J. Agric. Sci. Mansoura Univ., 25 (12): 7389 - 7398, 2000.

EFFECT OF PHOSPHORUS AND NITROGEN RATES AND TIME OF NITROGEN APPLICATION ON YIELD AND JUICE QUALITY OF SUGAR BEET

Hassanin, M.A. and Sohair, E.D. Elayan
Agron. Dept., Fac. Agric., Cairo University.

ABSTRACT

Yield response of sugar beet to P rates (30 and 45 kg P_2O_5 /fed), N rates (60 and 90 kg N/fed) and timing of N application viz., all amount 0f N at sowing, split application in two equal doses, at sowing and at thinning or in three equal doses 1/3 at sowing + 1/3 at thinning + 1/3 one month after thinning. The main results obtained from this study revealed that:

- Application of 45 kg P_2O_5 /fed increased root size, in terms of length and diameter as well as root weight and produced the highest yield of roots, sugar and tops /fed, while juice quality traits (TSS, sucrose and purity %) were not affected by P rates.
- Increasing N rate up to 90 kg N/fed improved size and weight of the individual root and increased root yield by 3.4 tons, sugar yield by 460 kg and top yield by 1.41 ton/fed. On the other hand, higher N rate depressed beet quality.
- Split application of N in three equal doses improved size and weight of individual root and produced the highest yield of roots, sugar and tops/fed, while juice quality traits, in terms of sucrose and purity % were not affected by timing of N application.
- The interaction between P and N rates was significant with respect to root diameter, root weight and root yield/fed.
- The interaction between N rates and times of N application was significant with respect to length and weight of the root, TSS and top yield.
- The second order interaction had a significant effect on root weight.

The highest yields of roots and sugar /fed resulted from 45 kg P_2O_5 /fed + 90 kg N/fed applied in three equal doses 1/3 at sowing + 1/3 at thinning + 1/3 one month after thinning.

INTRODUCTION

Supplies of nitrogen to sugar beet must be readily available during early and mid-season in order to promote root and top growth. However, beet must be deficient in nitrogen prior to harvest to attain the maximum sucrose concentration (Nelson, 1978). Carroll and Entroe (1970) found that applying all the nitrogen at sowing resulted in similar sugar yield to split application between sowing and singling, while applying the total amount at singling significantly reduced yields. Holmes and Devine (1976) also reported that seed bed application gave a higher sugar yield than the highest root and sugar yields resulted from split application of N at 4- and 8- leaf stages. Delaying N application reduced sucrose and juice purity. Carter and Traveller (1981) found that N application until mid-season caused a greater proportion of the photosynthate to be used for the continuity of top growth at the expense of dry matter and sucrose accumulation in the root and reduced extractability of stored sucrose. Badawi (1989) when applied all N dose either before the first or the second irrigation or splitted the amount into two or three equal doses before the 1st, 2nd and 3rd irrigation, found that the best growth attributes, leaf area index, relative growth rate and root fresh weight as well as the highest root yield was obtained when N was splitted and applied before the first and second irrigation. Early application of N improve juice quality in terms of sucrose and purity percentage.

El-Hennawy *et al*. (1998) studied the effect of N rates viz., 60, 90 and 120 kg N/fed and time of N application i.e. (a) all of dose applied at 4-leaf stage (b) 1/3 of the dose at sowing +2/3 at 4-leaf stage (c) 2/3 of the dose at 4-leaf stage + 1/3 at 8-leaf stage (d) ½ of the dose at 4-leaf stage + ½ at 9-leaf stage and (e) 1/3 of the dose at sowing + 1/3 at 4-and at 8-leaf stage, they found that increasing N rate up to 120 kg /fed increased individual root weight, root yield and top yield/fed. Excessive N application lowered beet quality in terms of sucrose and purity. Maximum yield of recoverable sugar resulted from 60 kg/fed. Early application of N improved beet quality in favour of 1/3 of the dose applied at sowing and 2/3 at 4-leaf stage. The highest yields of roots and recoverable sugar resulted from N applied in to equal doses at 4- and at 8-leaf stage. Top yield increased with delay of N application.

An adequate supply of nitrogen is essential for optimum yield but excess N may result in an increase in yield of roots with a lower sucrose content and juice purity. (Smith and Martin, 1977; Sayed *et al*., 1988; Mahmoud *et al*., 1990 and Lauer, 1995), widely ranging optimum rates of nitrogen have been reported in the literature. Last and Draycott (1972) reported an optimum 113 kg /ha. Stranad (1972) found that root yield responded to nitrogen rate up to 120 kg /ha, but that yield of tops continued to increase up to 180 kg /ha. Halverson and Hartman (1980) reported optimum rates as high as 350 kg/ha. In Egypt Kamel *et al*. (1979 a and b), Mahmoud (1979), Mahmoud *et al*. (1990) and Badawi (1989 and 1996) reported that root yield responded to rates up to 60 kg /fed. Maximum root yield and the best root character (length, diameter and weight) were obtained by adding 80 kg N/fed (Ghanem and Gomaa, 1985; Sayed *et al*., 1988; Mahmoud *et al*., 1990; Badawi *et al*., 1995 and Salama and Badawi, 1996). El-Hennawy *et al*. (1998) using 60, 90 and 120 kg N/fed, found that the largest and heaviest roots as well as the highest root yield resulted from 120 kg N. Recoverable sugar yield followed a production pattern similar to root yield with maximum sugar yield and profits at 90 kg N/fed. They added that TSS, sucrose %, purity % and recoverable sugar per ton of beet were significantly decreased as N rate increased.

Increasing phosphorus rates up to 45 kg P_2O_5/fed increased length, diameter and weight of the individual root and improved beet quality in terms of sucrose and purity percentage and increased yield of roots, tops and sugar/fed. (Kamel *et al*., 1979 a and b; El-Kassaby *et al*., 1991; Hassanin, 1992 and El-Hawary, 1994). Badawi *et al*. (1995) recommended the combination of 75 kg N + 15.5 kg P_2O_5 + 24 kg K_2O /fed to obtain the highest yields of roots and sugar as well as the best juice quality traits.

The objective of this present study was to find out the optimum rate of N and P as well as the proper timing for N application that could maximize yield and quality of sugar beet.

MATERIALS AND METHODS

Two field experiments were carried out at the Agricultural Experiment and Research Centre, Faculty of Agric, Cairo Univ., Egypt during 1994/95 and 1995/96 seasons to study the effect of two phosphorus rates; 30 and 46 kg P_2O_5/fed, two N rates; 60 and 90 kg N/fed and three times of N application; 1) all amount of N was applied at sowing; 2) split application in two equal doses at sowing and after thinning (4- leaf stage) or 3) three equal doses; at sowing, at thinning (4-leaf stage) and one month after thinning (8-leaf stage).

A split-split plot design with four replications was used with P rates allocated in the main plots, N rates in the sub-plots and time of N application in the sub-sub plots. Phosphorus was applied at sowing in the form of super-phosphate (15.5% P_2O_5) and N was applied in the form of ammonium sulphate (20.5% N) as the previously mentioned rates and times. Sub-sub plot area was 15 m^2 (6 ridges 50 cm apart and 5 m in length). Distances between hills were 20 cm. The variety ceres poly-3 was sown in Oct. 12^{th} and Oct. 21^{st} in the first and second seasons, respectively. All other cultural practices were carried out as usual. Soil analysis of the experimental site is presented in Table 1. At harvest (after 205 and 210 days from sowing in the first and second seasons, respectively), ten plants were taken at random from each treatment for determining the following traits:

1- Root characters: length, diameter and weight of the individual root.
2- Juice quality; total soluble solids (TSS) was determined by using digital refractometer model PR-10. Sucrose % was determined polarimetrically on a lead acetate extract of fresh macerated roots according to the method of Le Docte (1927). Purity % was calculated by dividing sucrose % by total soluble solids.
3- Root and gross sugar yields were determined on plat basis. Sugar yield was calculated by multiplying root yield (ton/fed) by sucrose %.
4- Data collected from both seasons were statistically analysis according to Snedecor and Chochran (1967). Treatment means were compared using LSD at 5% level of probability according to Waller and Duncan (1969).

Table 1: Soil physical and chemical analysis of the experimental sites in 1994/95 and 1995/96 seasons.

Physical characters	**Clay**	**Silt**	**Fine sand**	**Coarse sand**	
1994/95	43.1	26.9	20.2	9.8	
1995/96	43.3	26.8	20.2	9.7	
	Available (ppm)				
Chemical characters	N	P	B	$CaCO_3$	pH
1994/95	32.6	13.9	1.32	2.84	7.4
1995/96	31.8	14.1	1.21	2.84	7.4

RESULTS AND DISCUSSION

1. Phosphorus effects:

a- Root characters: (length, diameter and weight).

Data presented in Table 2 revealed that phosphorus exhibited significant effects on root characters in both seasons, except for root weight in the first season. Application of 45 kg P_2O_5 /fed increased root length by 4.1%, root diameter by 9.0% and root weight by 6.2 % on the average of the two seasons. The stimulation effect of phosphorus on beet growth was reported by El-Kassaby *et al*. (1991) and El-Hawary (1994).

Table 2: Effect of phosphorus rates on root characters, juice quality and yield of sugar beet.

Root traits						
	Root length (cm)		**Root diameter (cm)**		**Root weight (g)**	
P_2O_5 kg/fed	**1994/95**	**1995/96**	**1994/95**	**1995/96**	**1994/95**	**1995/96**
30	20.5	19.4	8.8	8.3	685	720
45	21.9	20.4	9.1	8.7	709	784
F-test	*	*	*	*	NS	*
Juice quality traits						
	Sucrose %		**TSS %**		**Purity %**	
30	16.7	16.3	20.7	21.5	81.0	76.0
45	16.7	16.2	21.0	21.4	80.0	76.0
F-test	NS	NS	*	NS	NS	NS
Yields of root, top and sugar						
	Root yield t/fed		**Top yield t/fed**		**Sugar yield t/fed**	
30	25.7	24.6	7.17	7.31	4.29	4.02
45	26.6	25.5	7.61	7.71	4.45	4.14
F-test	*	*	NS	*	*	*

b- Juice quality traits: (TSS, sucrose and purity percentages).

Data in Table 2 clear that quality traits were not significantly affected by phosphorus rates, except for TSS % in the first season where 45 kg P_2O_5/fed produced the highest percentage of TSS.

c- Yields of roots, tops and sugar.

Increasing phosphorurs rate up to 45 kg N/fed significantly increased root yield by 3.5%, top yield by 5.8% and sugar yield by 3.4% on the average of both seasons. It is worthy to mention that the increase in yields of roots, sugar and tops /fed might have resulted from increased size and weight of the individual root accompanying higher phosphorus rate as reported by Kamel *et al*. (1979 a and b), El-Kassaby *et al.* (1991) and El-Hawary (1994).

2- Nitrogen effects

a- Root characters: (length, diameter and weight).

Data presented in Table 3 indicated that application of 90 kg N/fed significantly increased root length by 10.7%, root diameter by 5.8% and individual root weight by 9.2% on the average of both seasons, effecting the major rate of N on beet growth as reported by Mahmoud *et al*. (1990), Badawi *et al*. (1995) and El-Hennawy *et al*. (1998).

Table 3: Effect of N rates on root characters, juice quality and yield of sugar beet.

N kg/fed	Root length (cm)		Root diameter (cm)		Root weight (g)	
Root traits						
	1994/95	1995/96	1994/95	1995/96	1994/95	1995/96
60	20.9	18.8	8.6	8.3	677	708
90	21.4	20.9	9.3	8.6	717	796
F-test	*	*	*	*	*	*
Juice quality traits						
	Sucrose %		**TSS %**		**Purity %**	
60	16.9	16.5	20.4	21.1	83	78
90	16.5	16.1	21.3	21.8	78	74
F-test	*	*	*	*	*	*
Yields of root, top and sugar						
	Root yield t/fed		**Top yield t/fed**		**Sugar yield t/fed**	
60	24.5	23.3	6.78	6.96	4.15	3.85
90	27.8	26.8	8.00	8.06	4.60	4.32
F-test	*	*	*	*	*	*

b- Juice quality traits: (TSS, sucrose and purity percentages).

Quality traits of beet roots i.e. TSS, sucrose and purity % were significantly affected by added N (Table 3). Increasing N rate up to 90 kg/fed increased TSS percentage but decreased sucrose and purity percentages. It is worthy to mention that the higher N rate caused lower sucrose and purity percentages. The depressive effect of higher N rate on sucrose and purity was reported by Smith and Martin (1977), Sayed *et al*. (1988), Mahmoud *et al.* (1990) and Lauer (1995).

c- Yields of roots, tops and sugar.

Increasing N rate up to 90 kg/fed significantly increased root yield by 3.4 tons, top yield by 1.41 ton and sugar yield by 460 kg/fed compared to 60 kg N/fed, reflecting the favorable effect of N on increasing size and weight of individual root as mentioned before. It is worthy to mention that the reduction in sucrose and purity % accompanying 90 kg N was compensated by the higher root yield finally increased sugar yield/fed. Results from the previous studies Last and Draycott, 1972; Halverson and Hartman, 1980; Mahmoud *et al*., 1990; Badawi *et al*., 1995 and El-Hennawy *et al*., 1998), showed that root , top and sugar yields increased by adding N fertilizer when soil N is limited.

3- Timing of N application:

a- Root characters: (length, diameter and weight).

Data listed in Table 4 indicated that timing of N application exhibited significant effects on length, diameter and weight of individual root in both seasons. Delaying N application favorable root size with the largest and heaviest roots resulting from split application of N in three equal doses. Similar results were reported by Badawi (1989) and El-Hennawy *et al*. (1998).

Table 4: Effect of timing of N application on root characters, juice quality and yield of sugar beet.

Timing of N application	Root length (cm) 1994/95	Root length (cm) 1995/96	Root diameter (cm) 1994/95	Root diameter (cm) 1995/96	Root weight (g) 1994/95	Root weight (g) 1995/96
Root traits						
Single	20.2	19.3	8.4	8.2	666	729
Two	21.3	20.0	8.9	8.4	702	748
Three	22.0	20.4	9.5	8.8	723	779
LSD at 0.5%	0.28	0.21	0.18	0.10	14.6	9.5
Juice quality traits						
	Sucrose %		**TSS %**		**Purity %**	
Single	16.5	16.3	20.6	21.3	80.1	77.0
Two	16.7	16.2	20.8	21.6	80.2	75.0
Three	16.8	16.4	21.1	21.6	80.0	76.0
LSD at 0.5%	NS	NS	0.13	0.13	NS	NS
Yields of root, top and sugar						
	Root yield t/fed		**Top yield t/fed**		**Sugar yield t/fed**	
Single	24.9	23.3	6.59	6.69	4.11	3.80
Two	26.5	25.6	7.53	7.70	4.43	4.14
Three	27.1	26.4	8.06	8.14	4.57	4.31
LSD at 0.5%	0.47	0.60	0.25	0.28	0.17	0.09

b- Juice quality traits: (TSS, sucrose and purity percentages).

Data in Table 4 revealed that sucrose and purity % were not significantly affected by time of N application in both seasons, while percentage of TSS was significantly affected by time of N application. Split application of N either in two or in three doses increased TSS % as compared with the single application of N.

c- Yields of roots, tops and sugar.

Timing of N application exhibited significant effects on yields of roots, tops and sugar /fed (Table 4). Split application of N outyielded the single application in root yield, sugar yield and top yield. The highest yields of roots, sugar and tops/fed resulted from N applied in three equal doses, 1/3 at sowing + 1/3 at thinning + 1/3 at one month after thinning. This treatment increased root yield by 11.05% top yield by 22.5% and sugar yield by 11 %. on the average of both seasons, as compared with the single application of N. Similar results were obtained by Mahmoud (1979), Badawi (1989) and El-Hennawy *et al*. (1998). On the other hand, Carroll and Entroe (1970) reported that applying all the nitrogen at sowing resulted in similar sugar yield to split application. Also, Holmes and Devine (1976) found that seed bed application gave higher sugar yield than split application.

4- Interaction effects:

a- Phosphorus x N rates:

Data presented in Table 5 revealed significant interaction between P and N rates for root diameter, root weight (in the first season) and root yield/fed (in the second season). The highest root diameter, (9.6 cm), root weight (821 g) as well as the highest root yield (28.7 ton/fed) resulted from the application of 45 kg P_2O_5 and 90 kg N /fed.

Table 5: Interaction between phosphorus and nitrogen rates on root diameter and root yield in 1994/95 and root weight in 1995/96.

P_2O_5 kg/fed	N kg/fed	Root diameter (cm)	Root weight (g)	Root yield t/fed
		1994/95	1994/95	1995/96
30	60	8.6	669	24.4
	90	9.0	771	27.0
40	60	8.7	747	24.6
	90	9.6	821	28.7
LSD at 0.5%		0.31	19.0	0.83

b- Nitrogen rate x time of N application:

This interaction exhibited significant effects on root length and root weight in the first season and TSS % and top yield in the 2nd season (Table 6). Application of 90 kg N/fed in three equal doses (1/3 at sowing + 1/3 at thinning + 1/3 at one month after thinning) gave the longest roots (22.4 cm), the heaviest root weight (760 g) as well as the highest percentage of TSS (21.9) and the highest top yield (8.88 ton/fed).

Table 6: Interaction between N rates and time of N application on root length and root weight in 1994/95 and TSS % and top yield (t/fed) in 1995/96.

N kg/fed	Time of N application	Root length (cm)	Root weight (g)	TSS	Top yield t/fed
		1994/95	1994/95	1995/96	1995/96
60	Single	20.1	665	20.8	6.28
	Two	21.0	688	21.3	7.20
	Three	21.6	687	21.3	7.40
90	Single	20.3	676	21.7	7.10
	Two	21.6	716	21.8	8.20
	Three	22.4	760	21.9	8.88
LSD at 0.5%		0.40	20.3	0.1	0.39

c- The second order interaction:

Data in Table 7 revealed that the 2nd order interaction was significant with respect to root weight in the 2nd season. The heaviest roots (831 g) resulted from the application of 45 kg P_2O_5 + 90 kg N splitted in three equal doses.

Table 7: Interaction between phosphorus, nitrogen rates and time of N application on root weight in 1995/96 season.

P_2O_5 kg/fed	N kg/fed	Time of N application		
		Single	Two	Three
30	60	640	668	700
	90	738	766	809
40	60	726	739	776
	90	813	819	831
L.S.D. at 0.5%		18.9		

REFERENCES

Badawi, M.A. (1996). Effect of soil and foliar fertilization with urea on yield, yield components and quality of sugar beet *(Beta vulgaris*, L.). J. Agric Sci. Mansoura Univ., 21 (2): 3083 – 3098.

Badawi, M.A..; M.A. El-Agroudy and A.N. Attia (1995). Effect of planting dates and NPK fertilization on growth and yield of sugar beet *(Beta vulgaris*, L.). J. Agric Sci. Mansoura Univ., 20 (6): 2683 – 2689.

Badawi, M.A. (1989). A preliminary study on the effect of some cultural practices on the growth and yield of sugar beet. J. Agric Sci. Mansoura Univ., 14 (2): 984 – 993.

Carroll, P.J. and M.C. Entroe (1970). Effect of source, rate and time of nitrogen application on sugar beet. Irish. J. Agric. Res., 9: 383 – 390.

Carter, J.N. and D.J. Traveller (1981). Effect of time and amount of nitrogen uptake on sugar beet growth and yield. Agron. J., 73: 663 – 671.

El-Hawary, M.A. (1994). Effect of phosphorus and potassium fertilization on salt tolerance of sugar beet plant. Proc. 6th Conf. Agron. Al-Azhar Univ. Cairo, Egypt, II: 881 – 895.

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

El-Kassaby, A.T.; S.E. El-Kalla; A.A. Leilah and H.S. El-Khatib (1991). Effect of planting patterns and level of N and K fertilization on yield and quality of sugar beet. J. Agric Sci. Mansoura Univ., 16 (7): 1497 – 1504.

Ghanem, S.A.L. and M.A. Gomaa (1985). The influence of nitrogen fertilization and growth regulators on yield and quality of sugar beet. Zagazig J. Agric. Res., 12 (2): 229 – 244.

Halverson, A. and G.P. Hartman (1980). Response of several sugar beet cultivars to N fertilization. Yield and crown tissue production. Agron. J., 72: 665 – 669.

Hassanin, M.A. (1992). Effect of P application on sugar beet productivity. Zagazig J. Agric. Res., 19 (1): 71 – 79.

Holmes, M.R.J. and J.R. Devine (1976). Nitrogen requirement of sugar beet. J. Agric. Sci., 87: 549 – 558.

Kamel, M.S.; E.A. Mahmoud; A.A. El-Garbowy and M.A. Hassanein (1979 a). Effect of different rates of nitrogen, phosphorus and potassium on yield and quality of sugar beet. Ain Shams Univ., Fac. Agric., Res. Bull., 1052.

Kamel, M.S.; E.A. Mahmoud; A.A. El-Garbowy and M.A. Hassanein (1979 b). Influence of NPK fertilization on some growth attributes of sugar beet under Egyptian conditions. Ain Shams Univ., Fac. Agric., Res. Bull., 1069.

Last, F.J. and A.F. Draycott (1972). Top-dressing of nitrogen for sugar beet. Experimental Husbandry, 22: 82 – 88.

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

Le Docte, A. (1927). Commercial determination of sugar in the beet root using the Sacha-Le Docte process. Int. Sug. J., 29: 488 – 491.

Mahmoud, E. A. (1979). Effect of time and rate of nitrogen application on yield and sugar content of sugar beet (*Beta vulgaris*, L.). Ain Shams Univ., Fac. Agric., Res. Bull., Oct., No.1118.

Mahmoud, E. A., N.A. Khalil and S.Y. Beaheet (1990). Effect of nitrogen fertilization and plant density on sugar beet. 2- Root weight, root, top and sugar yields and sugar quality. Proc. 4th Conf. Agron., Cairo, 15 – 16, Sept. Vol. II: 433 – 446.

Nelson, J.M. (1978). Influence of planting date, nitrogen rate and harvest date on yield and sucrose concentration of fall plant sugar beet in central Arizona. J. Am. Soc. Sugar Beet Tact. 24 (1): 25 – 32.

Salama, A.A. and M.A. Badawi (1996). Evaluation of six sugar beet cultivars under N levels and harvesting dates. J. Agric. Sci. Mansoura Univ., 21 (1): 139 – 153.

Sayed, K.M.; E.M. El-Hadidi; H.A. Sonbol and M.Y.S. El-Arquan (1988). Growth, yield and quality of sugar beet as affected by nitrogen and potassium fertilization. J. Agric. Sci. Mansoura Univ., 13 (4): 2213 – 2220.

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

Snedocor, G.W. and W.G. Cochran (1967). Statistical Methods. 6th Ed. Iowa State Univ. Pren., Amer., Iowa, USA.

Stranad, P. (1972). The effect of gradually increased rates of nitrogen on sugar beet yield and nutrient uptake. Rostlime Vyroba, 8: 1275 – 1282. (Cited after F.C.A., 25: 6656).

Waller, R.A. and D.B. Duncan (1969). A bays rule for the symmetric multiple comparison problem J. Am. Sta. Ausoc., : 1485 - 1503.

تـأثير معـدلات الفوسـفور والآزوت وميعـاد إضـافة الآزوت علـى محصـول وجـودة عصير بنجر السكر

محمود عبد الرحيم حسانين ـ سهير عليان دسوقى عليان
قسم المحاصيل ـ كلية الزراعة ـ جامعة القاهرة

درست استجابة محصول بنجر السكر لمعدلات التسميد الفوسفاتي وهى (٣٠ و ٤٥ كجم فو٢أ٥ /فدان) ومعدلات الآزوت (٦٠ و ٩٠ كجم ن/ فدان) وكذلك ميعاد إضافة الآزوت وهى: ١ـ إضافة كل كمية الآزوت عند الزراعة. ، ٢ـ إضافة السماد الآزوتى على دفعتين متساويتين عند الزراعة وبعد الخف . ٣ـ إضافة السماد الآزوتى على ثلاث دفعات متساوية عند الزراعة وبعد الخف وبعد شهر من الخف. وأظهرت النتائج المتحصل عليها من الدراسة مايلى:

- أدت زيادة معدل الفوسفور المضاف حتى ٤٥ كجم / فدان إلى زيادة ملحوظة فى طول وقطر الجذر ووزنه كما أعطت أعلى محصول من الجذور والعرش والسكر للفدان بينما لم تتأثر صفات جودة العصير ممثلة فى المواد الصلبة الكلية الذائبة والسكروز والنقاوة بزيادة معدل الفوسفور المضاف.
- كان لزيادة معدل الآزوت المضاف حتى ٩٠ كجم / فدان تأثيرا معنويا على زيادة طول وسمك ووزن الجذر كما زاد المحصول من الجذور بمقدار ٣,٤ طن / فدان والعرش بمقدار ١,٤١ طن للفدان ومحصول السكر بمقدار ٢٤٩ كجم وذلك بالمقارنة بمعدل ٦٠ كجم أزوت / فدان .
- أدت إضافة السماد الآزوتى على ثلاث دفعات متساوية إلى تحسن واضح فى حجم الجذر ووزنه وأعطت أعلى محصول من الجذر والسكر والعرش للفدان مقارنة بمواعيد الإضافة الأخرى وبينما لم تتأثر صفات جودة العصير بميعاد إضافة الآزوت.
- كان للتفاعل بين معدلات الفوسفور والأزوت تأثيرا معنويا على قطر الجذر ووزنه ومحصول الجذور للفدان كما كان للتفاعل بين معدلات الآزوت ومواعيد الإضافة تأثيرا معنوى على طول ووزن الجذر ونسبة المواد الصلبة الذائبة ومحصول العرش للفدان وكان للتفاعل الثلاثى تأثيرا معنويا على وزن الجذر الواحد.

وتوصى الدراسة بأنه للحصول على أعلى محصول من الجذر والسكر للفدان ينصح بإضافة ٤٥ كجم فوسفور + ٩٠ كجم آزوت مع تجزئتها على ثلاث دفعات (ثلث الكمية عند الزراعة + ثلث بعد الخف + ثلث بعد شهر من الخف).