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DEVELOPMENT OF A MECHANICAL WEEDING SYSTEM INTER-ROWS IN EGYPTIAN FIELD

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ABSTRACT: A self-propelled harvester was developed to be used as a mechanical cultivator for weeding between rows of maize crop (variety Giza 310) at different stages of plant growth considering the optimum parameters affecting the performance of the developed machine. The developed machine was compared to the traditional weeding methods.

The performance of developed machine before and after development was investigated in terms of field capacity, field efficiency, damage of crop plants, weeding efficiency, eradication slippage ratio, consumed energy and costs. The function of change in weeding forward speed and penetration angle were considered.

The experimental results revealed that the use of developed tiller maximize both of weeding and field efficiencies and minimize both of losses, energy and cost comparing with the traditional methods (Hand – hoeing) and animal drawn-weeder under average weeding speed of 5 km /h and cutting blade angle of 21°.

Key words: Mechanical, weed, control, weeding, system, inter-rows.

INTRODUCTION

Weed control is one of the most important operations in crop production because weeds compete crops for water, nutrients and sunlight. Therefore, weeds may cause variable effects in decreasing yield according to their variety and density.

The control of weeds and grasses is one of the greatest time and labour consuming operation in the crops production.

Kepner *et al* (1987) stated that the control of weed and grasses has always been one of the greatest time and labour consuming operations in production of crops.

In addition requiring extensive control measures, weeds rob crop plants nutrients and water, often serve as hosts to insects and other pests that attack crop plants, and create equipment problems especially in harvesting.

Oni (1990) showed that weeds account for about 50 - 75% reduction in yield due to lack of satisfactory weed control methods. He developed two types of rotary weeders for the draught animal named the high clearance straddle – row and the Emcot-attached (inter - row) rotary weeders. Weeding performance of these two implements were compared with that of strad, the commercially available rotary weeder and also with the manual method of weed control. Results show that the draft requirement for the straddle-row weeder average 1kN when operated at a speed range of 0.60 – 0.62 m/s while that for the Emcot-attached rotary weeder averaged 0.80 kN for the same speed range.

Shaiboon (1993) indicated that using hand hoeing for weed-control of (faba bean crop) gave the highest yield and net profit, but requires more labour comparing with the chemical weeding methods. He found that using mechanical cultivation was considered the suitable way for weed control of faba bean and the least pollution effect.

Biswas, *et al* (2000) reported that animal-drawn weeders play an important role in the mechanical control of weeds. Due to high output, animal- drawn weeders help in the time liness of operations compared to manual methods and are cheaper. Within the crop rows weeds may be removed manually. Other weed control methods such as chemicals, crop competition or crop rotation may be utilized for effective weed management.

Imbabi (2001) compared different method of weeding were rotavator, donkey- pulled cultivator and hand –hoe, besides the control method (unweeded). The evaluation included the bulk density of soil, plant growth parameters, field productivity and efficiency, regrwoth percentage and the operation a cost. Results indicated that using rotavator gave the highest field productivity (0.5 fed./h.), the lowest cost (126.27 L. E. /ton) and adequate efficiency. On the other hand, using hand – hoe gave the lowest field productivity (0.15 fed/h) highest cost (148.15 L. E. /ton) and efficiency (96.35%) comparing with the others.

Mganilwa, *et al* (2003) designed and constructed an engine powered hand held Prototype weeder to address the problem of manual weeding. The prototype weeding efficiency was 96.4% and the effective weeding capacity was 0.42 fed/h which is approximately twenty times than manual weeding. So the engine powered weeder could be useful equipment in modernizing agriculture for small holder farmers.

The proper row-crop weeder improved plant growth by eradication weeds, improving the soil properties, counteracting losses of water by evaporation and scarify the soil inter-row.

The objectives of this study are:

1-Develope a self propelled harvesting machine to be used as tiller inter-rows in maize fields.

2-Determine the optimum parameters affecting the performance of developed machine.

3. Comparing the developed machine with the traditional weeding methods.

MATERIALS AND METHODS

Laboratory Experiments

The developed machine was fabricated in a local workshop at Bordean, Zagazig Center, Sharkia Governorate, Egypt, during the years 2001 , 2002.

Field Experiments

Field experiments were carried out at El-Manshia farm, Belbeis Center, Sharkia Governorate, Egypt. Through two successful agriculture seasons 2002/2003 and 2003/2004. To develop and evaluate the self-propelled harvesting machine to be used as tiller inter-rows in maize crop (variety Giza 310).

Comparing with the traditional weeding methods under Egyption conditions.

The mechanical analysis of the experimental soil were carried out in unit of analysis and studies, Soils, Water and Environment Research Institute (SWERI) Agricultural Research Centre, Egypt. and classified clay soil (Table 1).

Table 1: Soil mechanical analysis

Depth (cm)	Moisture content %	% clay	% silt	% fine sand	% coarse sand	% Soil texture
20	24	58.1	25.3	13.42	3.18	Clay

The following equipment were used in this research. Tractor (IMT 553) of 76 Hp (56.6) kW, chisel plow locally made (7 tines), Land leveler locally made (3.00 m width) hydraulically controlled, the furrower locally made (4 furrows), animal–drawn weeder locally made, hand hoe (18cm width) (locally made).

The specifications of the machine before development as shown in Fig. 1 are: self-propelled harvester model BCS270: engine type lamberdini, made by Italy, powered by 9kw (12.24hp), Gear box: 4forward speeds, one revers speed, powerd wheel size (front wheel 16X600, steering wheel size 12X400 and total weight 392kg.

The developed machine is shown in Fig. 2

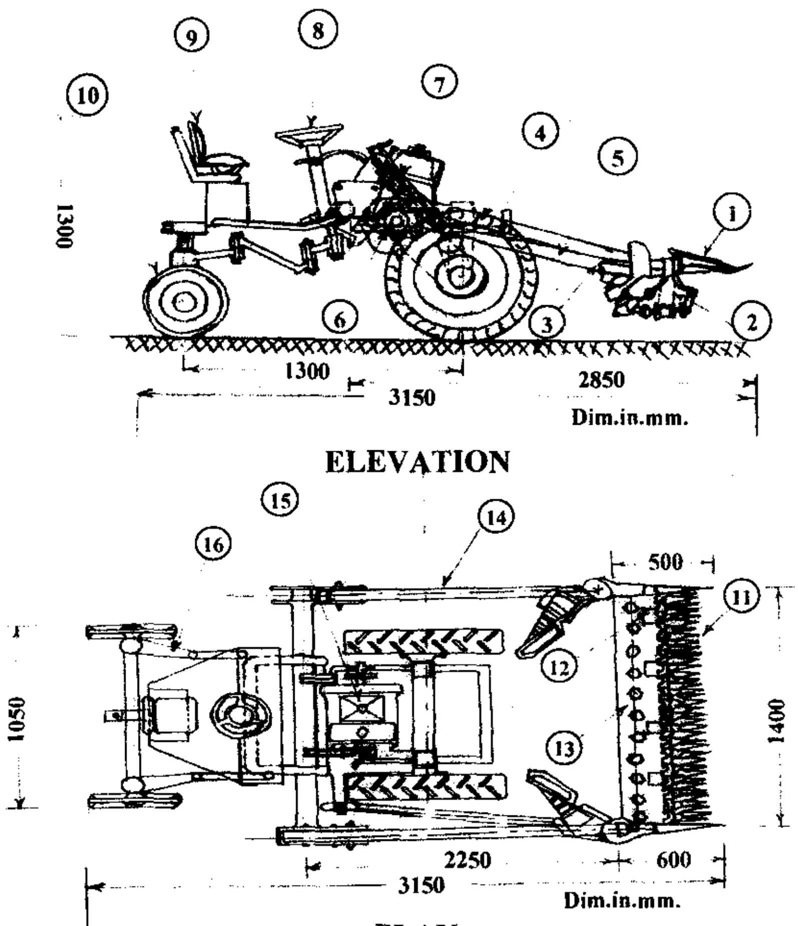
The machine was adopted to be qualified for weeding operations, between rows successfully. Consuming least power, least cost in the presence of maize plants at different periods (growth stages).

The developed machine consists of the following parts:

1. **Main frame:** A square hollow beam of mild steel having dimensions of (800x800), 5, 1800 mm for cross section, thickness and length, respectively.
2. **Tines:** having dimensions of 900, 46, 16 mm for length, width and thickness, respectively.
3. **Blades:** having two winges of 200mm length, 3mm thickness per each, fixed at angle of 45°. The distance between wings is 200mm.
4. **The spyders:** are two pair serrated spyders with diameter of 300mm at the front of the blades with distance of 60mm between each moving in rotational movement.
5. **The weeds rakes:** (Digited fingers) the rake consists of fivteen digited fingers fixed on triangular tool bar with a spacing of 5mm collect the cutted weeds out of the field.

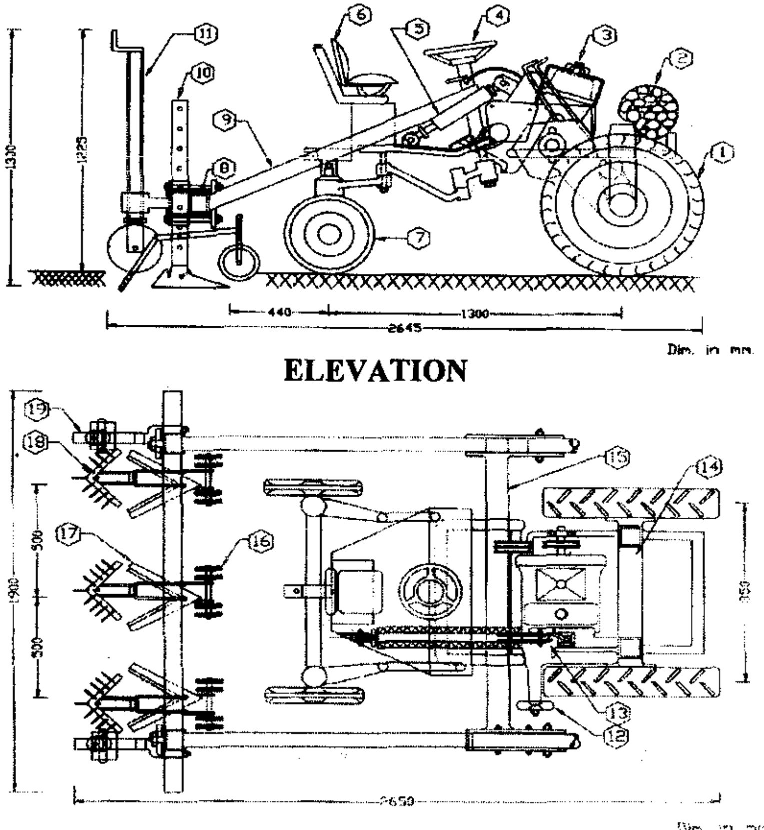
The experimental area was about (3 feddans) cultivated with Maize (variety Giza 310) divided into 18 equal plots, having dimensions of 11.5x60m per each.

Six treatments namely A, B, C, D, E and F were investigated and replicated three times in a completely randomized block design:



No.	Description	Qt.	No.	Description	Qt.
1	Guards	2	9	Driving seat	1
2	Cutter bar	1	10	Rear wheel	2
3	Swath board	2	11	Cutters	2
4	Front wheel	2	12	Fingers	4
5	Transmission	1	13	Knife bar	1
6	P.T.O.	1	14	Cutter bar lever	2
7	Hydraulic lev.	1	15	Engine	1
8	Driving wheel	1	16	Controlling	2

Fig. 1: Specification of self propelled mower before development



No.	Description	Qt.	No.	Description	Qt.
1	Drive wheels	2	11	Depth Adj. Scrow	2
2	Balancing weight	130kg	12	P.T.O.	1
3	Engine	1	13	Machine gear pox	1
4	Driving wheel	1	14	Front axle	1
5	Hydroulic lever	1	15	Machine main frame	1
6	Driver set	1	16	Cultivation spyders	6
7	Rear wheels	2	17	Cultiovation sweeps	3
8	Tool bar	1	18	Fixed finger raking weeds	3
9	Fixed arms	2	19	Depth adj. wheels	2
10	Beams	3			

Fig. 2: Specification of self-propelled mower after development to be inter-row tiller

Treatment A: Mechanical weeding with the developed machine at blades angle of 12° with two pair spyders (working depth was about 5 cm).

Treatment B: Mechanical weeding with the developed machine at blades angle of 12° without two pair spyders (working depth was about 5 cm).

Treatment C: Mechanical weeding with developed machine at blades angle of 21° with two pair spyders (working depth was about 8 cm).

Treatment D: Mechanical weeding with the developed machine with blades angle of 21° without two pair spyders (working depth was about 8 cm).

Treatment E: Animal drawn weeder (two passes). (working depth about 6 cm).

Treatment F: Manual weeding with the conventional hand-hoe (working depth about 5 cm).

The treatment F is considered as conventional method.

The developed machine were operated under three different forward speeds 3.5,5,6.5km/h, two different penetration blade angles of 12° and 21° and two different weeding depths and 8cm with and without adding two pair of spyders at the front of blades, for first and second weeding.

Measurements

Evaluation of developed machine performance was done taking into consideration the following indicators:

Weeding Power

Weeding power was estimated from the fuel consumed during the weeding operation using the following formula (Barger *et al.*, 1963).

$$Bhp = \frac{fc \times \rho f \times c.v \times 427 \times \eta_{the} \times \eta_m}{60 \times 60 \times 75} \text{...., hp}$$

Where :

Bhp : Brake horse power, …….hp.

fc : Fuel consumption L/h.

ρf : Density of fuel kg/L (for diesel fuel = 0.85 kg/L).

η_{th} : Thermal efficiency considered to be 40% for 5 diesel engine.

η_m : Mechanical efficiency of the engine considered to be 80% for diesel engine.

C.V.: Calorific value of fuel about 10000 kcal/kg.

427: Joules constant (thermo mechanical equivalent) J/kcal.

Weeding energy

Estimation of the energy required for operating weeding machines was carried out using the following formula:

$$\text{Energy requirements(kW.h/fed.)} = \frac{\text{Engine power(kW)}}{\text{Effective field capacity (fed/h)}}$$

The weeding efficiency

The weeding efficiency was calculated by :

$$EW = \frac{B - A}{B} x100$$

Wherer:

EW: The weeding efficiency.

B : Weight of dry matter of weeds before weeding.

A : Weight of dry matter of weeds after 21 days from weeding.

The performance index (P_i)

The performance index (P_i) was calculated by the following equation (as suggested by Gupta 1981):

$$P_i = \frac{a \times q \times e}{e}$$

Where :

a :The actual field capacity (fed/h).

q : (100-% plants damaged) (%).

e : Weeding index (%).

p : Power in put (hp).

P_i : The performance index.

The weeding index(e) is given by:

$$e = \frac{W_1 - W_2}{W_1} x100........(\%)$$

W_1 : Weed count before weeding.

W_2 : Weed count after weeding.

The field efficiency

The field efficiency was calculated the following equation:

$$\eta_f = \frac{\text{Effective field capacity}}{\text{Theortical field capacity}} \times 100$$

Cost analysis

The machine cost was determined using the following equation (Awady 1978).

$$C = P/h\,(1/a + i/2 + t + r) + (1.2\,W.S.F.) + m/144$$

C : Hourly cost (L.E./h).

P : Price of machine L.E.

h : Yearly working hours (h/Yr).

a : Life expectancy of the machine in year.

i : Annual interest rate (%/yr).

r : Annual repairs and maintenance rate (%/Yr).

W: Power (k.W).

S : Specific fuel consumption kg/ k.W.h).

F : Fuel price (L.E./L.).

m: Operator monthly salary L.E./mo.

1.2: A factors accounting for Lubrication.

144: Monthly average hours (h/mo.).

The operating cost was determined using the following equation:

$$\text{Operating cost/fed} = \frac{\text{Machine cost/h}}{\text{Effective field capacity (fed/h)}}$$

Theoretical Analysis

The operating force Q_f on the blade, in the direction of motion is distributed at the cutting edge into normal force Q_n and tangential force Q_t.

The force Q_n produces friction force $Q_f = Q_n \tan \theta_w$ (θ_w-angle of friction between weeds and blades).

The roots are cut through only when the tangential force Q_t is higher than friction force Q_f, i.e. as shown in (Fig. 3).

$Q_n \tan \theta_w < Q \cos \theta_o$

$Q \sin \theta_o \tan \theta_w < Q \cos \theta_o$

$\tan \theta_w < \tan(90-\theta_o)$

The apex angle $2\theta_o$ therefore should be, $2\theta_o < 180-2\theta_w$

Design Considerations

The weeder was designed to suit row crops spacing (60 cm) and more than 60cm.

The working width was computed the working zones of each blade and spacing between them. As shown in (Fig. 4).

$W_c > 4a \tan Ø_s + 2w_o + \Delta_s$

Where:

w_c : crop spacing (60cm),

w_o : effective width of each sweep, mm

d : operating depth (8cm),

Δ_s : spacing between working zones of each sweep, cm

$Ø_s$: angle of internal friction of soil, degree.

working width of each sweep.

W < ½ (distance between rows- 4 x depth x tan internal friction angle).

S : Space between two tines could be also competed from.

S : 2 x depth $\tan\theta$ + working width of each sweep.

Where

s: the space between two tines.

According to the equations given above, determine the draft and the optimum cutting blade angle.

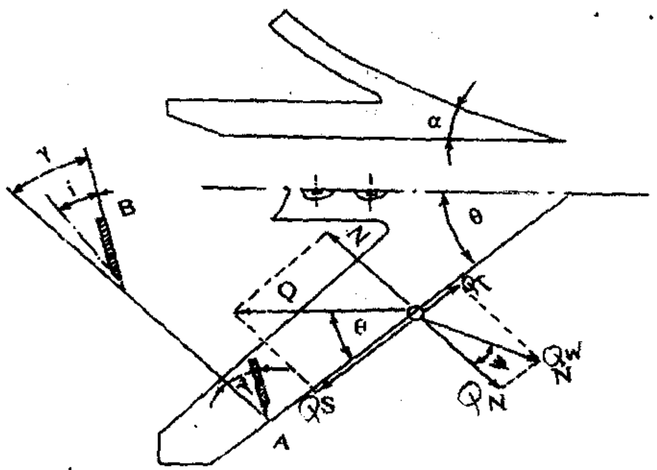
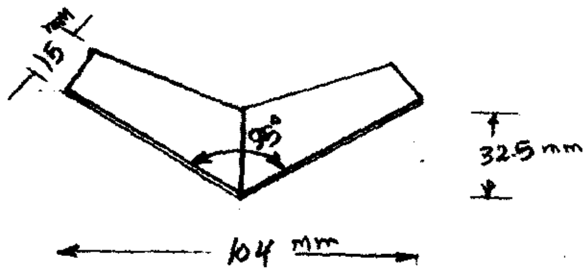


Fig. 3: Force analysis on the shear



V- Shaped sweep blade

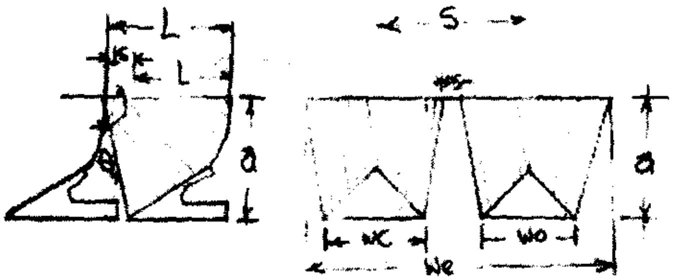


Fig. 4: Row width adjusting

RESULTS AND DISCUSSION

The main results obtained from the experiments are discussed under the following main points:

1. Effect of Different Weeding Methods on Wheel Slippage (%), Draft (N) and Consumed Energy (kW.h./ton $_{weeds}$)

Wheel slippage

(Figs. 5 a and b) show that the lowest mean values of slippage were 6.67%, 6.96% and 10.23% under treatment [B] at average weeding speed 3.5, 5, 6.5km/h, resp. for (WWG) Comparing with the mean values of wheel slippage were 15.98, 17.76 and 19.42% for (OWG) under the same treatment [B] and the same average weeding speeds.

Adding weight of 130kg to the machine, made it more balanced, decreased wheel slippage especially at low speed 3.5 km/h., where the value of slippage increase slowely at 5km/h by 7.19% and reached up to 10.32% at 6.5 km/h.

Moreover as depth of operation increase sequencly the slippage will be increased.

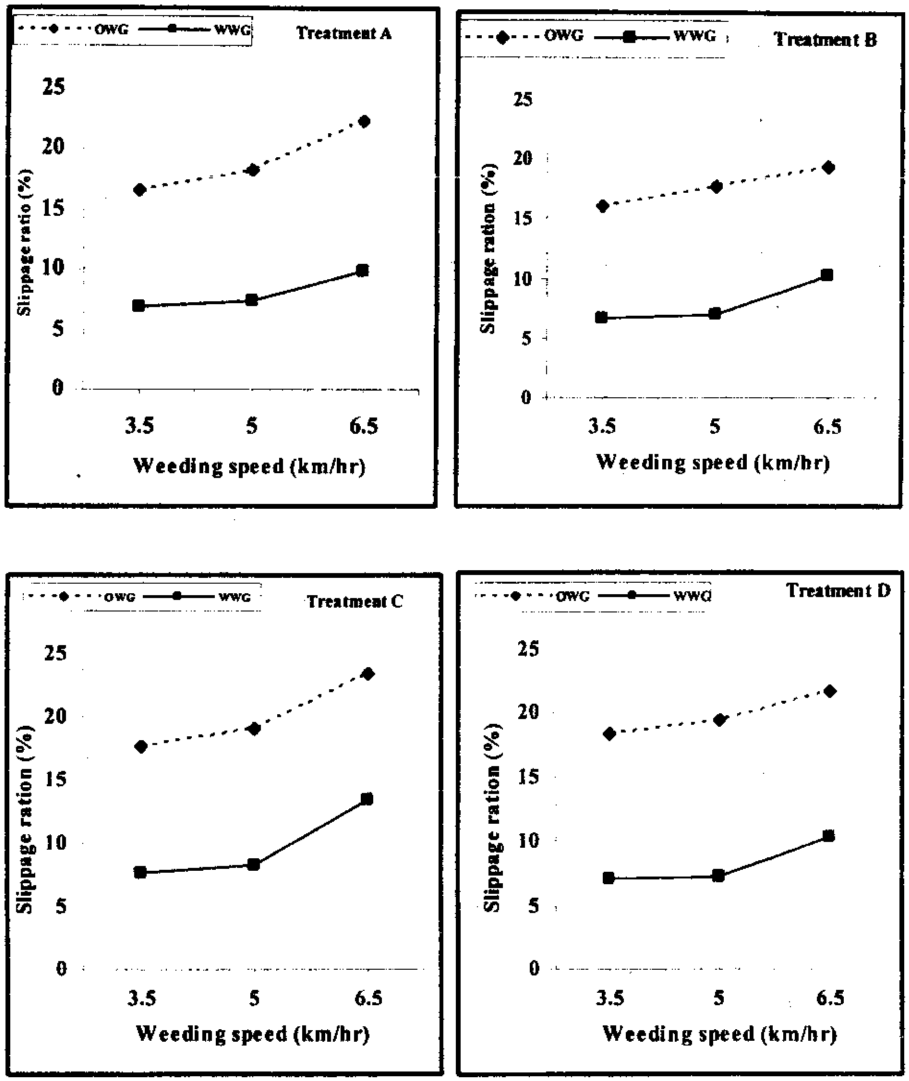
Draft (N)

The lowest mean values of draft were 137.01, 141.98 and 174.15 N for first weeding, while they were 98.26, 116.96 and 141.46 N for second weeding under treatment [B] (blades angle 12°, depth =5cm) at speeds of 3.5, 5 and 6.5km/hr, resp. for (WWG) while these values of draft were 153.94 , 173.15 and 197.90 N for first weeding and 105.54 , 125.32 and 151.57 N for second weeding for (OWG) under the same treatment [B] and the same average weeding speeds comparing with traditional weeding methods [E] recorded 139.95 and 136.62 N for first and second weeding res.

It is known that the cutting angle plays an important role where it affects deeply on draft requirement. Both of the low cutting angle of (12°), and less depth decrease required draft for weeding by 294.35 N with percentage of 56.17%.

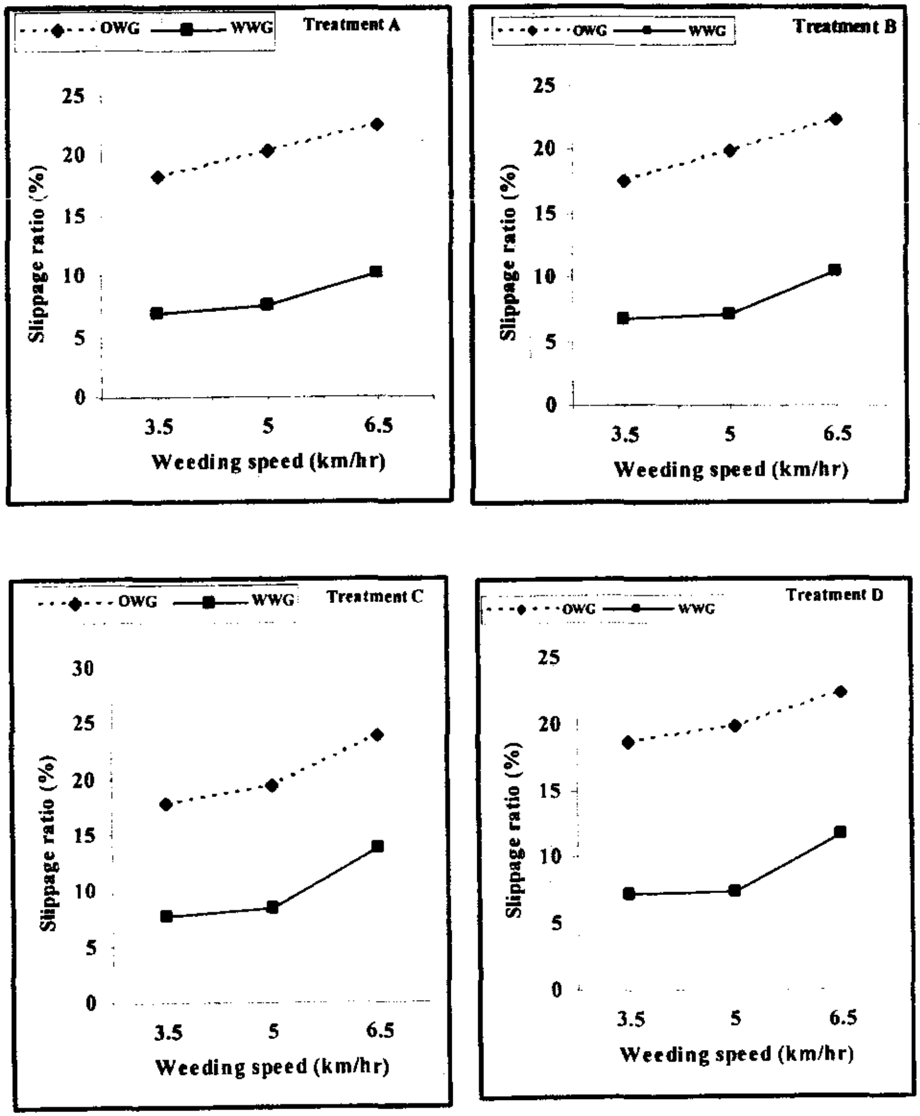
Consumed energy (kW.h./ton $_{weeds}$)

(Figs. 5 c and d) cleared that the lowest average values of consumed energy were 5.144, 4.937, and 5.094 for first and 4.646, 3.069 and 4.277 (kW.h/ton $_{weeds}$) for second weeding, under



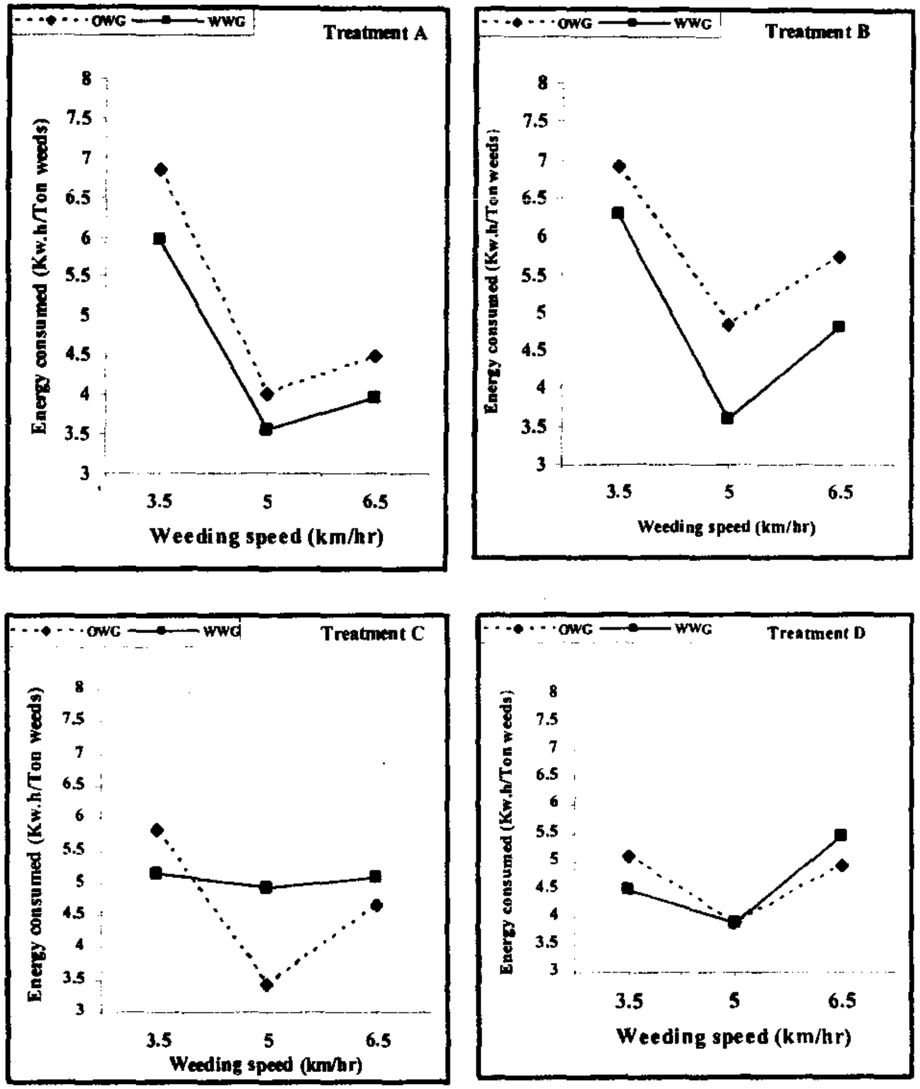
OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balancing weight on the front axel of the developed machine.

Fig. 5-a: Effect of different weeding methods on wheel slippage (%) for first weeding



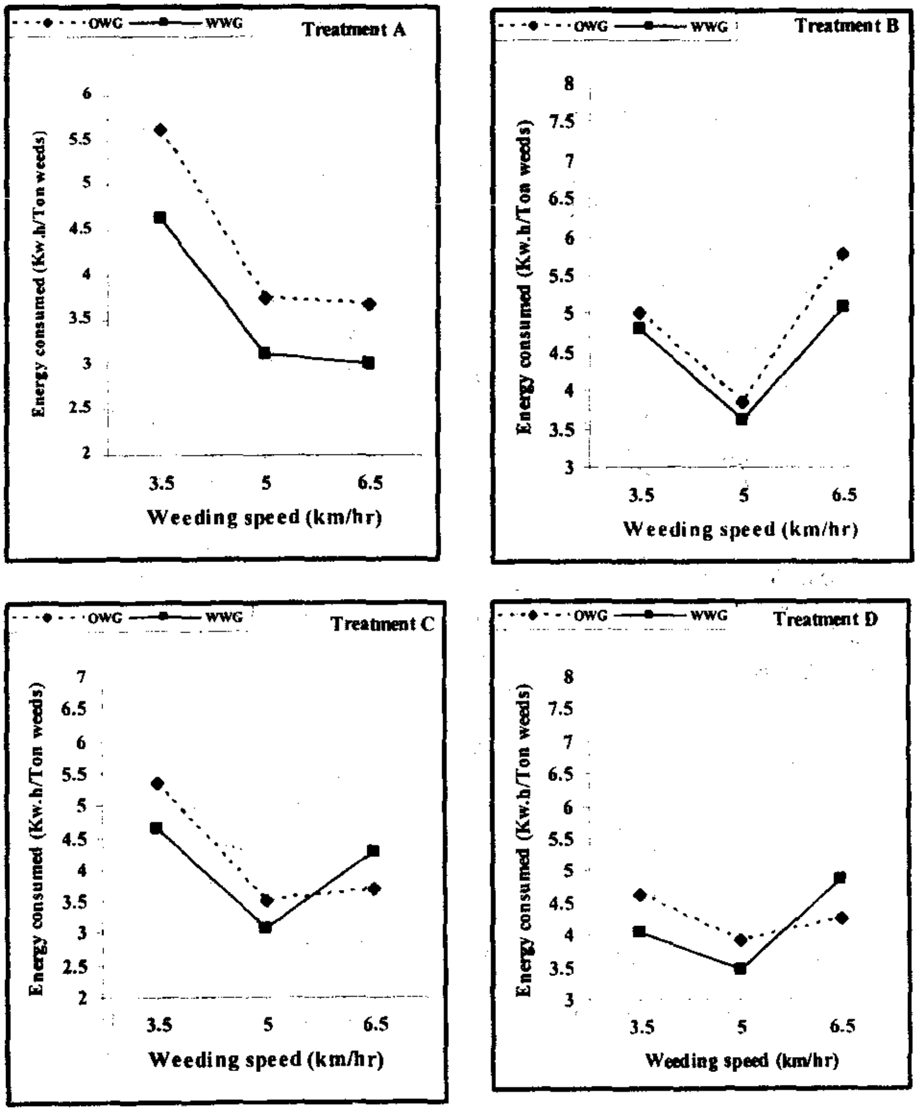
OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balancing weight on the front axel of the developed machine.

Fig. 5-b: Effect of different weeding methods on slippage ratio (%) for second weeding



OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balancing weight on the front axel of the developed machine.

Fig. 5-c: Effect of different weeding methods on consumed energy (kW.h/ton weeds) for first weeding



OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balancing weight on the front axel of the developed machine.

Fig. 5-d: Effect of different weeding methods on consumed energy (kW.h/ton weeds). For second weeding

[C] treatment (blades angle 21°+ two pair spyders) for average speeds 3.5, 5,- and 6.5km/h, resp., for (WWG) while the lowest values were 5.816, 3.439 and 4.662 kW.h./ ton $_{weeds}$ for first and 5.346, 3.495 and 3.698 (kW.h/ton $_{weeds}$) for second weeding under the same treatment [C] and the same speeds for (OWG) comparing with traditional weeding methods of 51.962 and 27.9989 (kW.h/ton $_{weeds}$) for first and 56.88 and 27.056 for treatments [F] and [E], respectively.

The lowest values of energy consumed at weeding speed of 5km/h may be due to the increase in weeding efficiency. Increasing weeding speed from 5km/h to 6.5 km/h. caused an increase in the energy consumed by 1.208 (kW.h/ton weeds) for (WWG), and 0.203 (kW.h/ton weed) for (OWG) for second weeding, while the rate of weeding decreased due to the decrease in weeding efficiency. The difference between the two rates can be explained as follows: when a balancing weight was added to the front of the developed machine decreased the slippage ratio and improved the draft, as a result low energy values will be consumed. The increased the amount of cutting weeds from the unit of the area due to reduced specific consumed energy by 0.157 (kW.h./ton weeds) for (WWG) and by 1.169 (kW.h/ton weeds) for (OWG) for first weeding under treatment C.

2. Effect of Different Weeding Methods on Field Efficiency(%)

Field efficiency (%)

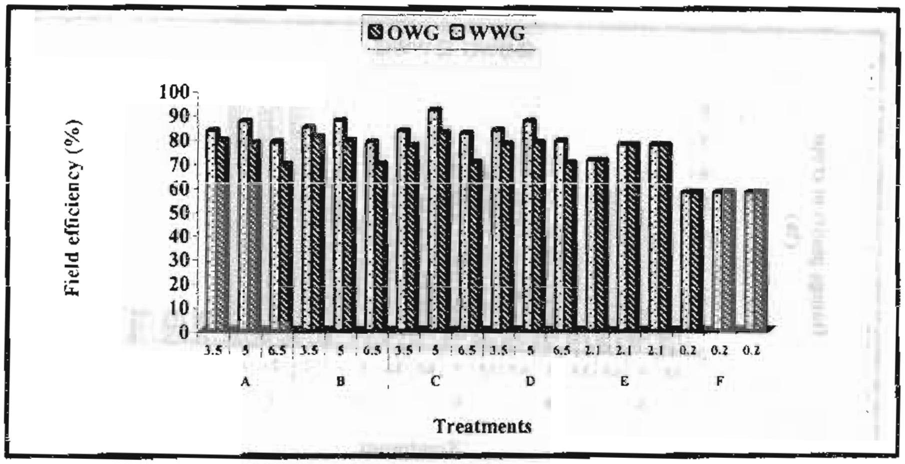
(Figs. 6 a and b) show that the highest values of field efficiency were 77.04,82.26 and 70.02% for the first weeding and 79.53, 80.90 and 84.89% for the second weeding for (OWG) and 82.95, 91.52 and 81.91% for first weeding and 81.66, 93.62 and 87.89% for second weeding for (WWG) at average weeding speed of 3.5, 5.- and 6.5 km/h res., under treatment [C] comparing with the traditional weeding methods of 77.33 and 57.52 % for first and 78.53%, and 59.54% for second weeding under treatment [E] (animal -drawn weeding) and [F] (Hand hoeing weeding), res.

The highest values of field efficiency may be due to the high control and steering of the developed machine under different conditions.

3. Effect of Different Weeding Methods on Damage Plants of Corp (%) and Weeding Efficiency (%)

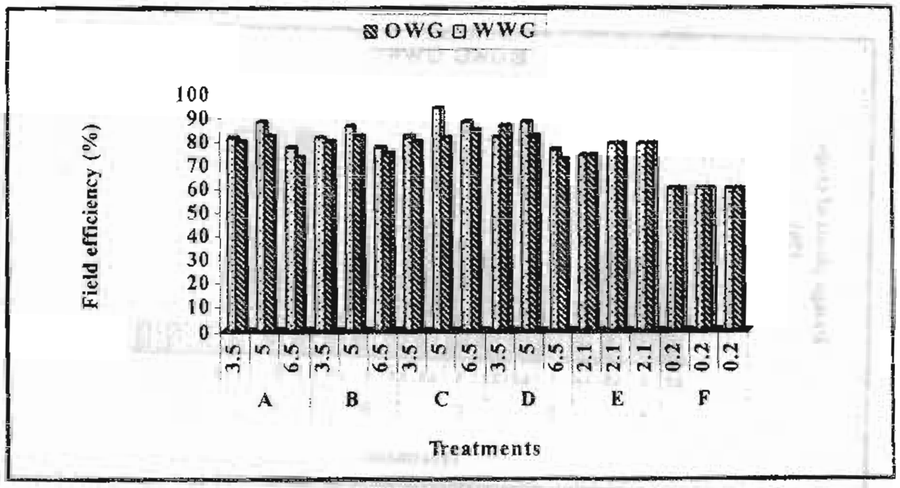
Damage plants of maize crop(%)

(Figs. 7 a and b) show relationship between damage plants of crop and adding 130 kg



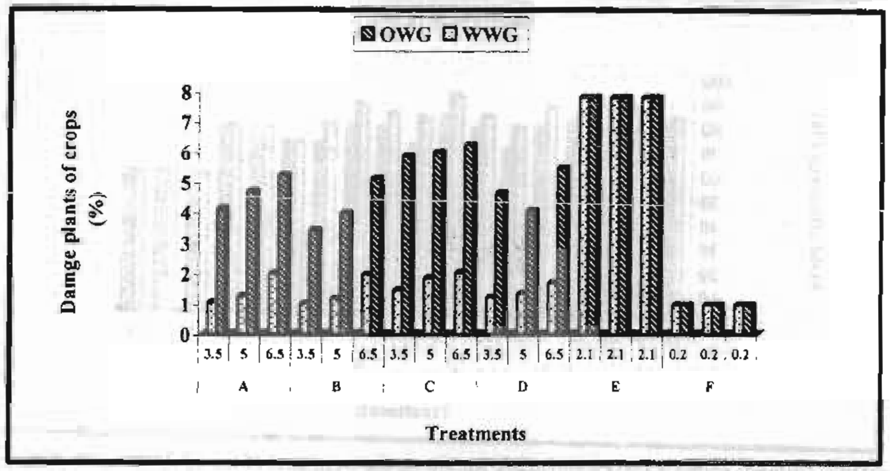
OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balancing weight on the front axel of the developed machine.

Fig. 6-a: Effect of different weeding methods on field efficiency (%) for first weeding



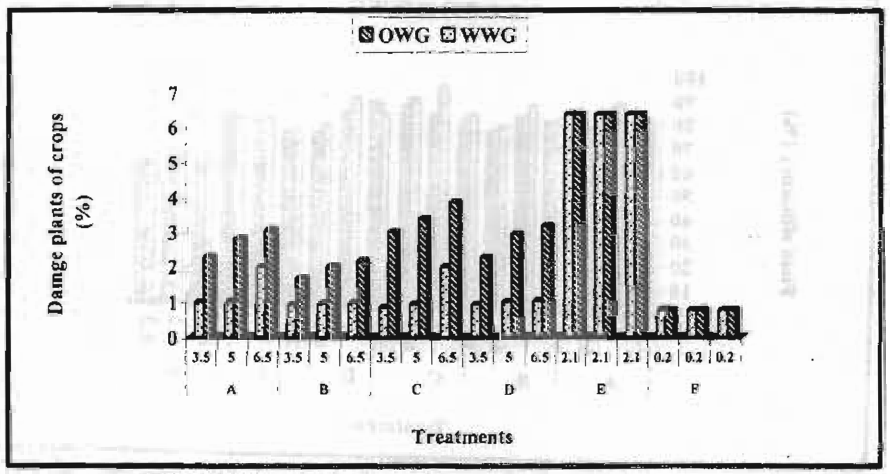
OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balancing weight on the front axel of the developed machine.

Fig. 6-b: Effect of different weeding methods on field efficiency (%) for second weeding



OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balaneing weight on the front axel of the developed machine.

Fig. 7-a: Effect of different weeding methods on damage plants of crop (%) for first weeding



OWG: Without added a 130 kg balancing weight on the front axel of the developed machine.
WWG: With added a 130 kg balaneing weight on the front axel of the developed machine.

Fig. 7-b: Effect of different weeding methods on damage plants of crop (%) for second weeding

balancing weight. Because adding balancing weights on the powered wheels at the front of the developed machine create more controlling in the machine performance keep plants less injures. So the damage plants of crop decreased by 3.43% for weeding speed 5km/hr for first weeding under treatment A.

Weeding efficiency (%)

The maximum values of weeding efficiency was 93.21% for first weeding and 95.63% for second weeding recorded for treatment [F], the higher values of efficiency were 84.49, 89.76 and 82.13% for first and 88.79, 92.46 and 85.69% for secand weeding (WWG) and 78.76%, 83.91 and 81.50% for first and 81.11, 84.53 and 79.72% for second weeding for (OWG) recorded for treat [C] for average. Speed 3.5, 5,- and 6.5km/hr, resp. Comparing with the lowest values of weeding efficiency of 75.63% for first weeding and 78.11 for second weeding recorded for treatment [E].

The higher values of weeding efficiency can be explained by the fact that, the percentage of weeding efficiency is function of some parameters for the developed cultivator. These parameters are cutting angle, cultivation depth, apex angle and the weeding speed, so, the weeding efficiency increased by adding the balancing weights on the front of the developed machine by 5.85% at weeding speed 5km/hr and first weeding under (C) treatment, due to decreasing the slippage ratio, improve performance of the developed machine and increased effective width and depth of weeding (a cross – section) of weeding soil by improving the cutting and apex angle increased weeding efficiency by 7.93% for weeding speed 5km/hr and second weeding under the same treatment C.

4. Effect of Different Weeding Methods on Eradication (%) and Total Costs (L.E./fed.)

Eradication (%)

(Fig. 7 c and d) clear that the highest percentage of eradication (%) were 100.00, 97 and 95.07% for first and 100.00, 98.21and 96.39% for the second weeding, directly, after 10 days and after 21°days, res. under treatment [F]. The higher of percentage of eradication were 98.18, 98.39 and 98.32 for first and 98.49, 99.06 and 98.68 for second weeding for

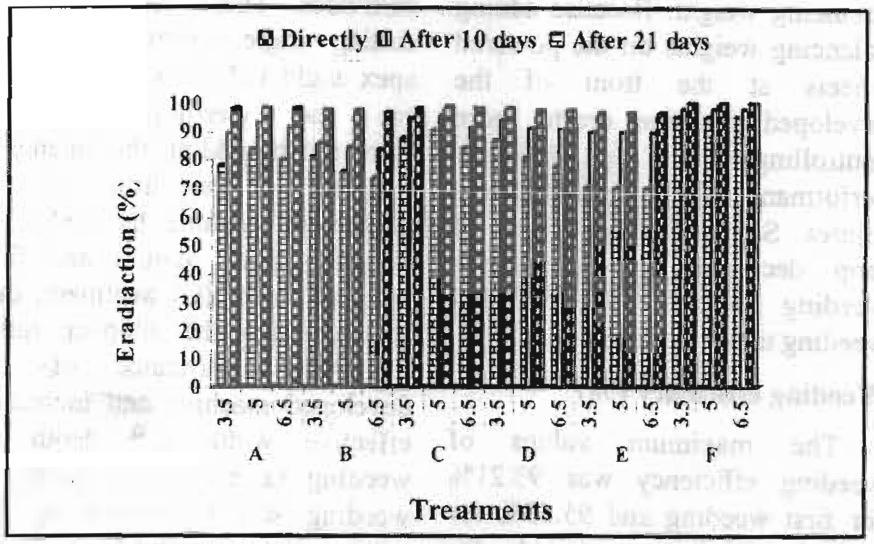


Fig. 7-c: Effect of different weeding methods on eradication (%) for first weeding

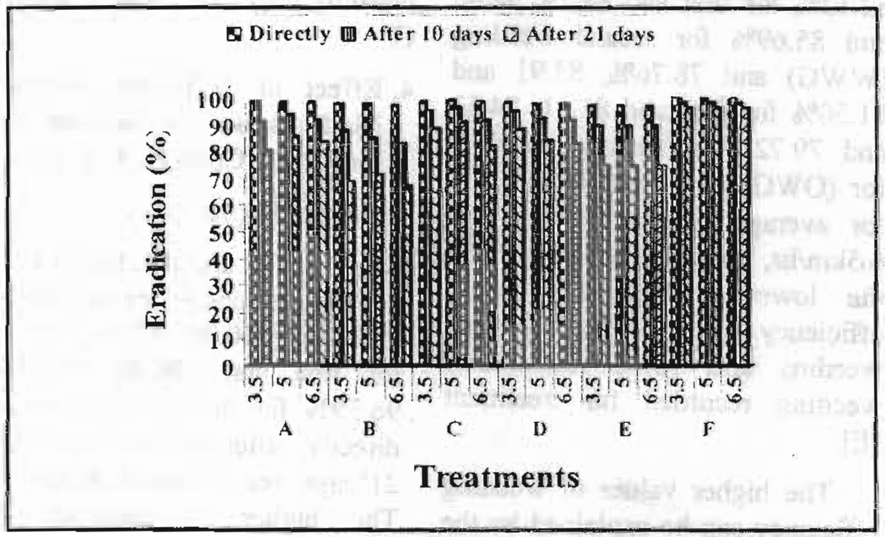


Fig. 7-d: Effect of different weeding methods on eradication (%) for second weeding

Table 2: Effect of different wedding methods on total costs (L. E/ fed)

Treatments	Average weeding speed (km /hr)	Average soil – moisture content (%)	Total coasts (L. E./fed)	
			OWG	WWG
A : Blade angles 12°t two pair spiders depth =5 cm	3. 5	23.75	17.35	14.89
	5.0	22.19	11.41	10.24
	6.5	20.86	10.12	8.84
B: blade angles 12° only depth = 5 cm	3.5	24.91	18.04	15.18
	5.0	22.73	11.91	10.15
	6.5	19.99	10.51	9.23
C = blade angles 12° only depth = 5 cm	3. 5	21.43	16.57	15.19
	5.0	23.26	10.99	9.43
	6.5	20.67	9.34	8.24
D = blade angles 21° only depth = 8 cm	3. 5	24.11	15.97	14.90
	5.0	25.63	11.41	10.34
	6.5	22.71	10.11	8.94
E: Animal drawn weeder depth = 6 cm	2.1			
	-	25.81	82.22	82.22
	-			
F = Hand hoeing angles depth = 5 cm	0.2	28.24	133.79	133.79
	-	-	-	-
	-	-	-	-

directly, and 94.36, 95.43 and 91.11 for first and 95.21, 96.04 and 91.38 for second weeding for after l0 days and 87.74, 90.35 and 84.33% for first and 88.23, 90.58 and 82.24 for secand weeding after 21days for average speed 3.5,5,-and 6.5km/hr resp. Under treatment [C] comparing with the lowest percent of eradication were 96.63, 89.56 and 70.26 for first and 96.82, 89.56 and 74.71% for second weeding that for directly after l0 days. And after 21days, res. under treatment [E] (animal-drawn-weeder d=6cm).

The highest percentage of regrowth (%) were low after weeding directly and increased with increasing the period after weeding (after 10 day and 21 day) that may be due to the tubers and rhizomes of some weeds that lift through the soil layers which regrowth after later time and the ratio of regrowth weeds increased by 2.35% for 10 days under treatment C at weeding speed 5km/hr and first weeding and by 8.04% for 21 day at the same conditions so, the eradication ratio decreased with increasing time period.

Total Costs (L.E./fed.)

The lowest Cost of 15.18, 10.15 and 9.23 (L.E/fed.) for (WWG) and 16.57, 10.99 and 9.34 (L.E/Fed) for (OWG) for average speed 3.5, 5.- and 6.5km/h, res. under [C] after that A,B then D, res., according to the price level of 2002.

All of that Comparing with the highest costs recorded of133.79 and 82.22 (L.E/Fed) resp. under treatment [F] and treatment [E]. as shown in Table 2.

Conclusions

1. The developed machine is recommended to be used for mechanical weeding under treatment [C] (blades angle 21°+Two Pair spyders, d = 8cm) at workable speed of about 5 km/h.
2. The cutting angle (blades angle) not increased about 21°.

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تطوير نظام آلى لمقاومة الحشائش بين الخطوط فى الحقل المصرى

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تم تطوير المحشة ذاتية الحركة لتعمل كعزاقة ميكانيكية تعمل بين خطوط المحاصيل المزروعة فى صفوف مثل الذرة (صنف جيزة ٣١٠) عند مراحل عمرية مختلفة للنبات. تم تطوير الآلة لتفعل فعل المحراث الحفار بين صفوف نباتات المحصول، كما تم تحديد أنسب عوامل تشغيل مؤثرة على أداء الآلة المطورة، وكما تم مقارنه أداء الآلة المطورة بطرق العزيق التقليدية مثل العزيق بالحيوان والعزيق اليدوى بالفأس.

وأهم مكونات الآلة المطورة التى تم إضافتها إليها لتناسب وظيفتها الجديدة هى:

الإطار الرئيسى، القصبات، الأسلحة، الأسلحة الدوارة، مجمعات الحشائش.

وقد تم تقييم أداء الآلة المطورة قبل التطوير وبعد التطوير فى هذه الدراسة من حيث السعة الحقلية، الكفاءة الحقلية، نسبة التلف لنباتات المحصول، كفاءة العزيق، دليل الآلة لعملية العزيق، نسبة الاستئصال، الإنتاجية الكلية، نسبة الإنزلاق للآلة المطورة، استهلاك الوقود، القدرة المستهلكة والطاقة المستهلكين والتكاليف كدالة فى التغير فى زاوية القطع لأسلحة العزيق ومتوسط سرعة العزيق.

اتضح من النتائج المتحصل عليها أنه باستخدام الآلة المتطورة يزيد كلاً من الكفاءة الحقلية وكفاءة العزيق ويقلل كلا من الفواقد والطاقة والتكاليف بالمقارنة مع طرق العزيق التقليدية (العزيق اليدوى، العزيق الحيوانى) فى ظروف متوسط سرعة العزيق للآلة المطورة ٥ كم/ساعة وزاوية القطع لأسلحة العزيق فى حدود ٢١°.