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Manual vs mechanical transplanting of main sugar crops

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ABSTRACT

The main aim of this research was evaluation performance of a locally developed transplanter for transplanting cane seedlings and sugar beet seedlings. Compare mechanically transplanting and manually transplanting in terms technical and economic aspects. Sugar cane is planted once every four or five year and use of the transplanter in transplanting sugar beet crop increases the number of annual operating hours and reduces the machine operation costs. The field experiments of the transplanter were conducted at four forward speeds of (0.7, 0.9, 1.2 and 1.4km/h) and included the power required, actual field capacity, field efficiency, actual in-row spacing, missing hills percentage and cost of mechanical transplanter and manual transplanting. Results show that the maximum value of transplanting efficiency of the mechanical transplanter was (82%) and (76%) at the forward speed of 0.7 km/h for crops of sugar beet and sugar cane, respectively. Actual field capacity of manual transplanting was 0.166 fed/h. The lowest values of missed seedlings (1.28%) and (1.53%) at forward speed of 0.7 km/h for crops of sugar cane (λ=0.262) and sugar beet (λ=0.525) that of manually transplanting may be null. Reduction in the cost of mechanically transplanting more than 25 and 50% for crops of sugar beet and sugar cane respectively compared with manually transplanting.

1. Introduction

The sugar industry in Egypt and many other countries around of the world depend on the two basic crops are Sugar cane (Saccharum officinarum L.) and sugar beet (Beta vulgaris, L). Area of Sugar cane in Egypt reached up to (341) thousand feddan, with average production of (49.9) ton per fed., and the total planted area of sugar beet in Egypt reached up to (423) thousand feddan, with an average production of (21.5) ton per fed., Egypt produces about 2.29 million tons of sugar from cane and beet sugar crops (CCSC, 2015). The main objective of introducing transplanting technique is to save at least high amount of seed/fed. and reduce the duration of sugar crops production season and to save about 15% of irrigation water. The problems of sugar crops transplanting represented in the difficulty of transplanting the crop seedlings in the main field. Manual transplanting of sugar crops seedlings in the main field is exhaustible, slow, and tedious operation. Consequently, the technique has not been applied at the farmers' fields. Actually, farmers accepted the technique because of its multiple advantages but they have been locking in suitable machine to facilitate easier application of sugar crops transplanting. In the sugar cane transplanting technique, seedlings are raised in a nursery bed using single bud sets. Then, when the seedlings are of about 6–8 week-old, they are transplanted in the prepared main field, and in the sugar beet transplanting technique seeds are planted in paper pots. Jakeway, (1985) indicated that "Automatic detection of seed cane nodes and/or eyes are technically feasible". The radio frequency, (RF) absorption method can locate nods with leafy trash still attached to the stalks at very fast detection rates, but this method requires different size

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coupling coils, complicating the design for a production system. The machine vision method cane detects nodes and eyes at considerably slower rates. Sundara (1998) Mention that advantages of the sugarcane transplanted is:

1. Saving in the seed cost as the seed requirement is only about 2.3 ton/ha in this system as against 8-10 ton used in the normal planting.
2. Synchronous tillering, leading to uniformly matured stalk population, which usually gives, better sugar recovery.
3. Sufficient time availability to prepare the main field.
4. Saving of 2-3 irrigations.
5. Saving of around 20-30 days in the main field duration.
6. Possibility of increased cane yield.
7. Efficient fertilizer management.
8. Better weed management.

Drees (2005) recommended that the sugarcane transplanting could be used as alternative method of the sugarcane seedlings. They could be prepared inside the plastic pots to maintain on the roots and decrease the percentage of the dead seedlings. In the future, it is recommended that development and construction of a special transplanter for the sugarcane crop. Genaidy (2008) tested the transplanter was designed to set the transplanting vertically. This machine has a disc pocket arrangement transplanting mechanism and equipped with furrow for placing seedlings and packing wheels. These parts are mounted on a frame attached to the 3-point hitch tool bar. Seedlings are placed manually into the transplanting pockets, which consist of two rubber plates to hold the seedling. The rubber plates are opened and closed with special spring mechanism. This transplanter is mounted on a small tractor 23.5 kW as a power source. During the field experiments, the following parameters were examined:

- Four forward speeds of transplanter 0.5, 0.8, 1.2 and 1.5 km/h.
- Two methods of transplanting (manually and mechanically).

Ismail and Ghatas (2009) found that the best results for sugar beet transplanting were obtained using feed metering speed of 0.16 m/s. The maximum field efficiency of 94.5% was obtained at forward speed of 1.5 km/h and the minimum field efficiency of 83.2 % was obtained at forward speed of 4.2 km/h. Abd El-Mawla et al. (2011) developed a sugarcane transplanter and found that the best of the results for sugar cane transplanting could be using the 0.9 km/h. forward speed, 40 cm distance between seedlings and 60 days age of seedlings for seedlings planted in plastic bags, and using the 0.6 km/h forward speed, 40 cm distance between seedlings and 50 days age of seedlings for seedlings planted directly in nursery. The maximum of field efficiency was 86% when the forward speed 0.6 km/h and minimum of field efficiency was 51% when the forward speed 1.50 km/h.

2. Materials and methods

2.1. Materials

The field experiments were carried out at the farm of Faculty of Agriculture, Al-Azhar University-Assiut Egypt. The experimental field was plowed three times by chisel plow, and pulverized using disc harrow, and leveling by using the hydraulic scraper .

A sample of 500 kg sugarcane stalks (variety of C-9) was used as seeds for planting and 500 g monogerm sugar beet seeds "Helna–variety". The sample was obtained from the Sugar Crops Research Center in Malawi, Minya Governorate, Egypt .

The mechanical transplanting of sugarcane seedlings was accomplished by using the developed transplanter by workshop of Faculty of Agriculture Engineering, Al-Azhar University-Assiut Egypt in May 2015, while the mechanical transplanting of sugar beet seedlings was accomplished by the same transplanter machine in October 2015.

Nursery's establishing

a) Buds separation machine

A manually operated cane bud's separation was fabricated used to cut cane buds with safety to be used in initiating cane seedling nursery. The bud's separation machine arc used according to (Drees 2005) after some modifications as shown in Figure 1 containing the following parts electric motor (0.75 kW), frame and cutting mechanism contents of the pair rotary disks, one of them diameter 20 cm and the other disk diameter 17 cm, two disks are together rotary by shaft is taken his motion by electric motor with rollers and (V) belt.

b) Cane stalks characteristics

The characteristics of sugarcane C-9 variety stalk before buds separation are presented in Table 1.

Planting sets of buds

The planting nursery of area was 25 m2 with 500 kg sugarcane stalks to give buds enough for planting this of area. Nursery was established by planting sets with intact buds as planting single bud in plastic bags. The nursery was planted with sugar cane buds in the first week of March 2015 .

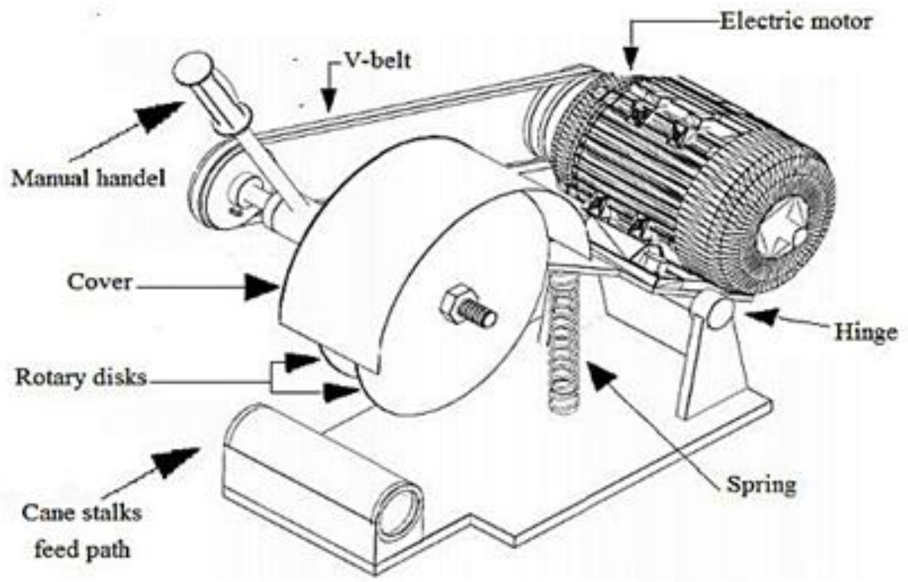

Figure 1. Bud's separation machine according to (Drees 2005) after some modifications.

Table 1
Characteristics of sugarcane C-9 variety stalk before buds' separation.

Characteristics	Mean
Stalk length "L" cm	295
Stalk diameter "D" cm	2.65
Stalk mass "M" kg	1.85
The number of buds on stalk	22

Planting seeds of sugar beet

The nursery of sugar beet seeds "Helna–variety" of monogerms seeds variety were planted in September 2015. Acre needed for planting with seedlings of paper trays to 120 trays which it set in 10 cm length for diameters "2.5 cm." (Nursery area was about 30 m^2).

Seedlings

1. Sugar cane seedlings ages from 6-8 weeks which mass was about 150 gm for plastic bags (6×13 cm of size) used in the field experiments, as shown in Figure 2.

Fig. 2. Sugar cane seedling.

2. Sugar beet seedlings ages 30-40 days and mass was about 60 gm for paper pots used in the field experiments, as shown in Figure 3.

Fig. 3. Sugar beet seedling.

Transplanter

One unit transplanter as shown in Figure 4 which is attached may need one labor for operations. The transplanter developed for sugar cane transplanting in the main field and can adjusted sugar beet transplanting. The transplanter prototype of mass 200 kg and consists of main frame, feeding mechanism consist of two units and 24 cells per unit for mechanical feed to overcome miss the seedlings by the labor, Chisel furrow-opener, covering device, two rubber ground-wheels, transmission motion system, labor seat, seedlings holder.

Power transported to feeding mechanism from of ground wheel to cells by groups of gears, a sprockets and chain to achieve equal seedling spacing to appropriate each of crops. Two motion ratios between ground wheel and feeding mechanism were designed to accomplish certain seedling spacing, this motion ratio ware 1:3 and 1:1.47 to forget 20 and 40 cm in row spacing for sugar beet sugar cane crops, respectively.

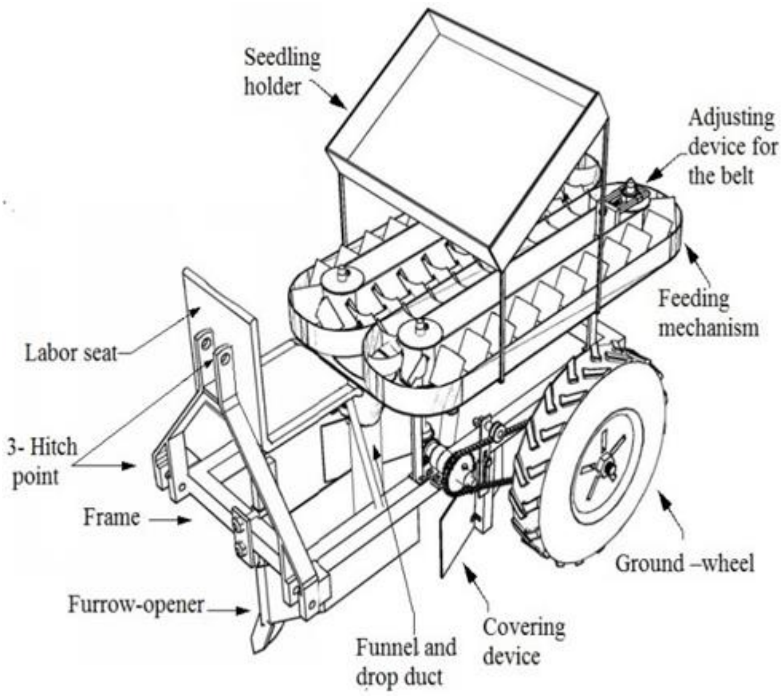

Figure 4. Developed transplanter of sugar crops.

Tractor

A tractor (IMT 65 Hp., 50 kW Romanian made) was used to drag the transplanter during transplanting operation.

2.2. Methods

Manual transplanting

Laborers are performed by planted of seedlings in a hills in planting furrow and has around covering of soil, the feddan (4200 m^2) needed to 20 and 35 laborers for raising the sugar beet and sugar cane seedlings respectively from the nursery land and manually transplanting in the field in about of time are six hours.

Mechanical transplanting

Before starting in operation of transplanter, the laborer is feeds of all cells at one of the two belts with seedlings, and when operation that seedlings are falling on consecutively in the tube transplanting and to bottom of furrow, and the same of time that laborer is feeds in cells which revolved by the other belt, when finishing of has cells feeding it is starting in feeds of cells for first belt. The four forward speeds of transplanter during the field experiments 0.7, 0.9, 1.2 and 1.4 km/h.

The seedlings were transferred from nursery to planting in main field, the acer (4200 m^2) needed to seven laborers for raising the sugar cane seedlings from the nursery land to seedling holder with transplanting machine, while are needed to five laborers for raising the sugar beet seedlings.

Measurements

Germination percentage

The percentage of germination seedlings (G%) was calculated from equation (1).

$$\frac{n_d}{n_t} \times 100 \quad \text{... [1]}$$

where:

n_d = Number of died buds or seeds after three weeks.

n_t = Number of total buds or seeds.

Percentage of missing hills

The Percentage of missed hills (M.h %) was calculated from equation (2).

$$\mathrm{M.h\%} = \frac{\mathrm{N_3}}{\mathrm{N_2}} \times 100 \quad \text{... [2]}$$

Where:

N_3= Number of missing hills seedlings 30 m row length.

N_2= Total number of seedlings by planting area.

Percentage of dead seedlings

$$\mathrm{D.s} = \frac{\mathrm{N_1}}{\mathrm{N_2}} \times 100 \quad \text{... [3]}$$

where:

D.s %= Percentage of dead seedlings, %.

N_1 = Number of dead seedlings after from one to three weeks.

N_2 = The total number of seedlings by planting area.

Actual field capacity

The actual field capacity was determined using the following equation:

$$A.F.C. = \frac{1}{\text{Actual time (min)}} \quad ... [4]$$

Field efficiency

The Field efficiency was determined using the following equation:

$$\eta_f = \frac{\text{Actual field capacity (fed/h)}}{\text{Theoretical field capacity (fed/h)}} \times 100 \quad ... [5]$$

Fuel consumption

The calibration glass was used to measure the amount of refilled fuel consumed through the test time of the transplanting. The fuel consumed was estimated in l/h.

Power and energy requirements

The power required by the tractor was calculated using the measured fuel consumption during transplanting operation under different variables of the study.

The following formula was used to estimate the tractor horsepower according to:

$$P = F_c \times \rho_f \times L.C.V \times \eta_{th} \times \eta_m \quad ... [6]$$

where

P = power consumed, (kW).
F_c = Fuel consumption, (l/h).
ρ_f = Density of fuel, (kg/l), (for diesel= 0.85).
LCV = Calorific value of fuel, (10000 k.cal/kg).
η_{th} = Thermal efficiency of the engine, (35 % for Diesel engine).
η_m = Mechanical efficiency of the engine, (80 % for Diesel engines).

The energy requirements in kWh/fed for transplanter was calculated from the following equation:

$$\text{Energy requirement } (kWh/fed) = \frac{\text{Engine power, (kW)}}{\text{Field capacity, (fed/h)}} \quad ... [7]$$

Human energy was estimated based on the power of one laborer, which was considered to about 0.075 kW, and then the human energy is determined using the following equation according to Chanceller (1981):

Human energy (kWh/fed) = 0.075 (kW) × number of laborers / actual field capacity (fed/h) … [8]

Transplanting cost

Cost of operation was calculated according to the equation given by Awady (1978) as follows:

C = p/h (1/a + i + t/2 + r) + (Ec * Ep) + m/144 … [9]

where:

C = hourly cost,
p = price of machine,
h = yearly working hours,
a = life expectancy of the machine,
i = interest rate/year,
t = taxes,
r = overheads and indirect cost ratio,
Ec = Electricity consumption kW.h/h,
Ep= Electricity price L.E/Kw.h,
"144" are estimated monthly working hours.

Notice that all units have to be consistent to result in L.E/h.

Manual transplanting = number of laborers for one feddan × labor wage per hour × number of hours per feddan.

3. Results and discussions

The discussion will cover the results obtained under the following headings:

3.1. Germination percentage and seedlings characteristics

The mean characteristics of sugar cane seedlings for planted in plastic bags and sugar beet seedlings planted in paper pots listed in Table 1.

a) Sugar cane nursery

The germination may start almost one week after planting. The percent of germinated seedlings increased directly with the period from planting for up to 4 weeks. Based on the activity of inspecting and selecting healthy buds before planted in the nursery, the percent of germination may reach very close to 100% after 4 weeks from planting .

Table 2.
The mean characteristics of sugar beet planted in paper pots and sugar cane seedlings for planted in plastic bags.

Properties	Sugar beet seedlings in paper pots	Sugar cane seedlings planted in plastic bags
Seedlings total length, mm	201	590
Stem thickness, mm	2.55	5.21
Stem length, mm	50.2	150
Length of root, mm	99.7	80
Ave. number of leaf's	2.8	6.8

Actually, some buds may need longer time for germination and arise over the soil. Seedling size development parameters were measured each five days after the full germination of the nursery. Consequently, the measurements of seedling size were started 30 days after planting in the nursery. Figure 5 show two parameters used to describe seedling sizes represented in the full length of the seedling and the length of seedling stem. As shown in the Figure, the seedling size developed rapidly after germination. The average seedling full length may reach at 59 cm within less than 50 days from planting. When planting several nurseries, considerable variation in seedling sizes may be easily seen. The variation may refer to the cane seed variety or to the nursery soil. The activities of seedlings treatment, planting at precise depth and nursery care may also be effective factors not only on germination but also on seedling size. Larger seedlings may cause difficulties in case of mechanical transplanting and longer seedling leafs may be rapidly dehydrated.

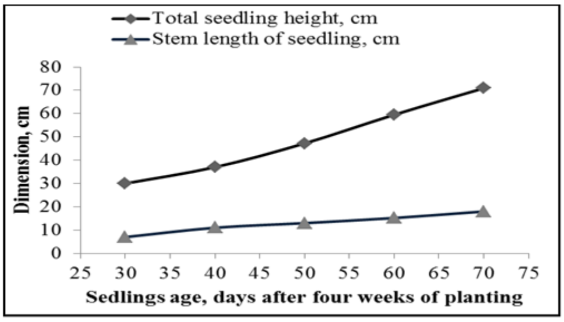

Figure 5. Seedling size as related to nursery age.

b) Sugar beet nursery

The germination percentages of sugar beet seeds were 90% when duration after a week, the germination percentages were constant at nearly 95 % for seeds for arrived in 30 days ages .

Transplanting achieves when are 2-4 real leafs of seedlings where the roots resulting from this technique are not complex and with a conical shape.

3.2. Transplanting accuracy

a) In-row spacing

The gear ratio set before starting transplanting operation determines the in-row spacing. As explained previously, two transmission ratios are possible from the ground wheel to the feeding belt ratio shaft.

Two values of Kinematic index λ= 0.525 and λ= 0.262 were sets by groups of gears, a sprockets and chain to getting of seedling spacing's 20 cm and 40 cm for sugar beet and sugar cane respectively. The machine was operated at the same values of λ, where the actual average seedlings spaces were measured in the field. The average actual in-row spacing was determined by measuring large number of actual distances between seedlings, where not including missing hills.

Figure 6 illustrates that the average actual seedlings spacing increased by increased forward speed for all spacing's in-row adjusted on the transplanter. The increased seedling spacing by increasing the forward speed may be due to variation of slip ratio of the machine ground speed as affected by the change of forward speed. The minimum average actual seedlings spacing 41.5 and 20.6 cm at forward speed 0.7 km/h for theoretical seedlings spacing 40 cm (sugar cane) and 20 cm (sugar beet) respectively. In case of calculate the average actual in-row spacing with including missing hills, the actual in-row spacing may be little larger than those computed for the transmission ratio because of wheel slippage, thus the average in-row spacing may be wider if the distances of missing hills included. Ability of the laborer on feed cells of feeding belt different at variable machine speed.

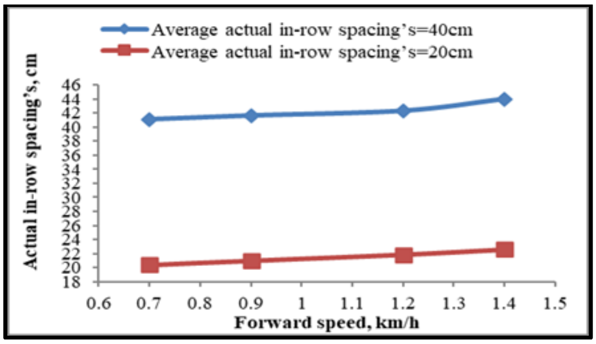

Figure 6. Effect of forward speed on average seedlings spacing for crops of sugar cane (theoretical in-row spacing's=40 cm) and sugar beet (theoretical in-row spacing's=20 cm).

Figures 7 and 8 shows the number of cells to be feeding within a single minute at the tested forward speeds corresponding to the percent increased average in-row spacing. At forward speed of 0.7 km/h, the labor has to feed about 58 cells per minute for sugar beet transplanting and has decreased cells missed without feeding to a minimum. While the labor can feed about 29 cells per minute for sugar cane transplanting, cells missed without feeding may be null.

At these operating conditions, the increase in average in-row spacing may be related to ground wheel slip. Increasing the forward speed to 1.4 km/h the labor has to feeding about 116 cells per minute which may be difficult, and some cells are missed without feeding. At this condition, the average in-row spacing may additionally increase because of the duplicated in-row spaces due to missed hills.

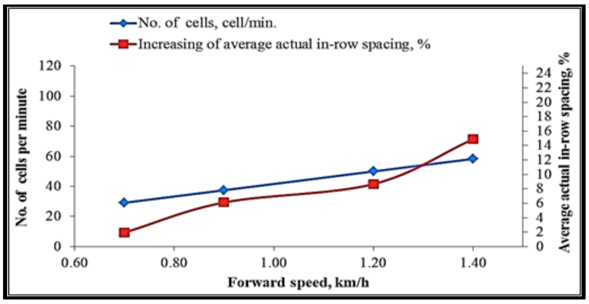

Figure 7. Average actual in-row spacing percentage as affected by forward speed and number of cells per minute for sugar cane seedlings.

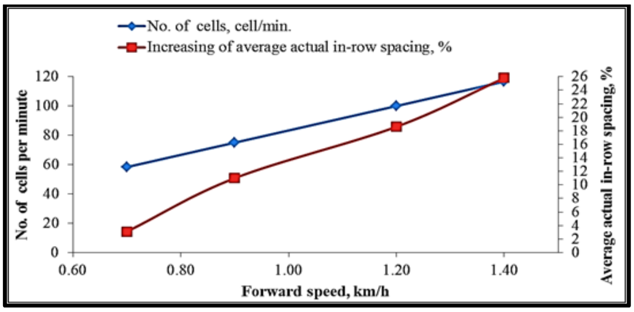

Figure 8. Average actual in-row spacing percentage as affected by forward speed and number of cells per minute for sugar beet seedlings.

In the manually transplanting, average actual in-row spacing was 43.3 and 22.3 cm for theoretical seedling spacing's 40 cm (sugar cane crop) and 20 cm (sugar beet crop) respectively.

b) Missing hills, %

The most important criterion considered for testing the operation was missing hills. The percentage of missing hills reflects the capability of the laborer to maintain continuous feeding of seedlings to the current cells passing in front of him. The main reason of missing hills is fast travel, the number of cells to be feed per minute increases where laborer may not be able to be feeding of all cells. The percent of missing hills was determined after transplanting the full field.

Figure 9 illustrates that the missed seedlings percentage increased by increasing the transplanter forward speed. The lowest values of missed seedlings (1.28%) and (1.53%) at forward speed of 0.7 km/h for crops of sugar cane (λ=0.262) and sugar beet (λ=0.525), while the highest value of missed seedling (9.03%) and (11.43%) at 1.4km/h forward speeds for crops of sugar cane (λ= 0.262) and sugar beet (λ= 0.525) .

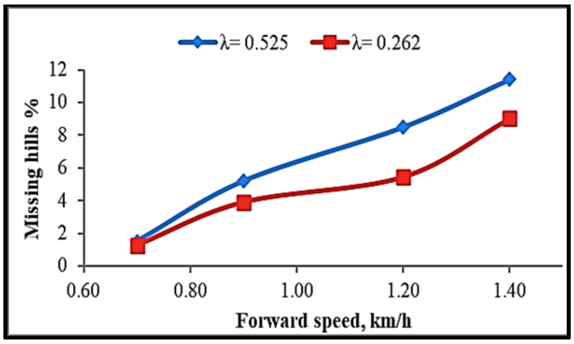

Figure 9. Missing hills percentage as affected by forward speed for crops of sugar cane (λ=0.262) and sugar beet (λ=0.525).

In case of sugar crops fields established by transplanting, the problem of missing hills would be manageable since the farmer can easily transplant the missed hills by hand in the same day directly before irrigation. In contrast, missed hills represent a complex problem in case of traditional planting method because the farmer will not be sure about missing hills before one and half month from planting. Finally, from the above-mentioned discussion, it could be concluded that using the 1.2 and 0.9 km/h forward speed for seedlings planted by spacing 40 and 20 cm between seedlings in row for crops of sugar cane and sugar beet respectively, decreased the percentage of missing hills reasonably can be processed by the farmer compared with the other top levels study.

In the other hand, the data obtained from the manual transplanting treatment showed that the missing hills percentage for manual transplanting may be null compare with lower than of forward speed when using mechanical transplanting.

c) Dead seedlings, %

The field should be daily inspected for one week after transplanting to localize the dead seedlings. The drought seedlings should be removed, and a healthy seedling transplanted by hand to eliminate the gap. Therefore, some extra seedlings should be left in the nursery to compensate both missing and died hills immediately after transplanting.

Figure 10 illustrate increased of dead seedling percentage affected by forward speed after one week of transplanting in the main fie. The minimum value of dead seedlings percentage was 1.65 and 1.3% at 0.7 km/h forward speed for both crops sugar cane and sugar beet respectively, and when operating the transplanter, the high speed to 1.4 km/h that the value of dead seedlings increased to less than 4 and 5 % for sugar cane and sugar beet crops, respectively. The dead seedling percentage affected by many factors such as peripheral speed of feeding belt, handling of seedlings by operating laborer, fixed in the soil and feeding rate of seedlings.

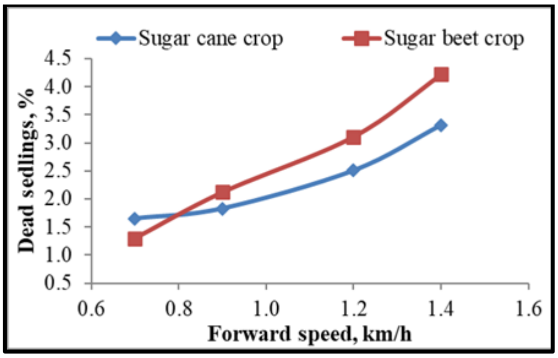

Figure 10. Dead seedlings percentage affected by forward speed for crops of sugar cane and sugar beet.

3.3. Transplanter performance

The transplanter was tested for transplanting of sugar cane and sugar beet seedlings of theoretical in-row spacing's 40 and 20 cm between seedlings and distance between rows was 90 and 60 cm for crops sugar cane and sugar beet, respectively. The length of rows was 30 m for each of experimental of field treatment. Field performance of the transplanter is shown in Table (3) at forward speeds 0.7, 0.9, 1.2 and 1.4 km/h.

In the manually transplanting, the actual field capacity of manual transplanting was 0.166 fed/h by 35 and 20 laborers for transplanting of sugar cane and sugar beet crops at time about six hours .

3.4. Fuel consumed, and power required

The tractor fuel consumption, (l/h) was 1.85, 2.33, 2.98 and 3.55 l/h by using forward speeds of tractor 0.7, 0.9, 1.2 and 1.4 km/h. The total power required for the transplanter (kW.hr/fed.) was estimated using the fuel consumption during transplanting operation. The results showed that the total power required was 49.55, 51.9, 53.37 and 59.07 kW.h/fed. when orating of sugar cane transplanting and 68.32, 70.29, 69.79 and 77.08 kW.h/fed for transplanting of sugar beet crop under forward speeds of tractor 0.7, 0.9, 1.2 and 1.4 km/h, respectively.

3.5. Cost analysis

Applying transplanting technique saves up to two months of the period required for sugarcane production and 30 to 40 days for sugar beet crop. This is important advantage that permits the chance to harvest the previous crop and well preparation of field soil. And saving this period reduces the production season that eliminates three irrigations and eliminate 2 cultivations by hand hoe.

The transplanter was compared with the manual transplanting for carry out the same work, with respect to time and cost of transplanting .

Table 3 listed costs of transplanting operation using the machine for advancing speeds 0.7, 0.9, 1.2 km/h and 1.4 km/h with average percentage of missing hills. As shown in the table, the highest transplanting costs were 1074 L.E. and 772 L.E. per feddan with forward speeds 0.7 km/h for sugar beet and sugar cane crops, respectively. While the lowest transplanting costs were 629 L.E. and 481 L.E. per feddan with forward speeds 1.4 km/h for sugar beet and sugar cane crops, respectively.

Table 3
Field performance rate and field efficiency percentage of the transplanter.

Forward speed, km/h	Kinematic index (λ)	Actual performance rate, fed/h		Field efficiency, %	Costs of feddan transplanting, L.E.	Ave. missing hills, %
		Fed/h	h/fed			
0.7	0.525	0.082	12.13	82.43	1074	1.53
	0.262	0.114	8.77	76.00	772	1.28
0.9	0.525	0.101	9.91	78.49	872	5.21
	0.262	0.137	7.30	71.04	643	3.92
1.2	0.525	0.126	7.97	73.23	699	8.51
	0.262	0.166	6.02	64.59	530	5.46
1.4	0.525	0.133	7.52	66.52	629	11.43
	0.262	0.175	5.72	58.25	481	9.03

Figure 11 shows comparison between mechanically by transplanter and manually transplanting for both sugar beet and sugar cane crops in terms of costs. The actual performance rate of transplanter at less than eight hours compared with six hours by manually transplanting. It notes decrease in the cost of mechanically transplanting more than 25 and 50% for crops of sugar beet and sugar cane respectively compared with manually transplanting.

4. Conclusions

This research was conducted to evaluate the transplanter of main sugar crops. Results can be concluded that:

1. Minimum average actual seedlings spacing 41.5 and 20.6 cm at forward speed 0.7 km/h and in the manually transplanting was 43.3 and 22.3 cm for theoretical seedlings spacing 40 cm (sugar cane) and 20 cm (sugar beet) respectively.

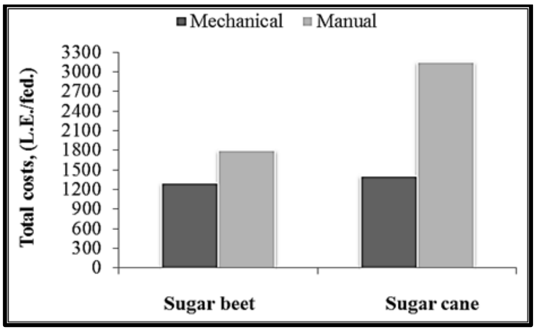

Figure 11. Costs per feddan of mechanically transplanting by transplanter compared to manually transplanting for both sugar beet and sugar cane crops.

2. Lowest values of missed seedlings (1.28%) and (1.53%) at forward speed of 0.7 km/h for crops of sugar cane (λ=0.262) and sugar beet (λ=0.525) and in the manually transplanting the missing hills percentage for manual transplanting may be null compare with lower than of forward speed when using mechanical transplanting.
3. Maximum field efficiency of transplanter was 82% and 76% with forward speed 0.7 km/h crops of sugar beet and sugar cane, respectively.
4. Mechanical transplanter for transplanting of sugar cane and sugar beet reduced planting costs.
5. Decrease cost of mechanical transplanting developed operation costs more than 25 and 50% for crops of sugar beet and sugar cane crops respectively compared with manually transplantin.
6. Maximum values of the power required to transplanter were 59.07 kW.h/fed. and 77.08 kW.h/fed for transplanting of sugar beet and sugar cane crops respectively under forward speeds of tractor 1.4 km/h. In the manual transplanting the total energy required was 92 and 161 kW.h/fed for transplanting of sugar beet and sugar cane crops, respectively.

References

Awady, M.N., 1978. Tractors and farm machines, in Arabic, text. Col. Ag., A. Shams U.: 164-167.

Abd El Mawla H.A, A.M. El Laithy, A. M. Drees, W.A. Mahmoud, 2011. A single row sugarcane trans-planter, Misr J. Ag. Eng., 28 No 4: 441- 454.

Central Council for Sugar Crops, 2015. World status of sugar crops, productivity of sugar crops in Egypt. Sugar crops and sugar production in Egypt and the world. Ministry of Agriculture 1:85.

Chamceller, W.I., 1981. Substituting information for energy in agriculture. Tran. ASAE. (5): 802-807.

Drees, A.M. , 2005. A study on mechanization of sugar cane Planting Ph. D. Agric. Eng. Dept. Fac. of Agric., Tanta Univ.: 108 -112.

Genaidy, M.A.I., 2008. Performance of small cotton transplanter under Egyptian condition, Misr J. Ag. Eng., 25(1): 1-14.

Ismail, Z.E., A.S. Ghattas, 2009. The semi- automatic transplanter of sugar beet, Misr J. Ag. Eng., 26(3): 1155 – 1171.

Jakeway, L.A., 1985. Mechanical planting of Sugarcane in small hold sizes in Egypt. Inter-American sugarcane seminars. Miami volume 1:168-174.

Sundara. B., 1998. Sugarcane Cultivation – First Edition pp. 56 –68.

مقارنة بين الشتل اليدوي والميكانيكي لمحاصيل السكر الرئيسية.

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الملخص العربي

تعتمد صناعة السكر في مصر على محصولين أساسيين هما قصب وبنجر السكر، وتنتج مصر حوالي ٢,٢٩ مليون طن من السكر سنويا من محصولي القصب والبنجر. وتناولت كثير من الأبحاث أهمية استخدام تقنية الشتل في زراعة محاصيل انتاج السكر بهدف تقليل كمية التقاوي وأيضا توفير كمية من مياه الري خلال فترة إنبات المشتل إلى غير ذلك من المميزات التي تحتم تطوير ميكنة شتل محاصيل السكر الرئيسية. وعند زراعة محصول قصب السكر بالشتل فإن السيقان يتم تقطيعها إلى عقل ذات براعم مفردة في أوعية بلاستيكية صغيرة داخل المشتل وعندما يصل عمر الشتلات من ٦ إلى ٨ أسابيع تصبح جاهزة لزراعتها بالحقل الرئيسي، أما عند زراعة محصول البنجر فإن البذور المفردة الأجنة تزرع في أوعية ورقية وعنما تصل فترة إنبات المشتل من ٤ إلى ٦ أسابيع فإن الشتلات تكون جاهزة للشتل بالحقل الرئيسي.

ويهدف البحث إلى تقييم أداء آلة شتل مطورة لشتل محصول قصب السكر ومدى إمكانية شتل محصول بنجر السكر بنفس الآلة، واشتملت الدراسة على السعة الحقلية والكفاءة الحقلية ومتوسط المسافة الفعلية بين الشتلات داخل الخط والنسبة المئوية للجور الغائبة وكذلك النسبة المئوية للشتلات الميتة بعد الشتل واستهلاك الوقود ومتطلبات الطاقة وتكاليف عملية الشتل مقارنة بالشتل اليدوي.

اختبرت الآلة عند أربع سرعات هي (٠,٧، ٠,٩، ١,٢، ١,٤ كم/س) وبينت النتائج الآتي:

١) متوسط المسافة بين الشتلات داخل خط الزراعة عند استخدام آلة الشتل ٢٠,٦ و٤١,٥ سم عند سرعة أمامية ٠,٧ كم/س بينما كانت ٢٢,٣ و٤٣,٣ سم عند الشتل اليدوي وذلك عند مسافات الزراعة النظرية ٢٠ و٤٠ سم لمحصولي البنجر والقصب على الترتيب.
٢) أقل قيمة لمتوسط الجور الغائبة ١,٥٣ و١,٢٨ % عند سرعة أمامية ٠,٧ كم/س وذلك لمحصولي البنجر والقصب على الترتيب.
٣) الشتل الميكانيكي باستخدام آلة الشتل يخفض تكاليف عملية الشتل بحوالي ٢٥ و٥٠٪ لمحصولي البنجر والقصب على الترتيب مقارنة بالشتل اليدوي.
٤) أقصى طاقة مطلوبة للشتل الميكانيكي ٥٩ كيلو وات.ساعة/فدان و٧٧ كيلو وات.ساعة/فدان لمحصولي البنجر والقصب علي الترتيب, بينما الطاقة المطلوبة للشتل اليدوي ٩٢ و ١٦١ كيلو وات.ساعة/فدان.