	5.80	5.59
Soluble Cations meq/L:		
Ca^{++}	2.25	2.11
K^{+}	0.36	0.36
Na^{+}	7.55	7.42
Fe	1.80	1.69
Cu	0.60	0.72
Zn	0.46	0.38
Soluble anions meq/L		
HCO_3-	5.30	5.24
Cl-	7.71	7.56
SO_4-	0.27	0.30
CO_3-	0.0	0.0

RESULTS AND DISCSSION

Average root length (cm),root fresh weight (kg) , sucrose% , root and sugar yield/fed (ton) of sugar beet plants as affected by source, rate and application time of nitrogen fertilizer in 2000/2001 and 2001/2002 seasons are shown in Tables (2-3).

Table 2: Root length, root fresh weight and sucrose percentage of sugar beet cv. Top poly as affected by nitrogen source, N rate and N time of application in 2000/2001 and 2001/2002 seasons.

Treatments		Root length(cm)		Root fresh weight(kg)		Sucrose percentage	
		2000/2001	2001/2002	2000/2001	2001/2002	2000/2001	2001/2002
Source of nitrogen (S)		*	*	*	*	*	*
Urea		33.2 b	34.1 a	1.10 b	1.2 b	17.2 a	17.9 a
A. sulphate		33.0 b	33.1 b	1.0 b	1.1 b	16.4 b	17.0 b
A. nitrate		34.4 a	34.6 a	1.2 a	1.4 a	17.2 a	18.3 a
Rate of nitrogen (kg/fed.) (R)		*	*	*	*	*	*
60		32.8 b	33.1 b	0.9 b	1.0 b	16.4 b	16.90 b
90		34.3 a	34.6 a	1.25 a	1.4 a	17.4 a	18.61a
Time of application (T)		*	*	*	*	*	N.S
40 days	70 days						
ALL	-	33.9 a	34.5 a	1.02 b	1.05 b	16.7 b	17.8
-	ALL	32.6 b	33.1 b	0.95 b	0.98 b	16.4 C	17.5
½	½	34.1 a	35.0 a	1.39 a	1.6 a	17.1 a	17.8
S x R		N.S	N.S	*	*	*	*
S x T		N.S	N.S	*	*	N.S	N.S
R x T		*	*	*	*	*	N.S
S x R x T		N.S	N.S	*	*	N.S	N.S

*** and NS indicate P<0.05 and not significant, respectively.**
Means of each factor designed by the same letter within the same column for each season are not significantly different at 5% level according to Duncan's multiple range test.

Table 3: Root yield and sugar yield of sugar beet cv. Top poly as affected by nitrogen source, N rate and N time of application in 2000/2001 and 2001/2002 seasons.

Treatments		Root yield/fed(ton)		Sugar yield/fed(ton)	
		2000/2001	2001/2002	2000/2001	2001/2002
Source of nitrogen (S)		*	*	*	*
Urea		28.0 a	29.0 a	4.82 a	5.08 a
A. sulphate		27.3 b	28.4 b	4.48 b	4.71 b
A. nitrate		28.1 a	29.3 a	4.97 a	5.22 a
Rate of nitrogen (kg/fed.) (R)		*	*	*	*
60		27.1 b	28.3 b	4.44 b	4.95 b
90		28.6 a	29.9 a	4.98 a	5.29 a
Time of application (T)		*	*	*	*
40 days	70 days				
ALL	-	27.5 b	28.2 b	4.59 b	5.07 b
-	ALL	27.0 c	27.5 c	4.43 c	4.88 c
½	½	28.9 a	30.1 a	5.09 a	5.34 a
S x R		N.S	N.S		
S x T		*	*	N.S	N.S
R x T		*	*	*	*
S x R x T		N.S	N.S	*	*

The obtained results showed that the effect of nitrogen sources was significant on root length, root fresh weight, sucrose %, root yield/ fed and sugar yield /fed in both seasons. Ammonium nitrate gave the highest values of root length (34.4 and 34.6 cm), root fresh weight (1.2 and 1.4 kg),sucrose % (17.2 and 18.2%), root yield/fed (28.1 and29.3 tons)and sugar yield/fed (4.97 and 5.22tons) as compared with other studied sources in 2000/2001 and 2001/2002 seasons, respectively.

The increase in root yield /fed due to ammonium nitrate may be attributed to this source was more quickly available and uptake by plants ,therefore increased length and fresh weight of root which led to increasing root yield /fed.

These results are in harmony with those of Khedr and Nemeat_Alla (2006),El-Sheref (2007), Leilah *et al*. (2007), Abou-Shady *et al.* (2008) Allam (2008), El-Sarag (2009), and Nemat-Alla (2009).

The obtained results showed that the effect of nitrogen rates was significant on all studied traits in both seasons. Applied nitrogen fertilizer at the rate of 90 kg N/fed increased root length (4.57 and 4.53%),root fresh weight (38.39 and 40.00%), root yield/fed(5.53 and 5.65%)and sugar yield / fed (12.16 and 6.87%) in 2000/2001 and 2001/2002 seasons, respectively. The increase in sugar yield due to the highest nitrogen rate may be attributed to the raising effect of nitrogen on root length and weight as well as root yield/fed. These results are in harmony with those of El-Hawary (1999), El-Geddawy *et al*. (2006), Stevens *et al.* (2009)and El-Sarag (2009).

The obtained results showed that the effect of nitrogen application time was significant on all studied traits in both seasons, except sucrose% in 2001/2002 season. Splitting nitrogen fertilizer rate into two equals half an added at 40 and 70 days from sowing gave the highest values of root length (34.1 and 35.00cm),root fresh weight (1.39 and 1.6 kg), , root yield/fed(29.9 and 30.1 tons)and sugar yield / fed (5.09 and 5.34 tons) in 2000/2001 and 2001/2002 seasons, respectively. The increase in sugar yield due to spliting nitrogen rate may be attributed to provide plants by nitrogen during vegetative growth which raising root length and weight as well as root yield/fed therefore greatest sugar yield /fed. These results are in harmony with those of Mousa (2004) and Leilah *et al*. (2007).

The results recorded in Table (2) show that root length significantly affected by the interaction effect between nitrogen rate and time of application in both seasons. Results recorded in Table (4) show that splitting nitrogen fertilizer rate of 90kgN/fed into two equals half and added at 40 and 70 days from sowing gave the longest root length (35.32 and 36.00 cm) in 2000/2001 and 2001/2002 seasons, respectively.

The results presented in Table (2) show that all the interaction effects between the three studied factors were significant on root fresh weight both seasons. Results recorded in Table (5) using ammonium nitrate as a nitrogen source at the rate of 90 kg N/fed gave the highest root fresh weight (1.37 and 1.48 kg), Using ammonium nitrate as a nitrogen source and splited into two equal's half at 40 and 70 days from sowing gave the highest root fresh weight (1.60 and 1.75 kg) as recorded in Table (6). Results presented in Table (7) show that splitting nitrogen at the rate of 90 kg N/fed into two equals half at 40

and 70 days from sowing gave the highest root fresh weight (1.62 and 1.69 kg) . Using ammonium nitrate as a nitrogen source and splited nitrogen at the rate of 90 kg N/fed into two equal's half at 40 and 70 days from sowing gave gave the highest root fresh weight (1.83 and 1.89 kg)in 2000/2001 and 2001/2002seasons , respectively(Table 8).

Table 4: Root length (cm) at harvest time of sugar beet cv. Top poly as affected by interaction between N-rate and N-time of application in 2000/2001 and 2001/2002 seasons.

Time / Rate	At harvest					
	2000/2001			2001/2002		
	All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
60	33.04 b	32.47 b	32.88 b	33.47 b	32.81 b	33.11 b
90	34.90 a	32.81 b	35.32 a	35.60 a	33.20 b	36.00 a

Table 5: Root fresh weight(kg) of sugar beet cv. Top poly as affected by the interaction between N-sources and N-rate in 2000/2001 and 2001/2002 seasons

Rate / N. source	2000/2001		2001/2002	
	60 kg N/fed.	90 kg N/fed.	60 kg N/fed.	90 kg N/fed.
Urea	0.953 c	1.316 a	0.959 c	1.531 a
A. sulphate	0.950 c	1.084 b	0.960 c	1.090 b
A. nitrate	1.082 b	1.366 a	1.211 b	1.479 a

Table 6: Root fresh weight (kg) of sugar beet cv. Top poly as affected by the interaction between N-sources and N-time of application in 2000/2001 and 2001/2002 seasons.

Time / Source	2000/2001			2001/2002		
	All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
Urea	1.06 cde	0.92 e	1.41 b	1.08 cde	0.97 e	1.45 b
A. sulphate	0.933 e	0.93 e	1.18 c	0.955 e	1.0 e	1.25 c
A. nitrate	1.08 cd	0.99 de	1.60 a	1.1 cd	1.30 de	1.75 a

Table 7: Root fresh weight (kg) of sugar beet cv. Top poly as affected by the interaction between N-rate and N-time of application in 2000/2001 and 2001/2002 seasons

Time / Rate	2000/2001			2001/2002		
	All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
60	0.920 d	0.890 d	1.176 b	0.950 d	0.885 d	1.376 b
90	1.130 b	1.013 c	1.622 a	1.160 b	1.250 c	1.690 a

Table 8: Root fresh weight(kg) of sugar beet cv. Top poly as affected by interaction among N-sources, N-rate, and N-time of application in 2000/2001 and 2001/2002 seasons

N-Source	N-Rate	N-Time of application					
		2000/2001			2001/2002		
		All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
Urea	60	0.923 fg	0.877 g	1.060 df	0.980 fg	0.947 g	1.110 df
	90	1.200 cd	0.980 eg	1.767 a	1.260 cd	1.040 eg	1.882 a
A. sulphate	60	0.877 g	0.873 g	1.100 de	0.937 g	0.933 g	1.155 de
	90	0.990 eg	0.997 eg	1.267 bc	1.060 eg	1.070 eg	1.327 bc
A. nitrate	60	0.960 eg	1.200 cd	0.920 fg	1.020 eg	1.260 cd	0.980 fg
	90	1.063 df	1.367 b	1.833 a	1.163 df	1.427 b	1.893 a

The interaction effect among source and rate of nitrogen in both seasons and the interaction effect among rate and application time of nitrogen in the first season were significant on sucrose %. Using urea as a nitrogen source at the rate of 90 kg N/fed gave the highest sucrose %(17.65 and 19.13) in both seasons , respectively(Table 9). Splited nitrogen at the rate of 90 kg N/fed into two equal's half at 40 and 70 days from sowing gave the highest sucrose % (17.32%)in 2001/2002 season(Table 10).

Table 9: Sucrose percentage of sugar beet plant cv. Top poly as affected by the interaction between N-sources and N-rate during 2000/2001 and 2001/2002 seasons

Rate / N. source	2000/2001		2001/2002	
	60 kg N/fed.	90 kg N/fed.	60 kg N/fed.	90 kg N/fed.
Urea	16.59 d	17.92 a	16.70 d	19.13 a
A. sulphate	15.99 e	16.83 c	16.10 e	17.94 c
A. nitrate	16.81 c	17.65 b	17.92 c	18.76 b

Table 10: Sucrose percentage of sugar beet plant cv. Top poly as affected by the interaction between N-rate and N-time of application in 2000/2001 season.

Time / Rate	All at 40	All at 70	½ at 40 + ½ at 70
60	16.31 d	16.08 e	16.99 c
90	17.23 b	16.85 c	17.32 a

Results recorded in Table (11) show that root yield / fed significantly affected by the interaction among sources and application time of nitrogen and by the interaction among rate and application time of nitrogen in both seasons. Using ammonium nitrate as a nitrogen source and splited into two equals half at 40 and 70 days from sowing gave the highest root yield /fed (29.26 and 32.20 tons) in both seasons , respectively. Splitting nitrogen at the rate of 90 kg N/fed into two equal's half at 40 and 70 days from sowing gave the highest root yield /fed (30.03 and 31.15 tons) in both seasons , respectively (Table 12).

Table 11: Root yield/fed (ton) of sugar beet cv. Top poly as affected by the interaction between N-sources and N-time of application in 2000/2001 and 2001/2002 seasons.

Time / Source	2000/2001			2001/2002		
	All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
Urea	27.78 c	27.30 d	28.91 b	28.80 c	27.80 d	30.00 b
A. sulphate	26.73 e	26.66 e	28.66 b	27.80 e	27.00 e	30.10 b
A. nitrate	27.90 c	27.10 d	29.26 a	28.00 c	27.85 d	32.20 a

Table 12: Root yield/fed (ton) of sugar beet cv. Top poly as affected by the interaction between N-rate and N-time of application in 2000/2001 and 2001/2002 seasons

Time / Rate	2001/2002			2001/2002		
	All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
60	26.76 d	28.51 d	29.86 bc	27.78 d	28.22 d	29.90 bc
90	28.17 b	26.00 c	30.03 a	29.19 b	29.70 c	31.15 a

The interaction effect among sources and application time of nitrogen and the interaction effect among rate and application time of nitrogen were significant on sugar yield/fed in both seasons. Using ammonium nitrate as a nitrogen source and splited into two equal's half at 40 and 70 days from sowing gave the highest sugar yield /fed (4.99 and 5.70 tons) in both seasons , respectively(Table 13) . Splitting nitrogen at the rate of 90 kg N/fed into two equal's half at 40 and 70 days from sowing gave the highest sugar yield /fed (5.90 and 5.88 tons) in both seasons , respectively(Table 14)..

Generally, it could be recommended that fertilized sugar beet plants with ammonium nitrate at a rate of 90 kgN/fed splitting into two equals at 40 and 70 days from sowing greatest root and sugar yield /fed at El-Hamoul area, Kafr El-Sheikh governorate, Egypt.

Table 13: Sugar yield/fed (ton) of sugar beet cv. Top poly as affected by the interaction between N-sources and N-time of application in 2000/2001 and 2001/2002 seasons.

Time / Source	2000/2001			2001/2002		
	All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
Urea	4.80 b	4.50 c	4.98 a	5.05 b	4.70 c	5.50 a
A. sulphate	4.54 c	3.83 c	4.38 b	4.44 c	4.44 c	5.24 b
A. nitrate	4.27 c	4.25 c	4.99 a	5.25 c	4.72 c	5.70 a

Table 14: Sugar yield/fed (ton) of sugar beet cv. Top poly as affected by the interaction between N-rate and N-time of application in 2000/2001 and 2001/2002 seasons.

Time / Rate	2000/2001			2001/2002		
	All at 40	All at 70	½ at 40 + ½ at 70	All at 40	All at 70	½ at 40 + ½ at 70
60	3.91 cd	3.83 d	4.20 b	4.28 cd	4.95 d	5.08 b
90	4.26 b	4.06 bc	5.90 a	4.99 b	4.50 bc	5.88 a

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تاثير مصدر ومعدل وميعاد اضافة السماد الازوتى على بنجر السكر

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****معهد المحاصيل السكرية – مركز البحوث – الزراعية – الجيزة – مصر**

أجريت تجربتان حقليتان في الحامول بمحافظة كفر الشيخ في موسمى٢٠٠٠/٢٠٠١ و ٢٠٠١/٢٠٠٢ لدراسة تأثير ثلاثة مصادر للنيتروجين (اليوريا وسلفات الأمونيوم ونترات الامونيوم) ، ومعدلين من النيتروجين (٦٠ و ٩٠كجم ن / فدان) وثلاثة مواعيد اضافة للنيتروجين (اضافة كل الكمية عند ٤٠ اوعند ٧٠ يوم من الزراعة ، وكذلك اضافة نصف الكمية عند ٤٠ + النصف الاخرعند ٧٠يوم من الزراعة على النمو والمحصول ومكوناته فى بنجر السكر . وقد صممت التجارب في تصميم قطاعات كاملة فى ترتيب عاملى فى ثلاث مكررات . وتتلخص اهم النتائج على النحو التالي :

اظهرت النتائج ان تاثير مصادر النتروجين كان معنويا على طول الجذر والوزن الغض للجذر والنسبة المئوية للسكروز ومحصول الجذور للفدان ومحصول السكر للفدان فى كلا موسمى الدراسة.اعطت نترات الامونيوم كمصدر للنترجين اعلى قيم لكل الصفات المدروسة سابقة مقارنة بالمصادر الاخرى فى كلا الموسمين .

بينت النتائج بوضوح ان كل الصفات المدروسة تاثرت معنويا بمعدل السماد النتروجينى فى كلا الموسمين . سجلت اضافة ٩٠كجم ن/فدان اعلى القيم لكل الصفات المدروسة مقارنة مع ٦٠ كجم ن/فدان فى الموسمين .

سجلت بوضوح مواعيد اضافة السماد النتروجينى اختلافات معنوية فى كل الصفات المدروسة. اعطت الاضافة على دفعتين عند ٤٠ و٧٠ يوم من الزراعة اعلى القيم لكل الصفات المدروسة فى كلا الموسمين .

كان تاثير التفاعل بين مصادر النتروجين وميعاد الاضافة وكذلك تاثير التفاعل بين معدل النتروجين وميعاد الاضافة معنويا على محصولى الجذور والسكر /فدان فى كلا موسمى الدراسة .

توصى الدراسة ان تسميد بنجر السكر بنترات الامونيوم بمعدل ٩٠ كجم ن / فدان على دفعتين عند ٤٠ و ٧٠ يوم من الزراعة ادى الى زيادة نمو ومحصول الجذور والسكر للفدان تحت ظروف مركز الحامول بمحافظة كفر الشيخ .

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