PERFORMANCE EVALUATION OF TWO DIFFERENT PLANTERS FOR SUGAR BEET CULTIVATION

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Abstract

This study was carried out to clear the role and importance of two planters of sugar beet on yield and quality. The field experiments were carried out at Sakha Agric. Res. Station at Kafr El-Sheikh Governorate in two successive seasons 2001/2002 and 2002/2003. Two planters (Tabata and Hassia planting machines) with three forward speeds (4.7, 6.5 and 7.7 km/h.) and one, two and three hoeings were used in this study. The main results can be summarized in the following points:

-Number of plants per feddan were38058, 32157 and 26846 in the first season and 37471, 30944 and 25825 in the second season for Tabata planting machine with forward speeds of 4.7, 6.5 and 7.7 km/h.. While, the number of plants with planting machine Hassia at the same speeds was 34608,29232 and 25378 in the first season but, in the second season was 34167,28870 and 24452 plants/fed., compared with manual planting which were 20814 and 21723 plants/fed. in both seasons, respectively.

-Sucrose percentage decreased from 15.98 and 16.42 to 15.62 and 16.10 % in both seasons with Tabata and Hassia planting machines, respectively with increasing forward speed from 4.7 to 7.7 km/h.. This decrease is due to wide space between plants, which compared with high speed, resulted in big roots with small sucrose percentage. Sucrose percentage attainted to increase the hoeing times compared with one and two hoeings.

-Root yields significantly increased with Tabata planting machine at low speed of 4.7 km/h. (30.521 and 31.217 ton/fed) at 35 cm plowing depth and three hoeings in both seasons, compared with Hassia planting machine which recorded 28.317 and 29.707 ton/fed. in both seasons under the same condition or the manual planting which recorded the lowest root yield in both seasons 12.168 and 13.470 ton/fed with one hoeing.

INTRODUCTION

The final goal for any research effect is to increase the yield and quality of any crop. So, this study were carried out to study the effect of many factors affecting on yield and quality of sugar beet as, planter machines, hoeing and speed of planter.

Hana et al. (1981) stated that mechanical methods for weed control must be used. They concluded that use of chisel plow with duck fool shares, rotary cultivator, digging machine and hand hoe resulted in control efficiencies of 91,81 and 61 percent respectively.

El-Nakib (1990) tested and compared the performance of two commercial planters in planting sugar beet cultivars. Three varieties of sugar beet were used (Sofia, Solid and Eva). He found that optimum speed for machine was 5.0 km/h to gave less missing and double stand.

Abd-El-Latif (1992) concluded that rotary cultivator or a chisel plow without herbicides could be used if the low cost was reguired. The efficiency and the productivity gave adequate results. Traditional weed control methods such as hand hoe and donkey-pulled cultivator not recommended to be used. These methods in spite of relative high efficiency (86 %) it has a relative cost (50.70 LE/fed.).

El-Zawahry (1994) observed that increasing the forward speed of the planters would decrease the depth of the seeds in the soil because of the furrow openers at high speed tend to floats near the soil surface under action of the component vertical forces. The operation speeds effected the seed distribution where the increasing of speeds increased the in row spacing.

Adel-Abd El-Aal (1995) reported that manual weeding by 3 harrowings gave the high roots and sugar yield/fed. Chhinnan et al (1995) observed that photo-diode and belt experiments were conducted for different planting speeds seed size and seed level in the hopper to determine effects on metering and seed placement accuracy. The major conclusion was the higher planting speeds resulted in more skips, higher seed placement error and higher average spacing.

Taieb (1997) found that optimum working speed can be selected to 3.8 km/h, which gave the highest germination ratio and the high density of sugar beet plants/m^2. Higher than speed of 3.8 km/h, the two indicators started to decrease. Metwalli et al (1998) observed that number of plants/m^2 decreased from (6.92 to 4.77) and from (6.77 to 4.62) by increasing forward speed from (1.5 to 6.0 km/h) for Gaspardo and Tabata planting machine respectively.

Helmy et al (2002) investigated the effect of planter speeds on sugar and root yields. They concluded that increasing or decreasing the planter forward speed than 5.03 km/h tended to decrease the root and sugar yields per feddan and for all the other characters.

Imara et al (2003) studied the effect of speed of planter on root and sugar yields found that 4.96 km/h forward speed of planter gave the highest values of root and sugar yields compared with manual planting.

MATERIALS AND METHODS

This investigation was carried out during 2001/2002 and 2002/2003 to study the effect of three forward speeds of 4.7, 6.5 and 7.7 km/h, for two planters (Tabata and Hassia planting machine) compared with manual planting and three hoeings on yield and quality of sugar beet. Treatments were arranged in split-split plot design with three replicates. The main plots were deucted to one, two and three hoeings while, sub-plots were assigned to three forward speeds (4.7, 6.5 and 7.7 km/h) and sub-sub plots contained three planting methods (Tabata, Hassia planting machines) and manual planting. Sugar beet cultivar (Lola) was sown in ridges 50 cm apart and 20 cm between hills. Recommended dose of NPK fertilizers were added (90, 15 and 48 kg/fad. respectively) as used in sugar beet fields. Sowing dates were at 1 st and 2 nd weeks of October in both seasons. Sowing was by two planters Tabata and Hassia and manual, plants were thinned to one plant/hill at 4 true leaf stage. The mounted planters (4 rows x 50 cm between rows) were used with a 37.5 kW (50-hp) Nasr tractor in this study. Planting machine types and their characteristics are shown in Table 1 as follows:

Table 1. Technical data and characteristics of two planters: -

Characteristics	Tabata planter	Hassia planter
Source of manufacture.	Japan	Germany
No. of rows	4	4
Row spacing, mm	300-850	300-850
Working width, mm	2.75	2.95
Weight, kg	250	310
Metering device	Inclined	Vertical

Table 2. Soil particle distribution for different soil depth of the experimental site.

Soil depth, cm	Soil participle distribution			Textural class
	Sand, %	Silt, %	Clay, %	
0-15	14.31	31.40	54.29	Clay
15-30	20.00	34.00	46.00	Clay
30-45	21.70	39.28	39.02	Clay loam
45-60	22.00	39.40	38.60	Clay loam

Nitrogen fertilizer was applied at two equal doses the first was added after thinning and the second was applied after one month later. While the phosphorus and potassium fertilizers were applied during land preparation before sowing.

The collected data were subjected to proper statistical analysis of complete randomized block design according to Gomez and Gomez (1984). Treatments were compared by Duncans multiple range. Test Duncans (1955). All statistical analysis was performed using analysis of variance technique by means of Irristat computer software package.

The measurements

Sucrose percentage, %

It was estimated by Saccarometer on a lead acetate extract of fresh macerated roots, as mentioned by *Le*-Docte (1927).

Planting rate

Planting rate was calculated by using equation as follows: -

$$Planting\ rate = \frac{4200}{S \text{ X } L} \text{X } F \text{ X } m, \quad kg / fed. \quad \text{.....(1)}$$

Where:

S = Distance between rows, (m)
L = Distance between hills within the row, (m)
F= Average number of seed per hill
m = Average mass of seed (kg)

Actual field capacity

The actual field capacity (AFC) was determined using the following equation:

$$AFC = \frac{1}{T_t}, \quad fed / h. \quad \text{.....(2)}$$

Theoretical field capacity (TFC)

$$TFC = \frac{1}{T_U}, \quad fed / h. \quad \text{..... (3)}$$

Field efficiency (η_F)

$$\eta_F = \frac{AFC}{TFC} \text{ X } 100 \ \% \quad \text{..... (4)}$$

Where: -

T_u = The time consumed in the planting operation, h/fed and
T_t = Total operational time, h/fed.
$= T_u + T_L$
T_L = The lost time in the field operations, h/fed.
$= T_1 + T_2 + T_3$
T_1 = Time spent in turning at the ends of the field, h/fed;
T_2 = Short rest time periods for the labors during operation, h/fed and
T_3 =Time spent in interruptions, simple repair and adjustments of planting units, h/fed.

Slippage of the planter wheel

Slip of ground wheel is an important factor, which affects performance Slippage percentage was calculated by using the equation:

$$Slippage = \frac{Theoretical\ dis\tan ce - Actual\ dis\tan ce}{Theoretical\ dis\tan ce} \text{ X } 100 \text{ .....(5)}$$

Where:

Theoretical distance = number of wheel revolution×π×wheel diameter.

RESULTS AND DISCUSSION

1-Slippage and field efficiency

Figures 1 and 2 show that, increasing forward speed, consequently increased slip ratio and decreased field efficiency for two seasons. The minimum slip ratio range (3.0 and 2.89 %) and (3.20 and 3.0 %) by using Tabata and Hassia planting machine for two seasons. While the maximum field efficiency were (92.40 and 93.01 %) and (91.20 and 92.11 %) by using 4.7 km/h. Increasing forward speed tended to increase slip ratio, but decrease field efficiency.

2-Planting rate and number of plants

Increasing forward speed decreased the planting rate and the number of plants per feddan, because slip ratio and hills missing tended to decrease the number of plants per square meter as shown in Fig (3). The largest planting rate was reached by using 4.7 km/h were (2.25 and 2.15 kg) and (2.32 and 2.27 kg), while, the smallest values were (1.75 and 1.68 kg) and (1.84 and 1.71 kg) at 7.7 km/h., by using Tabata and Hassia planting machines in both seasons. By manual planting the number of plants and planti-g rate were (20000 and 22000 plants/fed) and (4 kg multigerm seeds), at 55-cm distance between row and 20 cm distance between in both seasons.

Generally, increasing the forward speed tends to decrease the number of plants decreased as shown in Fig. 4.

3- Root dimensions

It is clear from Figures 5 and 6 that there were significant differences among the values of root dimensions in both seasons due to the types of machine. Tabata and Hassia planting machines recorded the highest root dimensions for sugar beet roots and gave the highest root length 39.82 and 41.27cm in addition to 38.40 and

39.83 cm in both seasons with high speed of 7.7 km/h when sugar beet take three hoeings. Compared with other speeds and hoeings times, which gave the lowest values.

The highest root diameter also, resulted from Tabata and Hassia planting machines with speed of 7.7 km/h and three hoeings which gave the highest root diameter of 14.27 and 15.05 cm in addition to 11.93 and 14.0 cm in both seasons. These results related to the role of hoeing, which gave a good chance for root extension in vertical or horizontal level and produced biggest roots than other treatments. On the other direction, manual planting gave the highest root diameter than planting by two planters, because the density was low than planting by machines.

4- Root volume

Data presented in Figure (7) showed that the highest root volume (1003.33 and 1012.67 cm^3) in both seasons resulted from sugar beet root planted by Hassia planting machine which progressive than Tabata planting machine at speed of 7.7 km/h and gave three hoeings. On the other hand, the lowest values of root volume of 678.33 and 695.67 cm^3 were obtained with Tabata planting machine at low speed of 4.7 km/h and sugar beet take one hoeing only through the season. Whereas, manual planting gave the highest root volume of 1022.5 and 1043 cm^3, because the density was low in manual and gave a chance for root to extension and gave maximum volume

5- Root yield (ton/fed.)

Figure 8 indicates the effect of planter type, forward speed and of hoeing times. The results pointed out that significant increase in root yield were obtained with Tabata and Hassia planting machines at low speed of 4.7 km/h. to plant sugar beet seeds and take the highest hoeing times. The minimum root yield were 20.344 and 18.514 ton/fed using forward speed of 7.7 km/h to both Tabata and Hassia planting machines, while, the maximum root yield were 31.217 and 29.707 ton/fed by using forward speed of 4.7 km/h at the same condition, respectively. Resulted from sugar beet roots planted manually and gave the lowest root yield because there is a negative correlation between root size and sucrose percentage, sugar beet root, which planted by Tabata planting machine gave the highest root yield. On the other side the manual planting with one hoeing gave the lowest root yield (13.470 ton/fed).

6- Sucrose percentage

Available data in Figure 9 revealed that the highest sucrose percentages were obtained (17.07 and 17.27 %) and (16.75 and 17.03 %) in both seasons respectively using Tabata and Hassia planting machines at 4.7 km/h forward speed. Compared with low sucrose percentage (14.92 and 15.43 %) and (14.67 and 15.23 %) using forward speed of 7.7 km/h at the same conditions. While, with manual planting sucrose percentage were 14.15 and 14.25 %. This result due to the big size if root which resulted from low density.

7-Sugar yield (ton/fed.)

In respect to influence of planter type and its forward in addition to hoeing times on sugar yield data in Fig. 10 clear that sugar yield significantly, increased by forward speed tended to decrease the sugar yield. The largest sugar yields were 5.209 and 5.390 ton/fed in addition to 4.707 and 5.060 ton/fed with Tabata and Hassia planting machines at low speed of 4.7 km/h and three hoeings in the both seasons. While the smallest sugar yields were (3.035 and 3.340 ton/fed) and (2.715 and 3.069 ton/fed) by using forward speed 7.7 km/h and one hoeing. These results indicated that, hoeing times are very important factor affected on sugar yield. On the other direction, manual planting gave the lowest sugar yield compared two planting machines, this result caused to low density in manual planting.

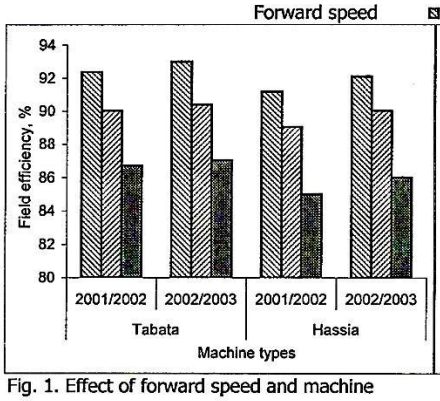

Fig. 1. Effect of forward speed and machine types on field efficiency.

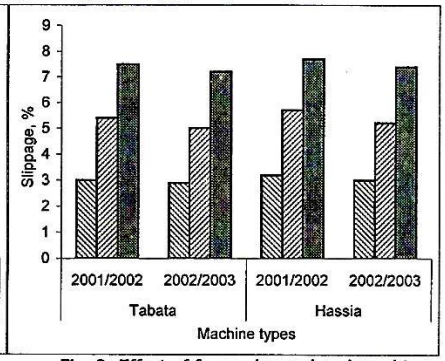

Fig. 2: Effect of forward speed and machine types on slippage.

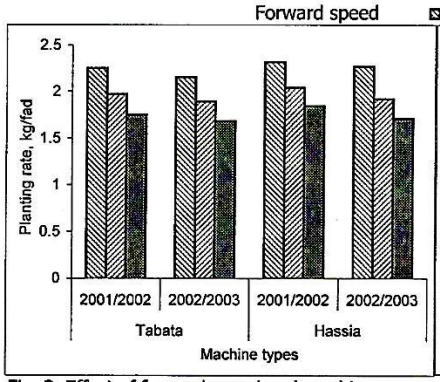

Fig. 3. Effect of forward speed and machine types on planting rate.

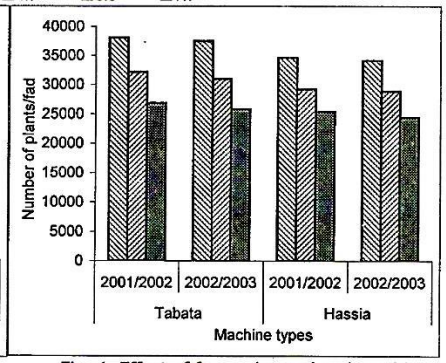

Fig. 4: Effect of forward speed and machine types on number of plants.

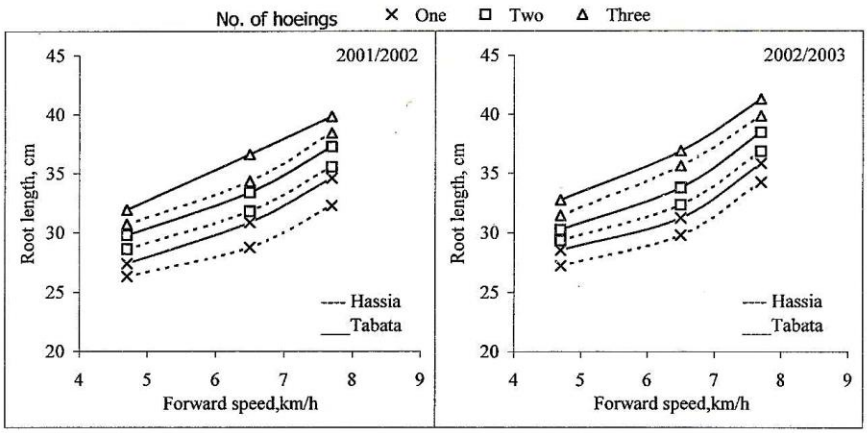

Fig 5.Effect of number hoeings, forward speed and machine types on root length in both seasons.

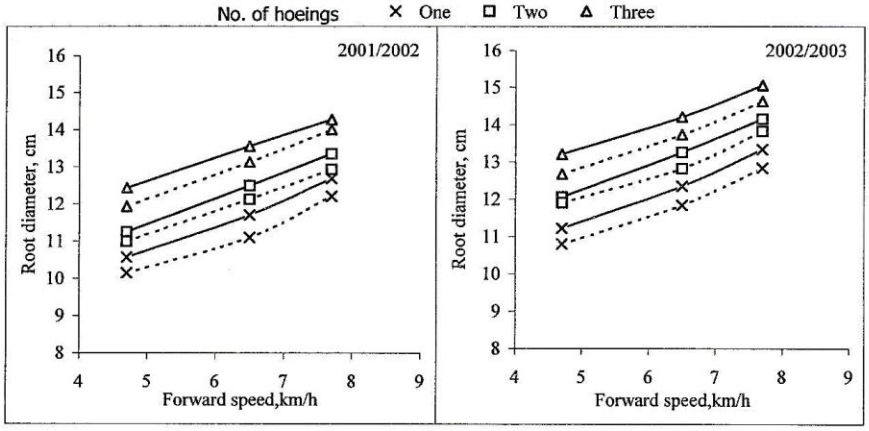

Fig 6. Effect of number hoeings, forward speed and machine types on root diameter in both seasons.

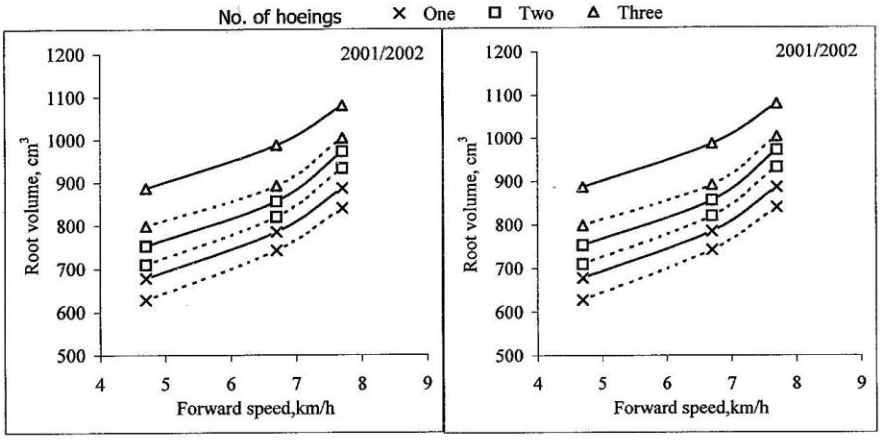

Fig 7. Effect of number hoeings, forward speed and machine types on root volume in both seasons.

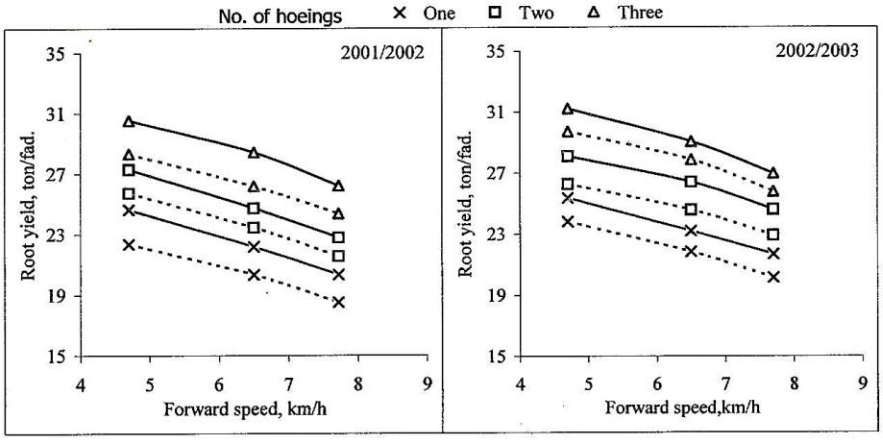

Fig.. 8 Effect of number hoeings, forward speed and machine types on root yield in both seasons.

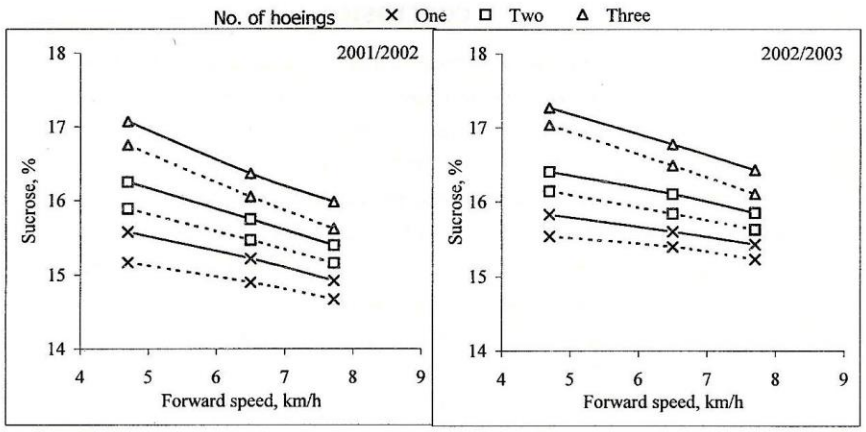

Fig 9. Effect of number hoeings, forward speed and machine types on sucrose in both seasons.

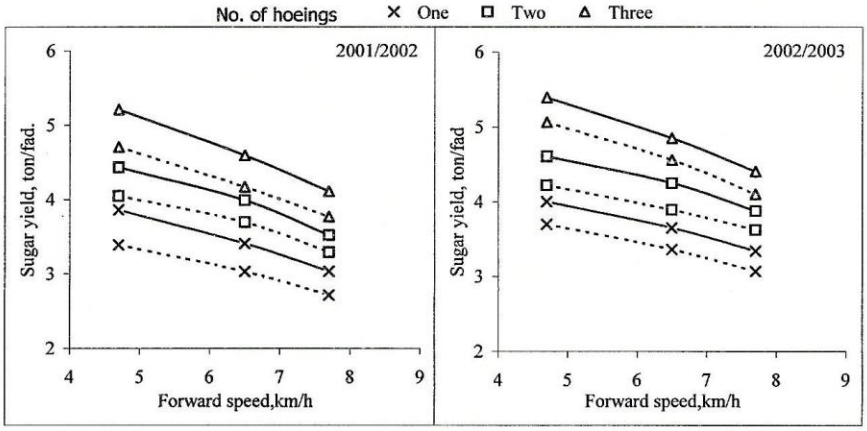

Fig.10 Effect of number hoeings, forward speed and machine types on sugar yield in both seasons.

CONCLUSION

The manual sowing of sugar beet in Egypt caused to decrease density and decrease sugar and root yields per unit area (feddan). So, mechanization of sugar beet planting is very necessary to increase density and sugar yield in the final at harvest. This investigation was carried out to study the effect of planter type, hoeing times and forward speed on sugar beet yield and quality. The obtained results pointed out that we can use Tabata planting machine for planting sugar beet with high forward speed of 4.7 km/h which gave the highest values for root dimensions, root volume, root yield and sugar yield with three hoeings. But the manual sowing gave the lowest values of sugar beet yield. Planters significantly increased number of plants per unit of area (feddan) and gave good chance to control weeds by hoeing to produce high sugar yield and largest net benefit.

REFERENCES

1. Abd- El-Latif, Y.Z. 1992. Evaluation of weed control in sugar beet production, Misr J. Ag. Eng.,9 (3):256-266.

2. Adel, Abd El-Aal 1995. Integrated weed control in sugar beet with relation to yield and quality. M. Sc. Thesis , Agronomy dep., Faculty of Agric. Ain Shams university.

3. Chhinnan, M. S., J. H. Young and R. P. Rohrbach 1975. Accuarcy of seed spacing in peanut planting. Trans. ASAE., 18(1):828-831.

4. Duncan, B. D. 1955. Multiple range and multiple F- test Biometrics. 11:1-42.

5. El-Nakib A.A. 1990. Sugar beet precision planting and emergency with cooled seed. Misr J. Ag. Eng., 7(3):208-223.

6. El-Zawahry, A.S.M. 1994. A study on mechanization of some operations in sugar beet production M. Sc. Thesis,Ag. Eng. Dep, Faculty of Agric. Al Azhar.Univ., Egypt.

7. Hana, G.B. ,A.E. Suliman and G.E. Nasr 1981. Performance of the mechinical digging machines cultivation, Res. Bull. No. 365, Oct. Fac. Agr. Zagazig Univ.

8. Helmy, M. A., Z. M. Imara and N. M. Awad 2002. The feeding device modification of a planter to suit sugar beet planting. Misr J. Ag. Eng., 19 (3): 556-570

9. Tieb, A.E. 1997. Comparative study on manual and mechanical sugar beet planting in the newly reclaimed lands. Misr J. Ag. Eng.,14(3): 299-309.

10. Imara, Z. M., N. A. Awad and M. A. Metwally 2003. Effect of different leveling and planting methods on yield Misr J. Ag. Eng., 20(1):102-114.

11. LE Docte, A. 1927. Commercial determination of sugar beet roots using Sacks Le Docte process. Int. Sugar J. 29:488-492.

12. Metwalli, M. M., E.A. Kalifa and I.S. yousef 1998. Performance evaluation of some planting machinary of sugar beet Misr J. agric. Eng.15(1): 57-68.

تقييم الآداء لنوعين مختلفين من آلات الزراعة لبنجر السكر

نبيل مرسى محمد عوض

محطة بحوث سخا – قسم المعاملات الزراعية- معهد بحوث المحاصيل السكريه- مركز البحوث الزراعيه

أجريت تجربتان حقليتان خلال موسمي الزراعة ٢٠٠١/٢٠٠٢-٢٠٠٢/ ٢٠٠٣بمحطة البحوث الزراعية بسخا – كفر الشيخ لدراسة تأثير عملية زراعة البنجر بماكينات الزراعة ومقارنتها بالزراعة اليدوية كما هو متبع لدى المزارعين (يدويا). على محصول وجودة بنجر السكر وتم استخدام بذور عديدة الأجنة صنف (لولا).

وقد اشتملت كل تجربة على عدد (٢) ماكينة زراعة آلية:- الأولى (Tabata) يابانية الصنع والثانية (Hassia) فرنسية الصنع. استخدمت ثلاث سرعات لكل ماكينة زراعة وكانت(٤,٧-٦,٥-٧,٧كم/س) وذلك بمقارنتها بالزراعة اليدوية وتمت الزراعة في الأسبوع الأول والثاني من شهر أكتوبر من كل عام على التوالي.

وقد بينت النتائج المتحصل عليها أن هناك تأثير عالى المعنوية لاستخدام ماكينات الزراعة الآلية على زيادة كلا من :

عدد النباتات في وحدة المساحة وكذلك زيادة قطر وطول الجذور كما كان هناك تأثير معنوي على محصول الجذور وكذلك محصول السكروز بالطن للفدان وأن الزيادة المعنوية كانت ترجع الي استخدام الماكينة (Tabata) يابانية الصنع عن الماكينة الأخرى والزراعه اليدويه. أما الزراعة اليدوية فقد سجلت أقل قيم لعدد النباتات في وحدة المساحة وكذلك أقل القيم للصفات السابق ذكرها.

عملية العزيق كان لها تأثير معنوي على خصائص محصول بنجر السكر فبزيادة عدد العزقات من عزقة إلي عزقتين إلي ثلاث عزقات أدت إلى زيادة التربة المثارة حول النبات وبالتالي سهولة عملية التربديم حول الجذور وبالتالي تحسين خصائص الجذور.

ومن هذا يتضح ضرورة استخدام ماكينات زراعة البنجر في حقول بنجر السكر بدلا من الزراعة اليدوية لما لها من فوائد كثيرة تؤدى إلى زيادة الإنتاج المتحصل عليه من وحدة المساحة من محصول السكر وهو الهدف النهائي لزراعة المحصول بأقل تكلفة لوحدة المساحة.