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AN ENGINEERING STUDY TO IMPROVE THE PERFORMANCE OF A LOCALLY PUSHING PLANTER FOR SUGAR BEET CROP.

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ABSTRACT

This paper aims to test and evaluate a locally fabricated hand planter performance in field conditions, and study some engineering factors that affect its performance. Field evaluation included three types of ground wheel (steel, lugged, and rubber), three types of furrow opener (single disc, double disc, and runner), four types of depth control device and three values of planting depth (1, 3, and 5 cm) to select the suitable design components of the machine. Also, the root yield and costs of using the machine were estimated and compared with manual planting method. The results demonstrated that the runner opener is generally satisfactory for sugar beet sowing due to their least variation in planting depth, highest plant emergence, and fastest rate of emergence. The pushing force increased by increasing in the seeds depth of planting. It ranged from 70 to 120 N for depth range of 1 – 5 cm. This trend shows that the planter is suitable for average worker. The best depth control was achieved by linked wheels and side wheel, with less control by the front wheel and poorest control by the rear wheel. The minimum slip of 5.3 % and rolling resistance of 30.2 N were recorded with rubber wheel, meanwhile the maximum slip of 15.6 % and rolling resistance of 57.6 N were obtained by using steel wheel type. By using the fabricated hand planter the beet root yield and sugar yield increased by 30 and 26 % respectively as compared with manual method. Hand planter reduced the labor requirement by 83.3 %, (kg of seed / feddan) was reduced by about 67.5 % and total cost of planting / feddan was reduced by 72.7 %. The energy requirement for sugar beet planting decreased by about 83.7 % by using the fabricated hand planter instead of the manual planting.

INTRODUCTION

A high beet root yield requires a high field emergence and a uniform development of each plant. To achieve this situation, there is a requirement for a uniform sowing depth as well as a uniform seed distribution over area. Both depend on the techniques used for seed placement into the soil.

Srivastava (1975) developed a hand drill with stationary hole type metering device provided with nylon brush type agitator. He reported that the field trials and given satisfactory performance with a field capacity of 0.8 ha/day (8 hrs) at walking speed of 2.5 km/h for sowing unpolished sugar beet seeds at uniform depth.

Kepner et al. (1978) stated that a tillage implement moving at a constant velocity is subjected to three main forces, which must be in equilibrium. These are:

1- Force of gravity acting upon the implement, 2- The soil forces acting upon the implement and

3- The forces acting between the implement and the prime mover.

The resultant of these forces is the pull upon the implement.

Awady and Ghoniem (1985) found that the pushing force of seed planter machine increased by increasing the seed depth of planting. The relationship between draw-bar pull, forward speed and depth during studing design characteristics of a push-type maize planter was as follows:

$F = 36.8 + 9.71\ V + 10\ D$....................... (1)

where: F = force, N, V = speed, km/h and D = depth, cm.

Tessier et al. (1991) measured soil disturbance caused by furrow openers using roughness meter made of a section of steel pins positioned across seed rows. A roughness coefficient was calculated as the standard deviation between the elevation of steel pins on the surface and a mean regression of the same data. The hoe type opener resulted in the highest soil disturbace, followed by the double disc opener.

Schaaf et al. (1979) reported that planter double disc furrow openers apply lateral forces to soil when forming seed furrows. These forces tend to form a uniform V-shaped furrow, free of loose soil, that assure uniform seed depth and seed-soil contact.

Tabassum and khan (1992) stated that, irregularity in longitudinal placement of seeds was an index of estimation of seeding quality sown by drill. However, the determination of longitudinal irregularity factor of seed deposition in the soil was very difficult due to unpredictable behavior of seeds.

Ahmed and Gupla (1994) designed and fabricated a manually operated electrostatic planter for small seeds. It can be substituted for broadcasting and for manual planting to reduce labor requirement, seed rate per hectare and operational drudgery.

Chaudhuri (2001) reported that disc openers were generally satisfactory for conventional tillage due to lower draught, less soil disturbance and less variation in depth. Hoe openers had low draught due to small rake angles. However hoe openers create more soil disturbance which increased the soil moisture loss from the furrow. Runner openers were suitable for sowing under conventional tillage systems only for shallow sowing under irrigated conditions.

Tajudin and Balasubramanium (1995) evaluated hoe, shoe, wedge, single disc, and double disc furrow openers. Single-disc gave the best performance index mainly due to less draught. Wedge-type required the maximum power. Double-disc had lower draught but the performance index was affected due to poor penetration.

According to Heege (1993) the uniformity of the sowing depth was described by its standard deviation. It was shown that the field emergence of small grains under average German conditions can be improved distinctly by seeding methods with small standard deviation of the mean seeding depth.

Baker et al., (1996) reported that direct seeding machines utilize three types of opener design. These were double disc, single disc, and hoe openers. The most common was the double disc opener. It required a small draft less than 700 N and a large vertical force for penetration. On other hand, the hoe opener required a large draft force, but less vertical force than the double disc opener.

The current study was devoted to:

1- Determine the performance of the fabricated machine in the field under actual conditions and include seed spacing uniformity, planting depth variation, emergence percent, etc.
2- Determine the relative precision of depth control achieved by contrasting four different designs.
3- Study the factors affecting the draft force and power requirement for the hand planter.
4- Modify the machine if changes are required to achieve the expected level of performance.

MATERIALS AND METHODS

The model of pushing planter under study was designed and locally fabricated by (Abd El-Tawwab and Badawy 2005). Figure 1 is a elevation and side view of the experimental pushing planter, which was tested and evaluated under field conditions. The fabricated push planter consists of seed hopper, cup metering device, runner furrow opener, firming wheel, press wheel, front drive wheel, and main frame with two handles for pushing the planter forward during planting operation. The present study was carried out at the Experimental Farm of Sakha Agricultural Research Station. The experimental field was two times ploughed by chiesl plough at an average depth of 15 cm, and followed by a disc harrow, and levelled by hydraulic land leveller. The bulk density of the top soil was determined. And the same sample was used for determining moisture content using the oven method. The soil characteristics were determined and summarized in table 1.

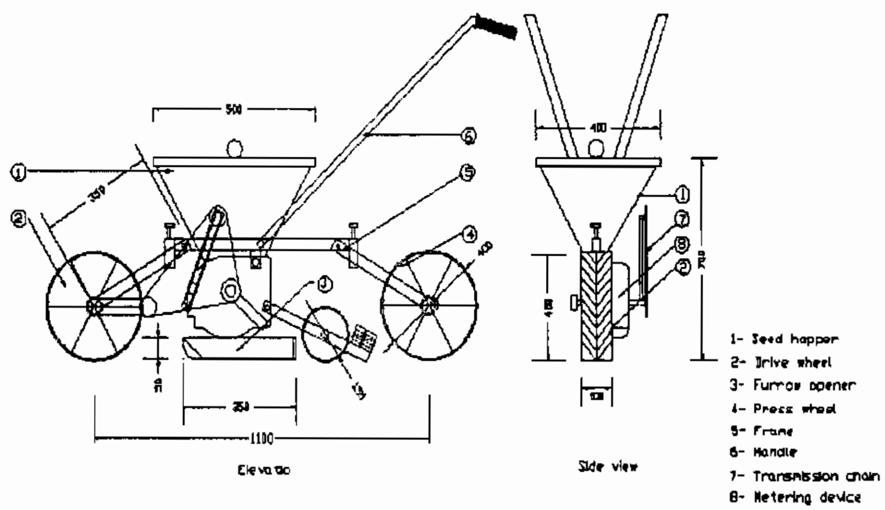

Fig. 1: An elevation and side view of the developed hand planter.

Dims. in mm

Table 1: Soil characteristics observed for the field test site.

Clay, %	Silt, %	$CaCo_3$, %	Sand, %	Soil texture	Bulk density, g/cm^3	Mean weight diameter, cm	Moisture content, %
52.96	30.96	2.28	13.8	Clay	1.4	2.92	14.5

Uncoated multi-germ beet seeds was used in planting. Seed is nearly of around shape with an average diameter of 6 mm.

The following parameters were considered for the field evaluation:

1- Furrow opener type:

Three types of furrow opener were used in this study (Runner, Single disc and Double disc). The runner opener are made of blade-like opener which is vertically split to form a wedge-shape for cutting and moving soil laterally to form furrow. Typical dimensions are 300 mm in length, 80 mm in depth at front and 30 mm in width at rear (According to ASAE standards 1997). The single-disc was made of a flat disc of 230 mm diameter and 3.5 mm thick with a sharpened circumference. It is set at a slight angle of 8 degree to the direction of the planter motion and 10 degree to vertical to move soil laterally to form a furrow (ASAE, 1997). The double disc furrow opener is made of plate with 2.5 mm thick, and 230 mm diameter are mounted symmetrically at an angle (β) of 10 degree to each other in a vertical plane. The width of furrows between the lower points of the cutting edges of both disks was determined according the following formula (Bosoi et al., 1987):

$$S = D(1 - \sin\alpha)\sin\beta / 2 \quad \text{.............. (2)}$$

Where: S is the furrow width, D is the disc diameter, β is inclination of two disks to each other and α is the angle of the point of contact of disc relation to horizontal axis is 30 degree.

2-Drive wheel:

The fabricated pushing planter was evaluated and tested with various type of ground wheels:

1- Plain steel wheel,

2- Lugged steel wheel: The lugs are 25 mm in height and were welded at an angle of 25 degree with the axis of rotation to reduce slip. The lugs were welded at an angle greater than zero and closed to reduce wear, vibrations, and rolling resistance and

3- Rubber wheel.

3-Depth control:

Planting depth control innovations are needed to improve the performance of the planter. Four depth control designs were evaluated with sugar beet crop.

1-Rear press wheel,

2-Front drive wheel,

3-Rear press wheel and front wheel pivotally connected by a rigid link and

4-Gage wheel beside the furrow opener.

4-Planting depth:

The performance of the fabricated planter was evaluated under three different planting depth of 1, 3, and 5 cm.

5-planting method:

The pushing planter performance was evaluated under the field conditions and compared with the traditional manual planting.

The following indicators were determined to investigate the effect of studying factors on the fabricated hand planter performance:

1- Seed spacing uniformity and missing percent:

These indexes were based on the theoretical spacing (X_{ref} = 20 cm). The quality of seed spacing uniformity index was the proportion of spacing between 0.5 to 1.5 X_{ref}. The multiple index was the proportion of spacing equal to or less than 0.5 X_{ref} and the missing index represented the percentage of spacing greater than 1.5 X_{ref}. (Kachman and Smith, 1995).

2- Emergence percent:

It is the ratio of the number of seeds which emergence from the soil to the number of seeds planted, indicated stand establishment ability of the treatments. Emergence counts for this calculation were taken after four weeks of beet planting date by using the following formula:

$$G_p = \frac{P}{S} \times 100,\% \qquad (3)$$

Where: G_p is the emergence percent, P is the average plant number per fifty meters along the sowing row, and S is the average number of delivered seeds per fifty meters along the planting row.

3- Panting depth variation:

The depth of planting was measured by digging the soil around beet seedling and carefully pulling the seedling out of the soil. A ring was always formed on the stem of the seedling at the boundary of the soil with the atmosphere. The distance between the ring and the radical root represented the depth of planting. The variation of the sowing depth is described by its standard deviation of the mean seeding depth, (Adekoya and Buchele,1987).

4- Slip:

Slip of machine ground wheel is an important factor, which affects planting rate per area. The percentage of slip was estimated for three different types of drive wheel. Slip percentage was calculated by using the following equation (Awady et al, 1997):

$$\text{Slippage} = \frac{\text{Effective distance} - \text{Theoretical distance}}{\text{Theoretical distance}} \times 100,\% \qquad (4)$$

Theoretical distance = No. of wheel rev. × π × drive wheel diameter

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5- Root yield:

The yield of the harvested roots was determined by massing the roots lifted by a manual shovel. The following equation was used:

$$R = \frac{4200 \times M}{1000 \times A}, Mg / fed \text{ ....} (5)$$

Where: R is the root yield, M is the mass of lifted root, kg and A is the harvested area, m^2.

6- Draft force, draft power and energy requirement:

Draft force was recorded under three types of furrow opener (runner, single disc and double disc), three types of drive wheels (plain, lugged, and rubber) and average planting depth of 1, 3, and 5 cm. A spring balance (calibrated hydraulic dynamometer) was used to measure the force required to push the planter. Force analysis figure 2 was carried out to calculate the rolling resistance and its coefficient to drive wheel and soil resistance to furrow opener as the following formulas:

Force analysis on the hand planter with lifted furrow opener:

$\sum x = 0$ .... (6)

$= P - C_r (R_1 + R_2)$

$\sum y = 0$ .... (7)

$= -W + (R_1 + R_2)$

Force analysis on the hand planter during operation:

$\sum x = 0$ .... (8)

$= P - C_r (R_1 + R_2) - S \sin \alpha$

$\alpha = 180 - \Theta$

$\sum y = 0$ .... (9)

$= -W + S \cos \alpha + (R_1 + R_2)$

Where: P is the draw pull, C_r is the coefficient of rolling resistance, R_1 is the soil reaction against front wheel, R_2 is the soil reaction against rear wheel, the rolling resistance $R_s = C_r (R_1 + R_2)$, W is weight of the planter and seeds (250 N), S is the soil resistance for furrow opener, and Θ is the rake angle of the opener formed between the furrow bottom and the tangent to the opener nose (Θ = 150 degree for runner opener and 140 degree for single disc and double disc openers).

The power required is defined as a pull force multiplied by speed as shown in the following formula:

Drawbar power, kW = drawbar force (kN) × speed (0.7 m/s)......... (10)

The consumed human energy (EH), was estimated based on the power of one labor which was considered to be about 0.1 hp (Chancellor 1981) using the following equation:

$$EH = \frac{0.1 \times 0.746 \times NL}{EFC}, \text{ kW.h / fed ....} (11)$$

Where:

NL = Number of labors, man;

EFC = Actual field capacity, fed. / h;

0.1 = hp of agricultural laborer, hp /man and

0.746 = Coefficient for changing from hp to kW, kW / hp

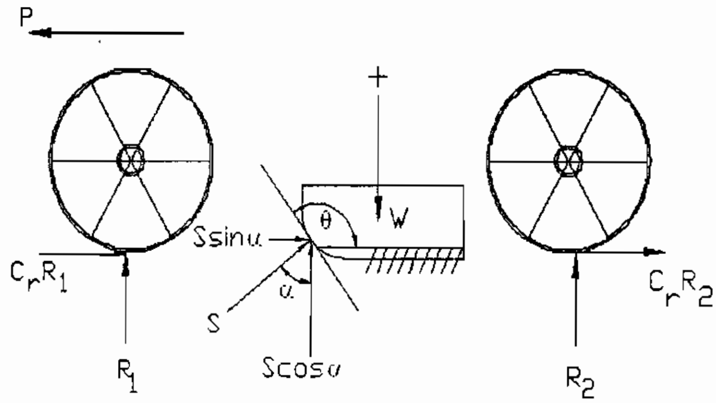

Fig. 2: Force analysis acting on the developed hand planter.

RESULTS AND DISCUSSION

1-Furrow opener:

The performance of furrow opener was measured in items of sowing depth variation, plants emergence, soil resistance for furrow opener, and draft requirement. Results in table 2 show that the least depth variation of 7.5 mm was obtained with double disc opener. While the maximum sowing depth variation of 10 mm occurred by single disc opener. But the difference of variation between double disc and runner opener was nil. Opener type had a significant effect on beet emergence. No signifincant differences in plant emergence were observed among runner and double disc during the study. While the minimum emergence was recorded with the single disc opener. Table2 summarizes the number of days required to reach 40 % emergence. The runner opener produced the fastest rate of emergence; the slowest rate of emergence was produced by the single-disc opener. The double-disc opener produced a somewhat faster emergence than the single-disc opener. This trend may be due to the single disc opener protrude below seed placement depth resulted in deep seed placement, and has a tendency to push dry soil into the seed groove. These factors contributed to higher sowing depth variation, slower and lower emergence. Meanwhile double-disk furrow opener prevents the furrow walls from falling that remained open during seed deposition and apply lateral forces to soil when forming seed furrows. These forces tend to form a uniform V-shaped furrow, free of loose soil, that assures uniform seed depth and seed-soil contact. The overall performance index of runner opener was the best as compared to the other two openers. This because runner opener has a long colter, transformed from behined into parallel jaws. The colter forms the furrow and the jaws prevent the furrow walls from falling during seed fall into their bottom and has better compaction of furrow bottom resulting in less sowing depth variation and higher emergence.

The draw-pull and soil resistance of furrow opener were affected by the type of furrow opener as well as depth of planting. Data of the draft power in figure 3 indicate that the draft increased by 34.38, 37.8, and 39.2% when the depth increased from 1 to 5 cm for single disc, runner and double disc, respectively. This may be attributed to the fact that the surface area in contact with the soil increased as the depth increased and hence the draft required by the opener also increased. The double disc furrow opener required significantly, less draft than the runner opener. In addition the single-disc opener had the lowest draft. The draw pull reached up to 120.3, 113.8 and 102.4 N with runner, double-disc and single-disc openers respectively. Additionally, the soil resistance values increased with the runner opener by 30.1 and 9.01 % over the single-disc and double-disc openers respectively.

Table 2: Depth variation, soil resistance, and emergence percent of beet seeds as affected by opener type.

Furrow opener type	Depth variation, mm	Soil resistance, N Planting depth, cm 1	3	5	Time to 40 % emergence, days	Emergence, %
Single disc	± 10	62.3	90.3	102.2	14.4	74.6
Double disc	± 7.5	69.4	99.4	122	13.5	81.6
Runner	± 8.5	80.4	103.9	133	12.8	83.4

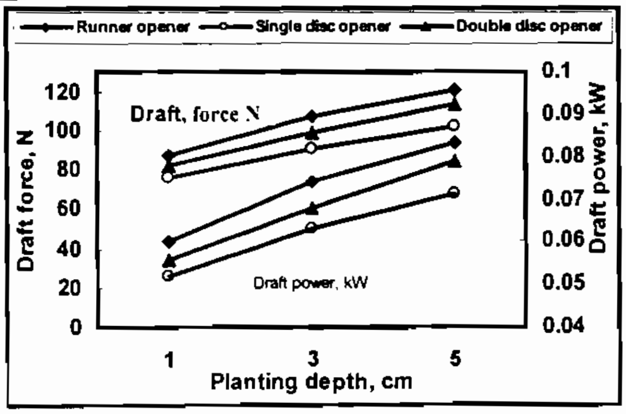

Fig. 3: The effect of furrow opener type and planting depth on the draft force and draft power.

2-Drive wheel:

The performance of ground wheel types were evaluated in relation to slippage, emergence, rolling resistance, and draft force. Data in table 3 indicate that there were a sensible differences of slip percent among wheel type. The minimum slip of 5.3 % was recorded with rubber wheel, meanwhile the maximum 15.6 % slip was obtained by steel wheel type. The variation in slip between wheel types may be due to the rubber wheel has greater contact with soil in addition to the presence of lugged protrusions. While the friction coefficient of steel wheel to the soil surface is very little resulting in higher slip. Slip results in decreased population, therefore, the desired population stand may not be achieved because fewer seeds per feddan are planted.

Also table 3 showed there were high differences in seed spacing uniformity among the different ground wheel. The best uniformity of seed spacing 84.6 % resulted with the rubber wheel. While the minimum uniformity 76.6 was recorded by steel wheel. The missing hill for rubber wheel decreased by about 64.1 and 94.3 % as compared with lugged and steel wheel respectively. Moreover the maximum emergence of plants was recorded with the rubber wheel. Emergence values were 82.9, 78.8, and 70.4 % for rubber, lugged, and steel wheel, respectively.

The average values of rolling resistance and draw-pull required for the push planter under three operating depths of 1, 3, and 5 cm are shown in figures 4 and 5. It is obvious that the rolling resistance and draft-pull increased by increasing the sowing depth for all ground wheel types. The variation in draft force and power requirement with different planting depth are due to rolling resistance increased against the wheel when the planting depth increased. In addition maximum draft force of 119.4 N , power requirement of 83.58 W and rolling resistance of 57.6 N were recorded with steel wheel at planting depth of 5 cm. Meanwhile the minimum draft of 70.1 N , power requirement of 49.07 W and rolling resistance of 30.2 N were recorded with rubber wheel at planting depth of 1 cm. This trend may be due to the steel wheel has a tendency to sink through the soil surface resulting in a higher draft force and rolling resistance.

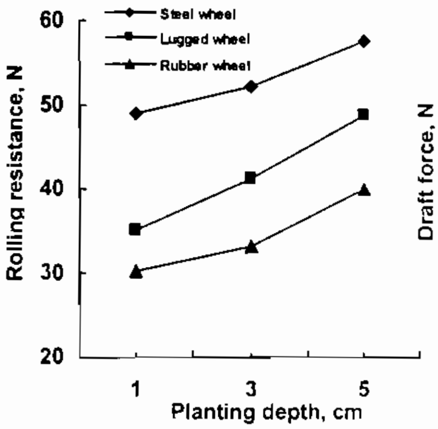

Fig. 4: Rolling resistance as affected by the wheel type.

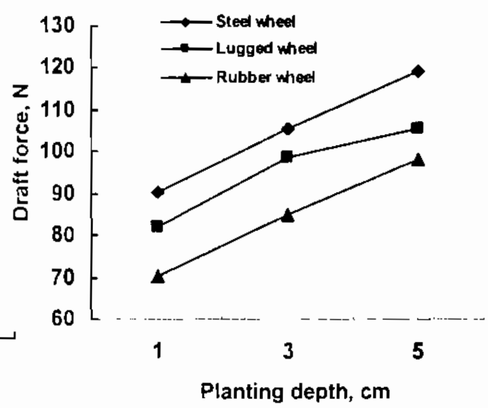

Fig. 5: Draft force as affected by the wheel type.

Table 3: Slip, missing hills, uniformity, rolling resistance, coefficient of rolling resistance and emergence percent of beet seeds as affected by wheel type.

Wheel type	Uniformity, %	Missing hill, %	Emergence, %	Slip, %	Coefficoient of roll. Res.
Steel	76.6	10.3	70.4	15.6	0.288
Lugged	81.7	8.7	78.7	9.72	0.244
Rubber	84.6	5.3	82.9	5.3	0.199

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3-Depth control:

Using mean standard deviation (depth variation) to evaluate the quality of planter depth control. As can be seen from the field study results in figure 6 the least planting depth variation of 7.5 mm was obtained with linked wheels. While the highest depth variation of 11.3 mm resulted with the rear press wheel, indicating the least depth control. Also good results in depth variation of 7.9 mm was obtained with side wheel. Moreover, it can be seen a gage-wheel opener either in front of or behind the opener alone is the worst way, where the wide distance between gage wheel and opener results in reactions on the unevenness of the soil surface, which occur either too early or too late. This is also due to the rear wheel operated on loosened soil with some wheel sink resulting in a depressed row trench. The other three designs appeared to operate on a firm soil without sink.

The histogram of the plant emergence figure 7 indicates that the emergence values were 82.1, 81.9, 77.4, and 73.6 % by using side wheel, linked wheels, rear wheel and front wheel respectively. Front wheel gave significantly lower plant emergence than that, with the rear wheel and linked wheels.

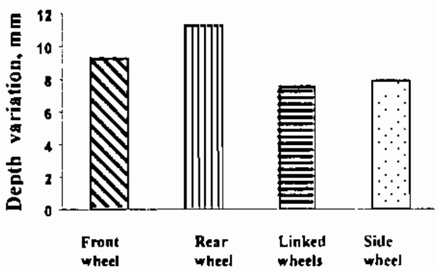

Fig. 6: The effect of depth control type on planting depth variation.

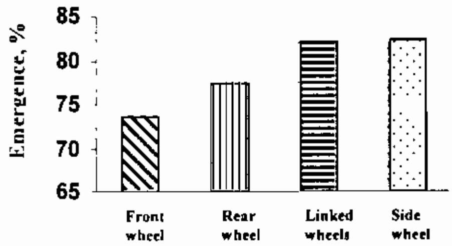

Fig. 7: The effect of depth control type on beet emergence percent.

4-Planting method:

Field tests were conducted to study the performance of the designed pushing planter comparing with manual planting. It is clear that the local push planter gave higher seed spacing uniformity of 84.2 % than the manual planting of 69.6 %. Regarding to the results, it is clear that, the local planter gave smaller depth variation of 7.5 mm and higher emergence of 82.3 % than the manual which gave 16.8 mm of planting depth variation and 74.1 % of emergence percent. Also, results illustrate that the mechanical planting leaded to more uniform spacing and planting depth variation resulted in higher root yield. Where the fabricated hand planter gave higher value of root yield 28.92 Mg/fed than the manual planting which gave 22.25 Mg/fed. Thus, the root yield increased by approximately 30 % when the fabricated planter was used instead of the manual planting method. In addition, the sugar yield was higher by about 26 % with hand planter as comparing to the manual planting method.

Table 4: Influence of planting system on distribution of beet plants and root yield.

Planting method	Seed spacing uniformity, %	Planting depth variation, mm	Seedling emergence, %	Root yield, Mg/fed	Sugar yield, Mg/fed	Eff.field capacity, fed/h	Field efficiency, %
Mechanical	84.2	± 7.5	82 3	28.92	4.67	0.25	84
Manual	69.6	± 16.8	74 1	22.25	3.71	_	_

Table 5: Influence of planting system on cost of beet planting and energyr equirement.

Sowing method	Labor req., man-h/fed	Operating cost, LE/fed	Seed consumed, kg/fed	Cost of seed, LE/fed	Total planting cost, LE/fed	Energy req., kW.h/fed
Mechanical	4	10	1.3	39	49	0.29
Manual	24	60	4	120	180	1.79

The costs of using the machine were estimated and compared with manual planting method. It was found that the amount of seeds consumed per feddan for the pushing planter decreased by 67.5 % as comparing to the manual planting method. Where this planter can plant one feddan with 1.6 kg meanwhile the manual planting consume about 4 kg / feddan. Assuming the seeds price of L.E. 30 per kg. This means that the seed cost in planting operation with the planter was about L.E. 39 while with manual method was about L.E. 120. Results indicated that the manual planting require about 24 man-hour/fed which costs about L.E. 60. The developed hand planter operated by one worker and can sow about 0.25 feddan/h, hence it requires 4 man-hour/fed which costs about L.E. 10. Thus, the total planting cost by planter is equal 27.2 % the manual planting system. This result clearly shows a net saving of about L.E. 131 per feddan. Data in table 5 present that the energy requirement for sugar beet planting operation was highly affected by the planting method. The energy requirement were 0.29 and 1.79 kW.h / feddan for the fabricated planter and manual planting respectively. This means that the energy requirement decreased by about 83.7 % by using the fabricated hand planter instead of the manual planting method.

CONCLUSIONS

The main results in the present study can be summarized in the following:

1- Results show that the least planting depth variation of 7.5 mm was obtained with double disc opener. While the maximum planting depth variation of 10 mm occurred by single disc opener.

2- Runner opener increased the plant emergence by about 2.2 and 17.7 % as compared to double disc and single disc openers respectively.

3- Soil resistance increased with the runner opener by 27.72 and 11 % comparing to the single disc and double disc, respectively.

4- The draw pull reached up to 120.3, 113.8 and 102.4 N with runner, double-disc and single-disc openers, respectively.

5- The minimum slip of 5.3 % was recorded with rubber wheel, meanwhile the maximum slip of 15.6 % was obtained by steel wheel type.

6- The maximum draft force of 119.4 N , and rolling resistance of 57.6 N were recorded with steel wheel at planting depth of 5 cm. Meanwhile the minimum draft of 70.1 N , and rolling resistance of 30.2 N were recorded with rubber wheel at planting depth of 1 cm.

7- The pushing force increased by increasing in the seeds depth of planting. It ranged from 70 to 120 N for depth rang of 1 – 5 cm. This trend shows that the planter is suitable for average worker.

8- The best control was achieved by linked wheels and side wheel, with less control by the front wheel and poorest control by the rear wheel.

9- Under mechanical method the root yield and sugar yield increased by 30 % and 26 % respectively as compared with manual method.

10- Mechanical planting method reduced the labor requirement by 83.3 %, seed consumed / feddan was reduced by about 67.5 % and cost of planting / feddan was reduced by 72.7 %.

11- The energy requirement decreased by about 83.7 % by using the fabricated hand planter instead of the manual planting method.

12- The optimum design of the fabricated pushing planter according to results are recommended as follows:

i. Furrow opener : Runner type
ii. Drive wheel : Rubber wheel
iii. Depth control : linked wheels
iv. Sowing depth : 1 cm

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دراسة هندسية لتحسين أداء آلة الزراعة مدفوعة محلية لمحصول بنجر السكر

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إن ميكنة عملية الزراعة تعد من أهم العمليات الزراعية لإنتاج محصول بنجر السكر وذلك لما لها من مميزات أهمها الوصول الى الوضع الأمثل من عدد النباتات والمسافات بينها وما ينتج عنها من زيادة فى الانتاج وبالتالى زيادة العائد المزرعى. إلا انه مازال تتم عملية الزراعة لهذا المحصول الهام مازالت بالطريقة اليدوية ولم تصل حتى الآن الى التطبيق المطلوب وذلك يرجع الى ارتفاع سعر آلات الزراعة المستوردة، وعدم توافق تلك الآلات وحجم الحيازات الزراعية الصغيرة والتى تمثل أغلب الأراضى الزراعية فى مصر. لذلك كان الهدف من هذا البحث هو تقييم الأداء الحقلى لآلة زراعة مدفوعة باليد محلية الصنع، ودراسة أهم العوامل الهندسية للوصول الى الأداء الأمثل للآلة. وقد اختبر عليها ثلاثة انواع من عجلة الأرض، ثلاثة انواع من الفجاجات، أربعة أنواع من اجهزة ضبط عمق الزراعة، وذلك بغرض تحديد انسب مكونات تصميمية ملائمة للآلة.

وتتلخص أهم النتائج فى الآتى:

١- أعطى الفجاج على هيئة قارب أعلى نسبة إنبات (٨٣,٤ %) يلية الفجاج مزدوج القرص (٨١,٦ %) ثم الفجاج مفرد القرص (٧٤,٦ %).

٢- وجد ان أعلى نسبة انزلاق سجلت مع العجلة ذات السطح الحديدي(١٥,٦ %) وأقل نسبة انزلاق مع العجلة ذات السطح المطاطي (٥,٣ %).

٣- أظهرت النتائج ان نوع جهاز ضبط العمق له تأثير كبير على تشتت عمق الزراعة،حيث أعطى جهاز ضبط العمق ذات العجلة الخلفية أعلى تشتت (١١,٣ مم) يلية الجهاز ذى العجلة الأمامية (٩,٣ مم)، بينما أعطى جهاز ضبط العمق ذات العجلتين المتصلتين اقل تشتت (٧,٥ مم) ثم يلية جهاز العمق ذى العجلة الجانبية (٧,٩ مم).

٤- وجد ان قوة الجر اللازمة للآلة تزداد بزيادة عمق البذر حيث تراوحت بين ٧٠ ، ١٢٠ نيوتن عند عمق ١، ٥ سم على الترتيب وهذا يدل على ان الآلة مناسبة لقوة العامل الزراعى العادى.

٥- بلغت الإنتاجية لمحصول بنجر السكر ٢٨,٩٢ ميجاجرام/فدان باستخدام الآلة المحلية فى مقابل ٢٢,٢٥ ميجاجرام/فدان باستخدام الزراعة اليدوية.

٦- إن استخدام آلة الزراعة المحلية حقق وفرا فى كمية التقاوى المستخدمة حيث بلغت تكلفة التقاوى ٣٩ جنية/فدان فى حين بلغت تكلفة التقاوى فى الزراعة اليدوية ١٢٠ جنيها/فدان.

٧- إن عدد العمالة فى الزراعة الآلية تمثل ١٦,٦ % من العمالة المطلوبة فى نظام الزراعة اليدوية.

٨- إجمالي تكاليف الزراعة باستخدام الآلة المحلية تمثل حوالى ٢٧,٢ % من تكاليف الزراعة اليدوية.

هذا وتعتبر الآلة قد لائمت المساحات الصغيرة من حيث توفرها لكميات التقاوى والإنتاجية الفدانية لجذور البنجر ومن التعديلات التى يمكن اجرائها فى الآلة لتحسين الأداء مستقبلا:

- تزويد الآلة بمحرك صغير لتكون ذاتية الحركة.
- تزويد الآلة بعدة وحدات للزراعة لزيادة العرض الفعلى للزراعة فى المساحات الكبيرة وذلك لزيادة الكفاءة الحقلية لها.
- ضرورة تطوير الآلة لتقوم بزراعة أغلب المحاصيل عن طريق تغيير أقراص التغذية لتكون متعددة الأغراض.