



Full length article

Development and evaluation of topping machine for sugar beet

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ABSTRACT

The aim of this investigation is to develop and evaluate a sugar beet topping machine suitable for smallholding farms, easy to use and high efficiency. The research was carried out in Al-Maseen Village, Al-Dilengat center, Al-Behera Governorate, Egypt during 2022-2023 season. The performance of the developed topping machine was evaluated at three different levels of forward speed (1.0, 1.2 and 1.5 Km/h), three different levels of vertical and horizontal distance between knife and sensor, (1.5, 2.0 and 2.5 cm) and (4, 5 and 6 cm) respectively and two types of knives (sharpened from one edge and two edges). Evaluation was based on the following parameters: Topping efficiency, correct topped beets, over topped beets, under topped beets, damage beets, non-topped beets, Effective field capacity and field efficiency. The result indicated that, maximum of topping efficiency was 96 % at forward speed 1.0 km/ h, 2.5cm and 6 cm vertical and horizontal distance respectively and maximum of correct topped beet was 95.65 % at forward speed 1.2 km/ h, 2.0 cm and 5 cm vertical and horizontal distance respectively. On the other hand, minimum of over topped beet and non-topped beet was 0.00, 4.00 % respectively at forward speed 1.0 km/h and under topped beet was 0.0 % at forward speed 1.5 km/h. Also, the maximum field capacity of machine was 0.211 fed/h at forward speed 1.5 km/h and field efficiency was 98.43 % at forward speed 1.0 km/h. The results of the study recommended operate the machine at forward speed 1.2km/h with vertical distance 2.0 cm and horizontal distance 5 cm by using two side knife, the value of the correct topped beet was 95.65 %.

1. Introduction

One of the most significant crops is sugar beet, which also produces feed and organic matter for the soil in addition to sugar. Sugar beet is used in the manufacturing of more than 40% of the world's sugar (Ibrahim et al., 1989). In Egypt, the importance of this crop as a source of sugar increasing consumption of sugar by Egyptian population. Between harvesting activities including digging, gathering, cleaning, and loading, the topping process consumes half of the total harvest time. Because of this reason topping process is the most important process of sugar beet harvest (Colak, 1990).

In order to harvest sugar beet, there are three main techniques: one level harvest using combine harvesting equipment, two level harvest, and three level harvest

(Colak, 1986). The separation of sugar beet tops from the sugar beet root's heads is one of the key steps in the sugar beet harvest process (Volodymyr Bulgakov et al., 2015). Kanafojski and Karwowski (1976) stated that topping above line a – a (the critical section of cutting) for instance by 1 cm. Fig. 1, increases the mass of roots by 5 - 8 %. On the other hand, too low topping decreases the useful mass of roots. Raininko (1990) mentioned that the losses during topping operation, Fig. 2 can be explained as: 1) if the cut of topping is lower than zero level (the critical section of cutting), the loss is 1.8% Mg/ha, 2) if the cut of topping is lower than zero level by 1cm, loss is 3.3 Mg/ha and 3) if the cut of topping is lower than zero level by 2 cm, loss is 3.5 Mg/ha. Ismail et al. (1993) developed a horizontal type of disc mower to remove the vegetative top- portion of potato and

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sugar beet crops, the experimental machine consists of; cutting disc, cutting knives, and simple mechanism was added to control mower height. Aly (1998) Mention how they used a power tiller to build a sugar beet topping for small holding farms. Frame, knife leveler, knife, feller, rubber ground wheel, knife level control, drive system and drawbar make up the device. Tayel et al. (2009) mention that created a sugar beet topping for small holding farms. Its components include a frame, cutting disk, vertical shaft, cut height controller, and transmission systems (gear box, pulley, and belt). The primary components of the created topping unit produced the finest results at laser leveling land and speeds of 0.5 and 7.72 m/s, which discovered the maximum topping eff. 97.39%, technical topping eff. 90.2%, and accurate topped beet percentage 92.62%. Lowest under-topped beet percentage (2.68%), over-topped beet percentage (4.7%), and topping losses (77.91kg/fed). Salman (2013) reported that a machine was developed that might be used to remove sugar beet leaves from reclaimed land prior to mechanical harvesting. The major three components are the frame, the horizontal rotary shat, and the sets of rectangular rubber strippers that are mounted in the circular rings surrounding the shaft and secured with clamps and quadrants. Three

different PTO speeds—540, 725, and 1000 rpm—three different forward speeds—0.48, 1.0, and 1.68 m/sec—and three different levels of cutting—3, 6 and 10 cm—were used in the study to evaluate the machine and gauge its mechanical effectiveness. It was noted that the average weight loss was 6.2%. The data acquired showed that the optimal treatments boosted topping efficiency up to 88%: PTO speed of 1000 rpm, forward speed of 0.48 m/s, and cutting level of 10 cm. The purpose of this project is to create and assess a low-cost, simple-to-use sugar beet topping machine that is appropriate for Egyptian farms. Tayel. et al. (2014) said that Fig. (2.9) shows how to top sugar beets using a small machine. At a sugar beet moisture content of 50.0% and a topping height of 2 cm, increasing the forward speed from 1.5 to 2.5 km/h tends to increase overtopping from (2.9 to 3.22%), under topping beet from (2.82 to 4.02%), and un topped beet from (3.71 to 4.26%), These trends could be caused by the difficulty of maintaining a topping knife adjusted at a constant height while moving at high speeds, since increasing forward speed from 1.5 to 2.5 km/h tends to decrease the percentage of correctly topped beets from 92.00 to 90.39 percent and the efficiency of topping from 96.29 to 95.74%.



Fig. 1. Critical section of sugar beet cutting.

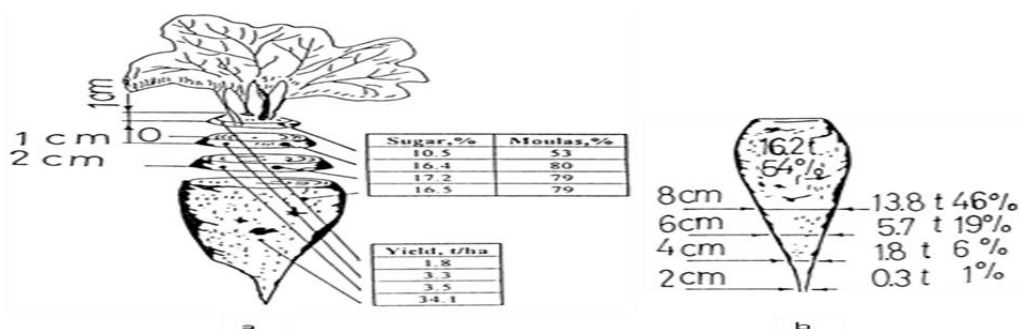


Fig. 2. Loss of yield during topping operation. (a) Loss caused by incorrect topping. (b) Loss caused by broken root tips.

2. Materials and methods

Field experiments were conducted at Al-Maseen Village, Al-Dilengat center, Al-Behera Governorate, Egypt during 2022-2023 season in an area of about 0.5 feddan.

Variety of sugar beet seeds the multi-germ seeds (BTS 970), show some physical properties in Table 1, this variety is the most used in this area.

Table 1
Mean dimensions of sugar beet plants, mass and root volume.

Physical properties	Root length "Lr" (cm)	Root width "Wr" (cm)	Root thickness "Tr" (cm)	Root Diameter "Dr" (cm)	Diameter taproot end "De" (cm)	Leaf cluster Width "Wc" (cm)	Leaf cluster Thickness "Tc" (cm)	Leaf cluster diameter "d" (cm)	Vegetative growth height "H" (cm)	Rosette width "Wros" (cm)	Mass of sugar beet plant "M" (kg)	Actual volume of root "Vac" (cm ³)	Calculated volume of root "Vcal" (cm ³)	Density of sugar beet root "Q" (kg/cm ³)
Mean	27.99	11.45	10.36	10.90	0.75	7.08	6.40	6.74	56.62	60.84	1.55	1164.2	1425.99	1.45
Maximum	49.50	14.06	12.75	13.40	1.56	9.70	8.78	9.24	72.00	84.00	3.61	3950	4425.65	2.14
Minimum	16.00	6.14	5.56	5.85	0.20	4.48	4.06	4.27	41.00	34.00	0.678	280	419.04	0.75
C.V	22.25	14.06	15.89	16.47	49.78	15.83	15.89	15.86	12.32	18.55	40.49	53.20	51.49	26.34
S.D	6.22	1.61	1.01	1.31	0.38	1.12	1.01	1.06	6.97	11.28	0.62	619.37	734.33	0.381

Cutting force: Table 2, show the cutting force required to cut and removal leaf cluster from sugar beet plant by knife. The cutting force was ranging from (607.5 to 1330 N), with a mean value of (929.31 N), (C.V = 23.25%).

Table 2

The cutting force required to cut leaf cluster from sugar beet plant.

	P.P	min	max	average	S.D.	C.V%
Force (N)		607.5	1330	929.31	216.08	23.25
Leaf cluster diameter (mm)		62.7	90.6	77.05	7.11	9.23

The sugar beet topping unit (Table 3) consists of frame, sensor lever, knife, control unites. The construction of a sugar beet topping unit was carried out local workshop.

Table 3

The dimensions of sugar beet topping unit.

Items	Specification
Overall width (cm)	20
Overall length (cm)	50
Overall height (cm)	50
Total mass (kg)	20.8

Frame: The frame was used for fixing all components. It consists of base, part for fixing a bill attached to the knife control unit, part for fixing a bill attached to the sensor control unit, part for fixing a bill attached to all the control unit and part for fixing tension spring. Hitching with drawbar and the unit is raised and lowered by hydraulically clamping it with upper arms.

Topping sensor: The sensor was designed to raise and lower the topping unit until the cut is in the right place. It consists of three same parts designed to pass the top of the sugar beet without any distortions of the sugar beet.

Knife: The knife made by steel thickness 6 mm, length 240 mm. Two knives typed namely knife is sharpened from one edge (one side knife) and knife is sharpened from two edges (two side knife).

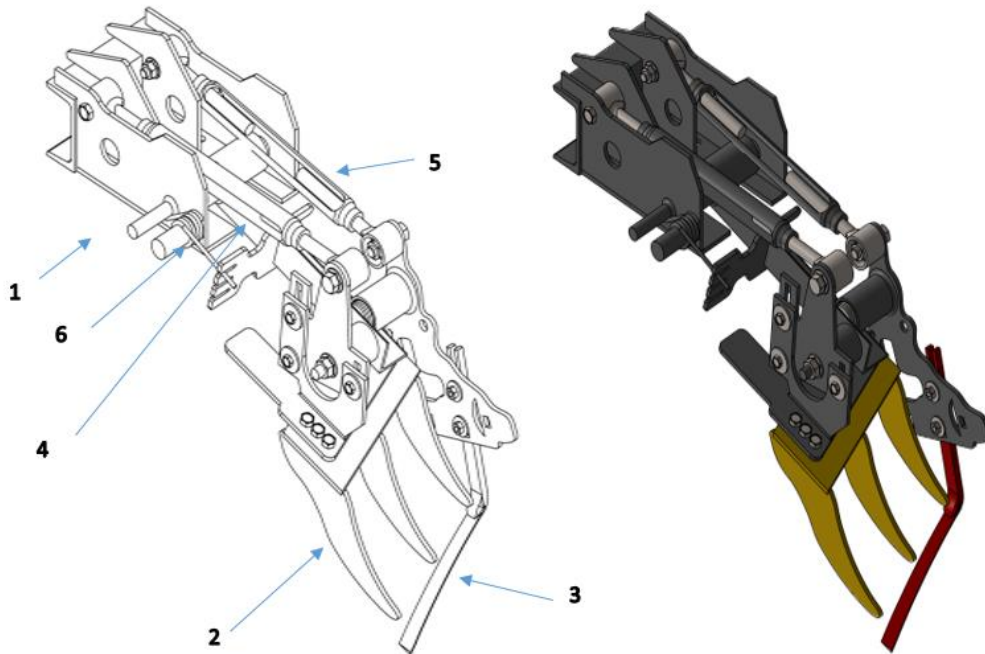
Control unites: The control unites consist of Control unit for sensor and knife together, control unit for sensor, control unit for knife and tension spring:

- Control unit for sensor:** the control unit for sensor represented in arm, through its movement, the

position of the sensor is controlled before the start of the topping process.

2. **Control unit for knife:** the control unit for knife represented in arm, through its movement, the position of the knife is **controlled** before the start of the topping process.

3. **Control unit for sensor and knife with tension Spring:** the tension spring keeping of the position of the sensor and knife together at the bottom point for three levels after passing it from the top of the sugar beet.



- ① Frame.
- ② Topping sensor.
- ③ Knife.
- ④ Control unit for sensor.
- ⑤ Control unit for knife.
- ⑥ Control unit for sensor and knife with tension Spring.

Fig. 3. Assembling of topping unit.

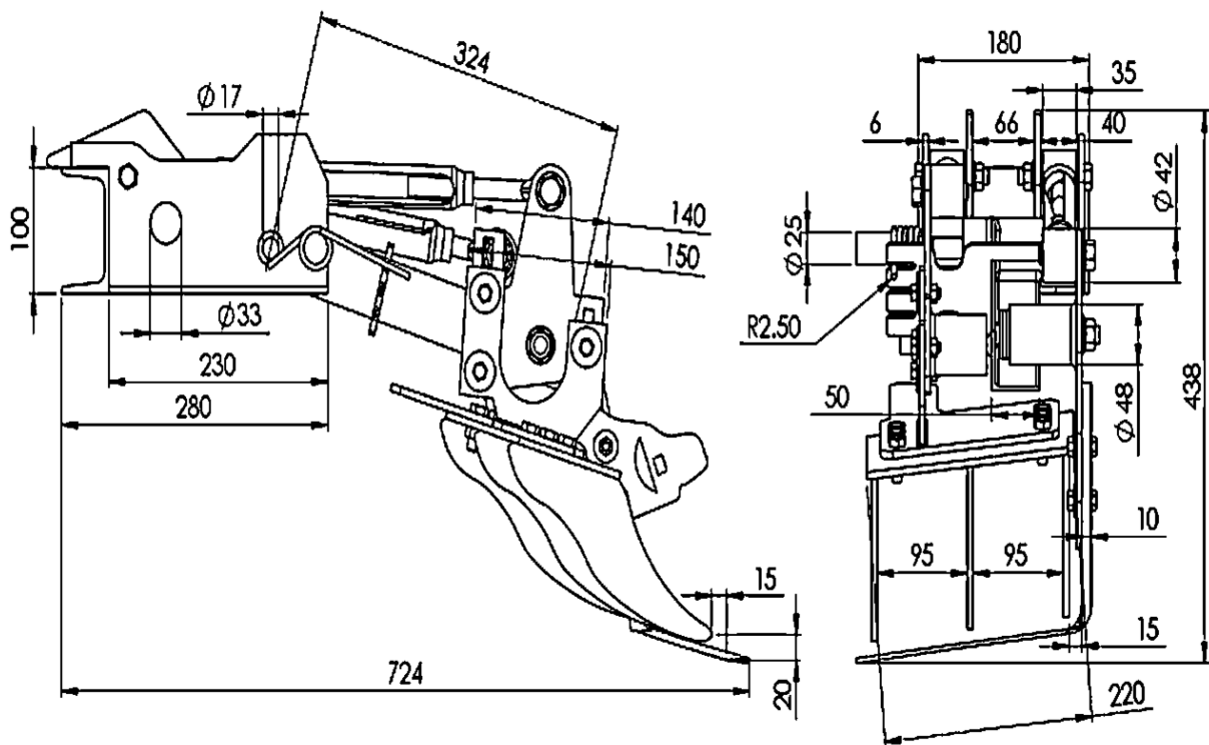


Fig. 4. Elevation and side view of topping unit set up. (Dimensions in mm)

A tractor (Kubota) was used for operating the topping machine. The tractor power 25.36 Kw (34 HP), 4 cylinder and diesel engine.

2.1. Mechanical soil analysis

The mechanical soil analysis shows in Table 4.

Table 4

The mechanical soil analysis.

Soil composition (%)			Soil classification
Clay (%)	Silt (%)	Sand (%)	
55.92	6.00	38.08	Clay

2.2. Evaluation of the developed machine

The experiments were designed and carried out to study factors affecting on performance topping unit of sugar beet following:

1. Forward speed (1,1.2, and1.5 km/ h).
2. The horizontal clearance between the sensor topping and the knife (4,5 and 6 cm).
3. The vertical clearance between the sensor topping and the knife (1,5,2,0 and 2,5 cm).
4. Two kinds of knives (sharpened from one edge and two edges with 22 degrees.

2.3. Forward speeds (S)

$$S = \frac{L}{T \times 3.36} \text{ km/h}$$

where:

- S = forward speed in (km/h).
- L = travel distance in (m).
- T = time of experiment in (s).

2.4. Beet crop quality

Topping efficiency, correct topped beets, over topped beets, under topped beets, damage beets and non-topped beets were assessed in a percent as indicator for the topper unit performance.

$$T_{\text{eff}} = \frac{T_n}{B_t} \times 100 \quad \dots \dots \dots \quad TO = \frac{T_o}{T_n} \times 100$$

$$BD = \frac{B_D}{T_n} \times 100 \quad \dots \dots \dots \quad TU = \frac{T_U}{T_n} \times 100$$

$$TC = \frac{T_C}{T_n} \times 100$$

where:

- T_{eff} = Topping efficiency in (%).
- T_n = Topped beet.
- B_t = Total beet.
- BD = Broken beet in (%).
- B_D = Damage beet.
- TC = Correct topped beet in (%).

- T_C = Correct topped beet.
- TO = Over correct topped beet in (%).
- T_O = Over correct topped beet.
- TU = Under correct topped beet in (%).

2.5. Effective field capacity (C_{ef})

The Effective field capacity is the actual average working rate of area the amount of time lost during the operation is conceding.

It can be determined from the following equation:

$$C_{\text{ef}} = \frac{1}{T_o + T_i}$$

where:

- T_o = Theoretical time per feddan.
- T_i = Summation of time lost in minute such as turning time.

2.6. Field efficiency

The field efficiency was calculated by using the following equation:

$$E_F = \frac{\text{effective field capacity "C}_{\text{ef}}" \text{ (fed/h)}}{\text{theoretical field capacity "C}_{\text{th}}" \text{ (fed/h)}} \times 100$$

$$C_{\text{th}} = \frac{S \cdot W}{4200}$$

where:

- C_{th} = Field capacity in feddan per hour.
- S = forward speed, in meters per hour.
- W = Operation width of the topping unit.

2.7. Fuel consumption

Fuel consumption was recorded by accurately measuring the decrease in fuel level in the fuel tank immediately after executing each operation. The fuel consumption per unit time was determined by measuring the volume of fuel consumed during turning time (the decrease of fuel level in the fuel tank). It was calculated by using the following equation:

$$F_C = \frac{V}{T} \times 3.6$$

where:

- FC = Fuel consumption rate in (L/h).
- V = Volume of fuel consumed in (cm³).
- T = Time of topping process in (s).

2.8. Topping power

Power is the most helpful criterion for judging the energy required for topping process with high efficiency. The topping process power determined by following equation (Embaby, 1985):

$$T.P. = \frac{F_C}{3600} \times \rho_f \times L.C.V \times 427 \times \eta_{\text{th}} \times \eta_{\text{me}} \times \frac{1}{75} \times \frac{1}{1.36}$$

where:

- T.P. = Topping power in(kW).

FC = Fuel consumption rate in (L/h).
 ρ_f = Density of fuel in (kg/L), (0.85 kg/L for diesel fuel).
 L.C.V = Lower calorific value of fuel, kcal/kg (11000 kcal/kg).
 427 = Thermomechanical equivalent in (kg.m/kcal).
 η_{th} = Thermal efficiency of the tractor engine in (%), (35 % for diesel engine).
 η_{me} = Mechanical efficiency of the tractor engine in (%), (80 % for diesel engine).

2.9. Energy requirements

The energy requirement for topping process depends on the amount of power consumed by the topper unit, field capacity. Energy requirements were calculated by using the following equation:

$$E.R. = \frac{T.P}{C_{th}}$$

where:

E.R. = Energy requirements in (Kw.h/fed).

C_{th} = Field capacity in (fed/h).

3. Results and discussions

3.1. Topping efficiency

Generally, the obtained data cleared that the topping efficiency decrease with increased of forward speed at different vertical and horizontal distance with knife types, while the topping efficiency decreased by decrease vertical distance at different forwarded speed, horizontal distance and knife types.

The highest topping efficiency value 96% was recorded at operational condition of 1.0 km/h, 2.5 cm vertical distance, 6 cm horizontal distance for the two-side knife type. The same value was recorded at operational condition of 1.0 km/h, 2 and 2.5 cm vertical distance, 5 cm horizontal distance space for two side knife type; on the other hand, the lowest topping efficiency value 79.16% was recorded at operational condition of 1.5 km/h forward speed, 1.5 cm vertical distance, 4 cm horizontal distance space for the one side knife as shown in Fig. 5.

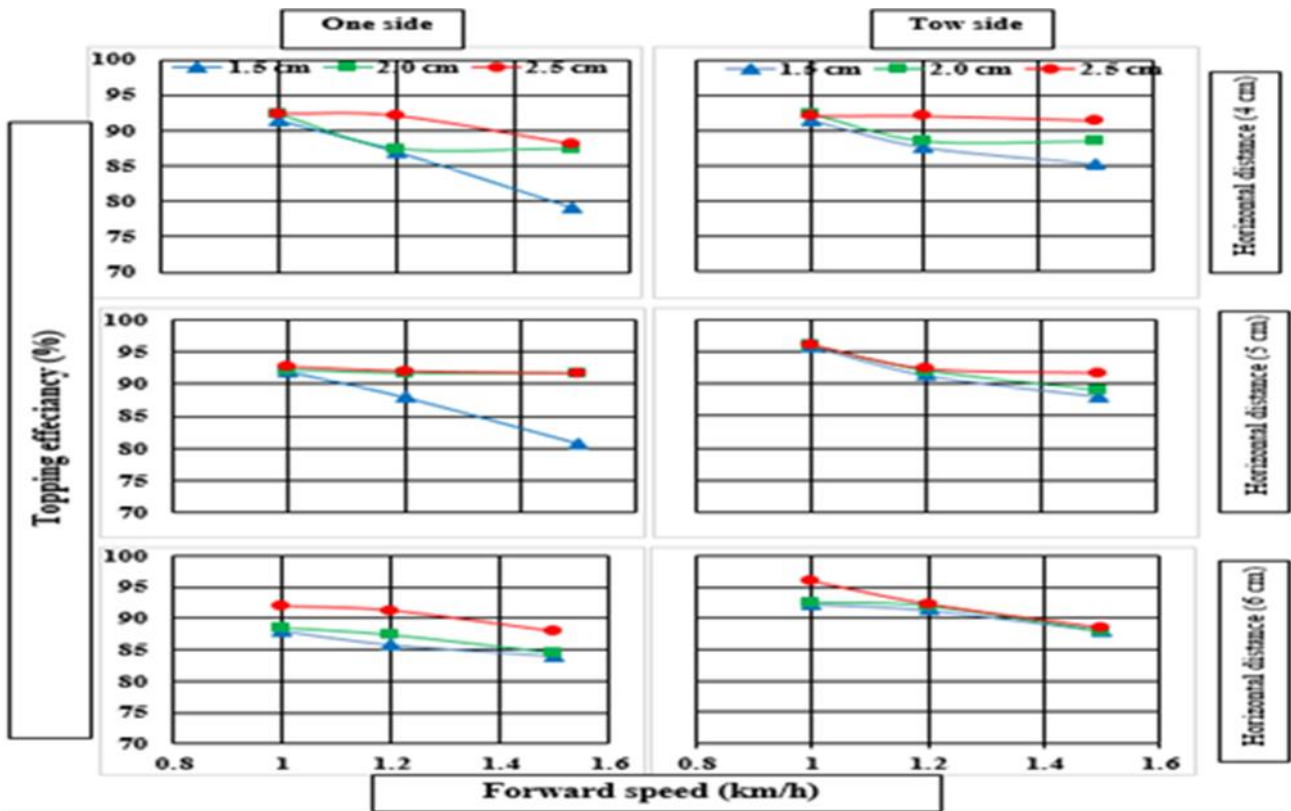


Fig. 5. Effect of different forward speed on topping efficiency, at three different levels of vertical and horizontal distance for two knife types.

3.2. Correct topped beet

Generally, the obtained data cleared that the correct topped beet increased by decrease of forward speed at vertical distance 1.5 cm, horizontal distance 4 cm at both two types of knives.

The highest correct topping value 95.65 % was recorded at operational condition of 1.2 km/h, 2.0 cm

vertical distance, 5 cm horizontal distance for the two-side knife type; on the other hand, the lowest correct topping value 63.16% was recorded at operational condition of 1.5 km/h forward speed, 1.5 cm vertical distance, 4 cm horizontal distance space for the one side knife as shown in Fig. 6.

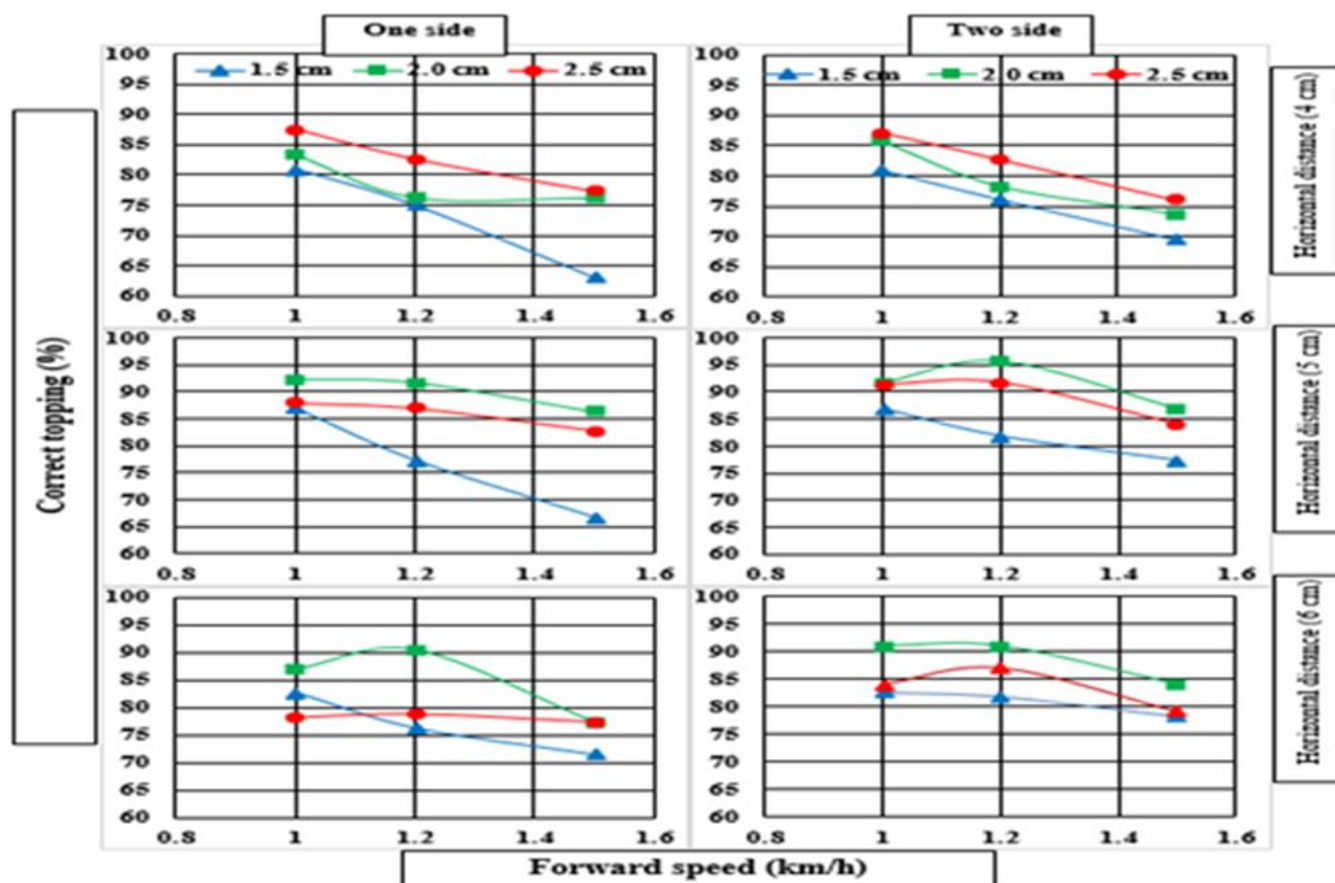


Fig. 6. Effect of different forward speed on correct topped beet, at three different levels of vertical and horizontal distance for two knife types.

3.3. Under correct topped beet

Generally, the obtained data cleared that the under correct topped beet decrease with increased of forwarded speed at different vertical and horizontal distance with knives types, while under correct topped beet decreased by decrease vertical distance at different forwarded speed, horizontal distance and knives types.

The highest under topped beet value 13.05% was recorded at operational condition of 1.0 km/h, 2.5 cm vertical distance, 6 cm horizontal distance for the one-side knife type; on the other hand, the lowest under topped beet value 0.00 was recorded in more than one situation, especially 1.5 and 2 cm vertical distance spaces, 5 and 6 cm horizontal distance with the three different forward speeds, for both two knives types as shown in Fig. 7.

3.4. Over correct topped beet

Generally, the obtained data cleared that the over correct topped beet increases with increase of forwarded speed at different vertical and horizontal distance with knife types, while over correct topped beet decreased by increase vertical distance at different forwarded speed, horizontal distance and knife types.

The highest over topped beet value 36.84 % was recorded at operational condition of 1.5 km/h, 1.5 cm

vertical distance, 4 cm horizontal distance for the one-side knife type; on the other hand, the lowest over topped beet value 0.00% was recorded at operational condition of 1.0 km/h forward speed, 2.5 cm vertical distance, 5 cm horizontal distance space for the two side knife as shown in Fig. 8.

3.5. Damage beet

Generally, the obtained data cleared that the damage beet increases with increase of forwarded speed at different vertical and horizontal distance with knife types, and also increases by increase vertical distance at different forwarded speed, horizontal distance and knife types.

The highest damage beet value 9.08% was recorded at operational condition of 1.5 km/h, 2.5 cm vertical distance, 6 cm horizontal distance for the one-side knife type; on the other hand, the lowest under topped beet value 0.00% was recorded in more than one situation, especially 1.5 and 2 cm vertical distance spaces, with three different levels of horizontal distance spaces and forward speed 1.2 km/h, for the both type knives, as shown in Fig. 9.

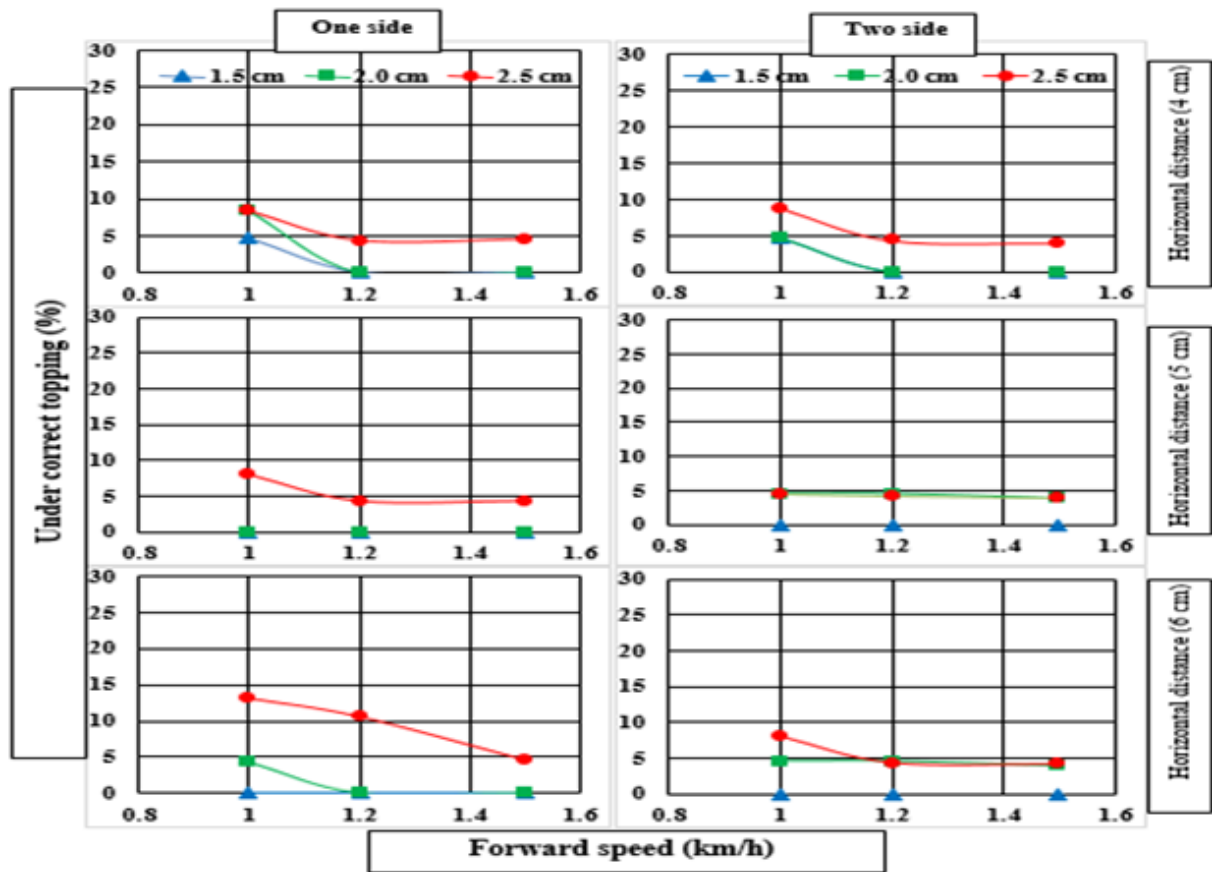


Fig. 7. Effect of different forward speed on under correct topped beet, at three different levels of vertical and horizontal distance for two knife types.

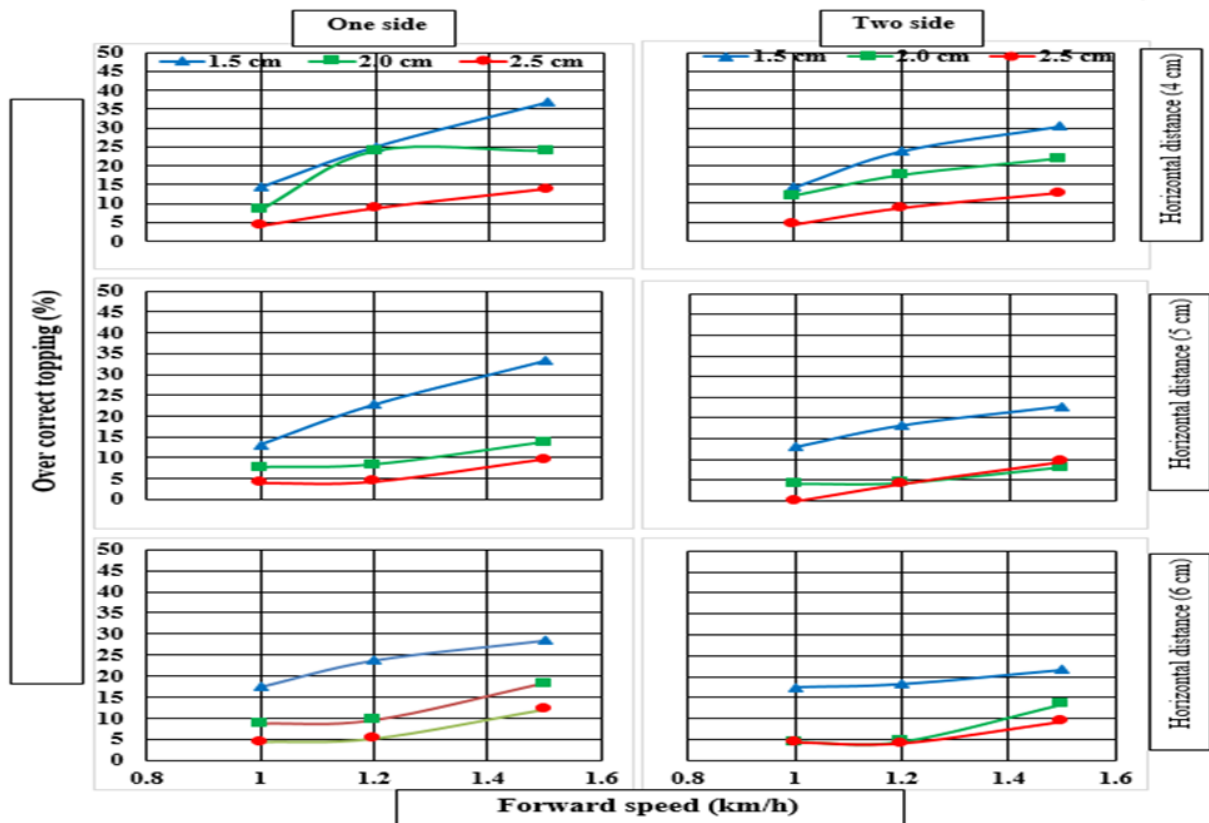


Fig. 8. Effect of different forward speed on over correct topped beet, at three different levels of vertical and horizontal distance for two knife types.

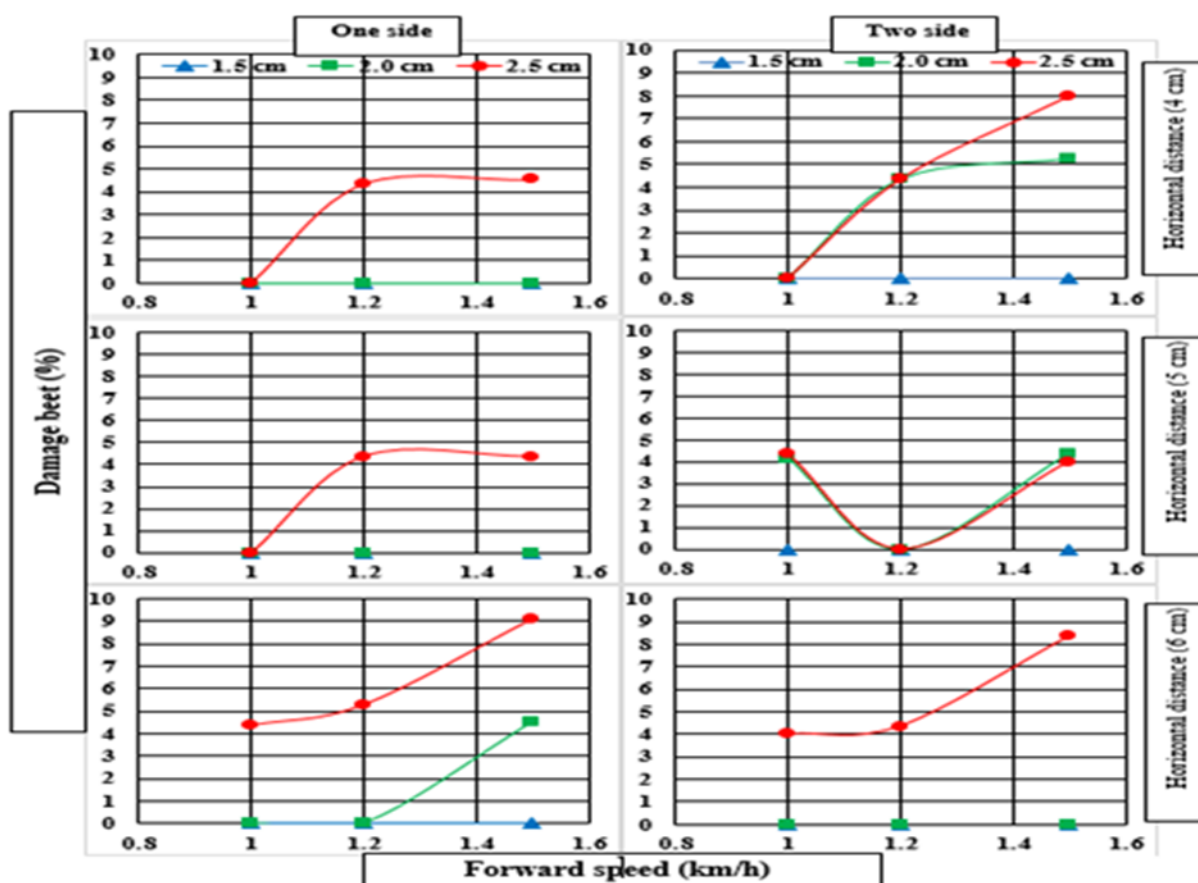


Fig. 9. Effect of different forward speed on damage beet, at three different levels of vertical and horizontal distance for two knife types.

3.6. Non topping beet

Generally, the obtained data cleared that the non-topping beet increases with increase of forwarded speed at different vertical and horizontal distance with knife types, while decreases by increase vertical distance at different forwarded speed, horizontal distance and knives types.

The highest not topped beet value 20.84% was recorded at operational condition of 1.5 km/h, 1.5 cm vertical distance, 4 cm horizontal distance for the one-side knife type; on the other hand, the lowest not topped beet value 4.0% was recorded at operational condition of 1.0 km/h forward speed, 2 and 2.5 cm vertical distance, 5 cm horizontal distance spaces, also 2.5 cm vertical distance, 6 cm horizontal distance spaces for both type knives, as shown in Fig. 10.

3.7. Effective field capacity

The operational width is considered to be constant 0.60 m. Therefore, field capacity is a function of traveled distance and effective time which includes the time losses for turning (average 8 sec) at forward speed. During test operation in field, the distance was constant, so the main effect factor to measure the effective field capacity "EFC" is the time (Table 5).

Generally, the obtained data cleared that by increasing forward speed "S" from 1.0 km/h to 1.5 km/h, "EFC" increased at all treatments. It has a direct proportional with "S". The maximum value of "EFC" 0.214 fed/h, was obtained at "S" 1.5 km/h, has directly proportional to topping forward speed, Also, it was related with "S" by linear relationship, as shown in Fig. 11.

Table 5

The relationship between field efficiency and effective field capacity at different forward speeds.

S (km/h)	Field efficiency (%)	Effective field Capacity (fed/h)
1.00	98.43	0.139
1.2	98.13	0.168
1.5	97.67	0.211

3.8. Fuel consumption:

Fuel consumption is an important factor in the cost of topping operation. Fuel consumed for both two knife types was determined per hour.

The results indicated that the fuel decreased by increasing of forward speed for both two knife types. The same trend was clear at use of both types of knives.

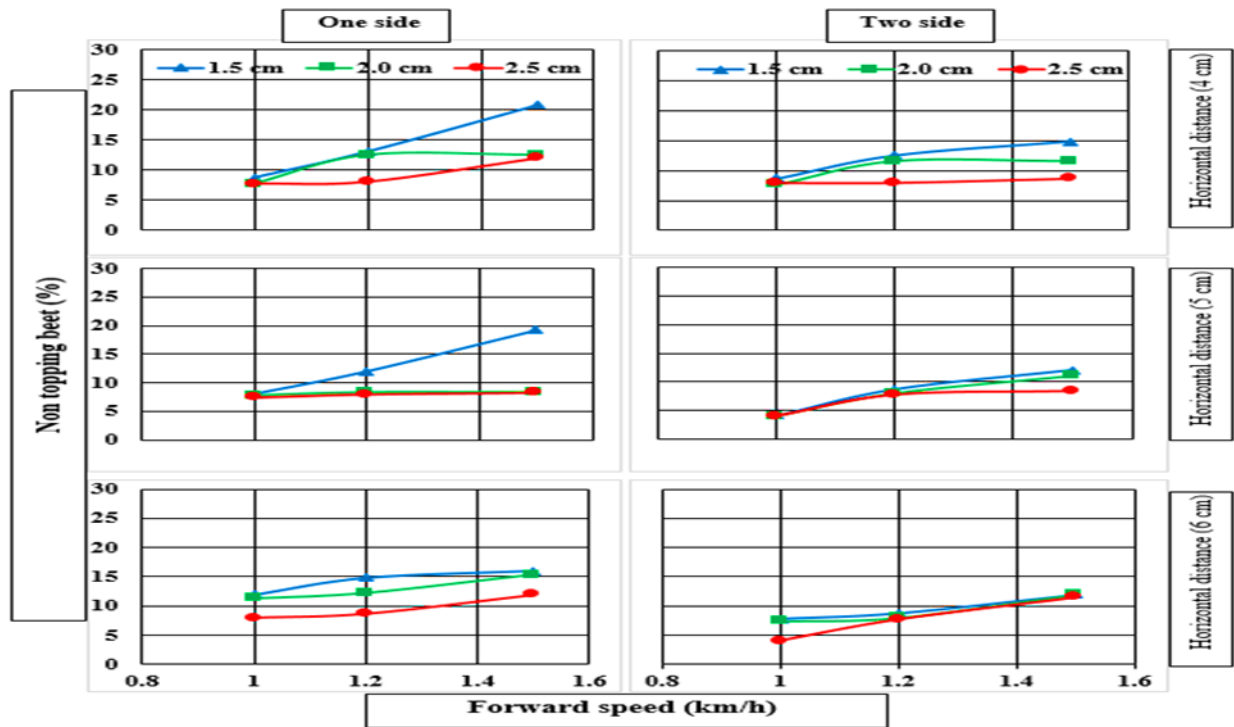


Fig. 10. Effect of different forward speed on non-topping beet, at three different levels of vertical and horizontal distance for two knife types.

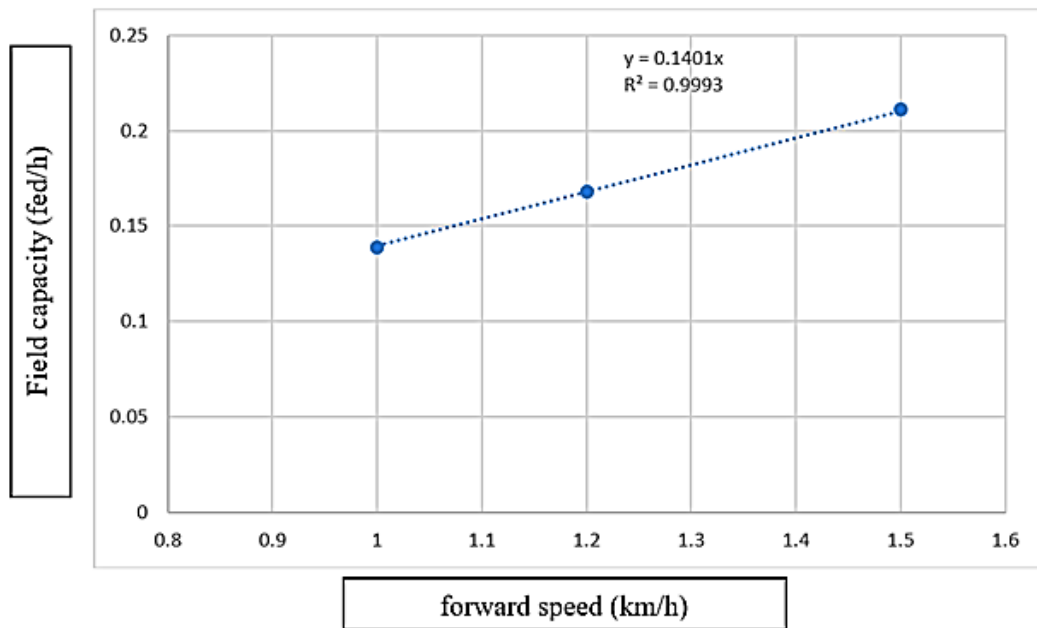


Fig. 11. Effective field capacity “EFC” (fed/h), Vs forward speed “S” (km/h).

3.9. Power requirements for topping

It could be realized that one side knife recorded the lowest value of power requirement (4.56 Kw) at forward speed of (1.5 km/h) (Table 6). Meanwhile, one side knife recorded the highest value of power requirement (12.17 Kw) at forward speed of (1.0 km/h). The same trend was clear at use of both types of knife.

Table 6

Effect of tractor forward speed on the fuel consumption (L/h) and Power requirement (Kw).

S (km/h)	Fuel consumption (L/h)	Power requirement (Kw)
1.00	4.0	12.17
1.2	2.3	7.00
1.5	1.5	4.56

4. Conclusions

The conclusions of this study can be summarized as follows:

- By increasing forward speed decrease topping efficiency. While under topped beet, over topped beet, damage beet and non-topped beet were increased. On other hand, the correct topped beet increases to (1.2 km/h) then decreases to (1.5km/h).
- The best result for topping efficiency 96% at forward speed 1.0 km/h, 2.5 cm vertical distance, 6 cm horizontal distance and two side knife.
- The best result for correct topped beet 95.65% at forward speed 1.2 km/h, 2.0 cm vertical distance, 5 cm horizontal distance and two side knife.
- The best result for effective field capacity 0.214 at forward speed 1.5km/h.

Applied recommendations

- The highest values of the correct topped beet were obtained by using two side knife with vertical distance 2.0 cm and horizontal distance 5 cm at forward speed 1.2 km/h.
- The possibility of using more than one unit with the tractor, thus increasing the field capacity and decrease total costs for feddan.

References

Aly, A.H., 1998. Design and development of a sugar beet topper. Ph.D., Thesis. Agric. Mech., Dept., Fac. Agric., Ain Shams Univ: 57-146.

- Colak, A., 1986. Investigation the measurement methods which can be used at determining of the sugar beet topping resistance. Ankara University, Graduate school of natural and applied sciences, Department of Agricultural Machinery Master thesis.
- Colak, A., 1990. Development of the Method to Determine the Main Characteristic Which Effect Operating Conditions of Sugar Beet Topping Knives in the Field Operating Conditions. (summary in English) Ankara University. Graduate School of Natural and Applied Sciences, Department of Agricultural Machinery PhD Thesis.
- Ibrahim, M.M., A.E. Abou El – Magd., Z.E. Ismail. and M.A. El-Saadany., 1989. Estimating the performance of a developed digger to harvest sugar beet. J. Agric. Sci. Mansoura. Univ. 14 (4): 2340-2349.
- Ismail, Z.E., Y.M. El –Hadidi, M.A. El – Saadany., 1993. The utilization of a developed disc mower to remove the vegetative tops of some tuber crops. Misr. J. Ag. Eng., 10 (3): 508 – 524. [Misr Journal \(researchgate.net\)](http://www.researchgate.net).
- Kanafojski, C.Z., T. Karwowski., 1976. Agricultural machine theory and construction (2: Crop – harvesting machines). Published for the U.S. Department of Agriculture and the National Science Foundation, Washin ton, D.C.: 830-920
- Raininko, K., 1990. Sweeden sugar beet production, J. of Sugar. 1 (29): 32:62. [C.F. Aly, 1998]
- Salman, A. K., 2013. development of a topping machine to suit mechanical harvesting of sugar beet. Journal of Soil Sciences and Agricultural Engineering, 4(12), 1421-1433. https://jssae.journals.ekb.eg/article_52914.html.
- Tayel, S. A., A. A. El-Nakeeb, M. F. A. Khairy., El-Biale, N. M., 2009. Develop and evaluate sugar beet topper unit to suit in small holding. Misr Journal of Agricultural Engineering, 26(1), 44-55. <https://doi.org/10.21608/mjae.2009.109861>.
- Tayel, S., Khairy, M. F. A., O. M.Kamel., El-Shazly, A. S., 2014. Manufacturing a small machine to suit topping sugar beet. Misr Journal of Agricultural Engineering, 31(4), 1291-1316. <https://dx.doi.org/10.21608/mjae.2014.98239>.

تطوير وتقييم آلة تطويش لبندر السكر

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الملخص العربي

يعتبر بنجر السكر من أهم المحاصيل، ليس فقط لإنتاج السكر، ولكن أيضًا لإنتاج الأعلاف والمواد العضوية للتربة، حيث يتم إنتاج أكثر من ٤٠٪ من إنتاج السكر العالمي من بنجر السكر، في مصر زادت أهمية هذا المحصول كمصدر للسكر بسبب زيادة استهلاك السكر نتيجة لزيادة عدد السكان. حيث تستغرق عملية إزالة القمم الخضراء نصف وقت الحصاد بين عمليات الحصاد مثل الإقتلاع والتجميع والتنظيف والتحميل لهذا السبب فإن عملية إزالة القمم الخضراء (قطع القمم) تكون أهم عملية في حصاد بنجر السكر.

تهدف هذه الدراسة إلى تطوير وتقييم آلة تستخدم في إزالة القمم الخضراء لبنجر السكر قبل عملية الحصاد تناسب الحيازات الصغيرة، تم تصميم الآلة ثم تصنيعها في ورشة محلية في مركز الدلنجات، محافظة البحيرة، مصر. كما تم اختبار وتقييم أداء الآلة عن طريق إجراء التجارب الحقلية اللازمة خلال الموسم ٢٠٢٢-٢٠٢٣، وتم استخدام عوامل الدراسة ثلاثة مستويات مختلفة للسرعة الأمامية (١,٠، ١,٢، ١,٥ كم / ساعة)، ثلاثة مستويات مختلفة للمسافة الرأسية (بين السكين والحساس الميكانيكي) (١,٥، ٢,٠، ٢,٥ سم)، ثلاثة مستويات مختلفة للمسافة الأفقية (بين السكين والحساس الميكانيكي) (٤، ٥، ٦ سم) ونوعان من السكاكين (شطف جانب واحد وجانبين)، تم تقييم كفاءة أداء الوحدة بحساب كل من كفاءة التطويش، نسبة التطويش الصحيح، نسبة الجذور ذات التطويش تحت الصحيح، نسبة الجذور ذات التطويش اعلي الصحيح، السعة الحقلية الفعلية، والكفاءة الحقلية.

وقد بينت الدراسة الآتي:

- أفضل نتيجة لكفاءة التطويش ٩٦٪ عند السرعة الأمامية ١,٠ كم / ساعة، مسافة رأسية ٢,٥ سم، مسافة أفقية ٥ سم وسكينة ذات شطف مزدوج.

- أفضل نتيجة للقطع الصحيح للبنجر ٩٥,٦٥% عند سرعة أمامية ١,٢ كم / ساعة ، مسافة رأسية ٢,٠ سم، مسافة أفقية ٥ سم وسكينة ذات شطف مزدوج.
 - أفضل نتيجة للقطع فوق الصحيح والغير مقطوع ٤,٠٠,٠٠,٠٠% علي التوالي عند سرعة أمامية ١,٠ كم/ساعة، والقطع تحت الصحيح 0.0% عند سرعة أمامية ١,٥ كم / ساعة.
 - أفضل نتيجة للسعة الحقلية الفعلية ٠,٢١١. بسرعة أمامية ١,٥ كم / ساعة، والكفاءة الحقلية ٩٨,٤٣%.
- ومن نتائج الدراسة يُوصى بتشغيل الآلة بسرعة أمامية ١,٢ كم/ساعة وبمسافة رأسية ٢,٠ سم ومسافة أفقية ٥ سم باستخدام سكينة ذات شطف مزدوج حيث كانت نسبة التطويش الصحيح للبنجر ٩٥,٦٥%.