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DEVELOPMENT AND EVALUATION OF A FLAME UNIT FOR WEED CONTROL IN NEWLY SOILS.

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ABSTRACT

The present study aims to reduce the use of herbicides for weed control, solving the problem of decrease agricultural manual operators in industry - city such as Domiatta Governorate and decrease the cost of weed control in newly reclaimed soils. So, an attempt was carried to develop a flame unit in a trail to kill seeds, rhizomes, bulbs and tubers of weeds which lie dormant in the soil directly after secondary tillage and before crops planting. The flame unit was tested under different forward speeds, burners spacing, height of burners above the soil surface and arranged the burners in one and two rows. The weed control cost was 22.9 LE/Fed at 40 cm burners spacing. However when decreasing burners spacing to 30 and 20 cm the weed control cost increasing to 28.1 and 47.6 LE/Fed, respectively at 1.8 km/h forward speed, 25 cm flame height when burners arranged in two rows for both rice and corn fields. It would be conculded that the mechanical weed control costs at the previous parameters with burners spacing of 40, 30 and 20 cm were 14.3, 17.6 and 29.8 % from manual control cost. Whilest, the flaming efficiency increased with decreasing burners spacing due to the intensity of flaming into soil surface.

INTRODUCTION

Weeds are considering one of the most agricultural problems in newly reclaimed lands. This is because weeds cause losses in yield and its quality. However, farmers have to use herbicides to control in weeds. But food products may become contaminated with herbicides through direct application of the chemical herbicides to the plant and land. Also the herbicides prices are expensive, environmental pollution, some of it kills one weed and leaves another, lead to loss of natural – balance between the pests and natural enemies (Ismail, 1990). So to avoid these harms and increase the crops yield, an attempt was carried to develop a flame unit. In a trial to kill seeds, rhizomes, bulbs and tubers of weeds which lie dormant in the soil directly after tillage and before crops planting for increase crop yield and reduce environmental pollution.

El-Nakib (1990) stated that flame was more efficient with the grass, the efficiency was 98-100%. Flame is preferable with the grass than the mechanical methods because of mechanical cultivators diffuse the rhizome (stock root) in the soil. Hosny *et al.* (1992) showed that effect of herbicides on bacteria and cynobacteria is more that warranted this is more pertinent in such cause where the herbicide is applied to the soil. Mahran (1993) found that the flame width represents an important parameter among the flaming parameters which affect the resulting temperature histories, the resulting temperature levels increase as the used travel speed increases also. High temperature flame width is increased and the corresponding time of exposure to heat levels antime of exposure to heat can be obtained by using multiple flames, hence the effective flame width will be increased. He added that the weed must be heated to a temperature not less than 100 °c at period of 0.1-1.0 second to obtain the required flaming effect.

Ibrahim *et al.* (1997) stated that a simple flame unit could be fitted on the frame of chisel plough to push flame on under ground to burn all pests. The highest effect on weeds number was at 1.9 km/h forward speed and 0.25 m width between beams. The field capacity of this unit was 0.59 Fed./h, the cost was 72.51 LE/Fed., and the fuel consumption was 115.8 l/Fed.

Lague *et al.* (1997) tested the effect of three different types of propane burners at operating pressures ranging from 135 to 485 kPa (20 to 70 psi) on temperature distribution. Data indicated that flat vapor burners are more suited for thermal treatment that requires abroad coverage. While round vapor burners produce long and narrow flamers that can be precisely directed where heat needs to be applied. Fitting flat vapor burners with either narrow or wide jet nozzles can promote heat penetration in the first case or more uniform heat distribution in the second one. Also the type of burner, burner setting and travel speed of the flaming equipment effected on heat distribution.

EL-Danasory (2000) reported that the flame weeder was tested at different forward speeds, angle and height of burner under different conditions of growing weeds. It was found that in manual planting, the longitudinal distribution of plants across the row centerline was deviated by $\pm$ 11cm for 55.6% of plants. The highest efficiency of flame weeder was obtained when the flame height was in range of 3 to 6 cm and at an angle 0-20. The high length and high moisture content of weeds decreased the weed control efficiency. Flame weeding in old wetted weeds costs more than that by using manual hoeing. But the low moisture content of young weeds decreased the cost of flaming weed. Using flame weeding in the first stages of crop growing (during the first or second cultivation) increased damage of plants to 15.8%. Flame weeding after 65 days from planting (during third cultivation) decreased damage to about 3.0%.

MATERIALS AND METHODS

Experiments were carried out in EL-Serw Agric. Res. station, Domietta governorate in 2003 season, on two crops (rice and corn). Mechanical, chemical and physical properties of soil samples were summarized in Tables 1,2 and 3. The developed flame unit was used directly after tillage (using chisel plough two passes followed land leveler for rice crop and chisel plough two passes followed land leveler and before using the ridger for corn) before planting the crops. The developed flame unit as sketched in Fig. (1) was manufactured in small workshop at EL-Kordy city, Dakahliya Governorate, it consists of a frame, 9 burners, petrogas cylinder, feeder lines, deep wheels, pressure gauge gas regulator valve. It has advantages such as simple mechanism, small weight (80 kg) without gas cylinder, low price (300 LE), made from local materials. It's weight when it an empty gas cylinder was 17.5 kg, and the weight when it filled gas cylinder was 27.5 kg, so the gas weight is 10 kg.

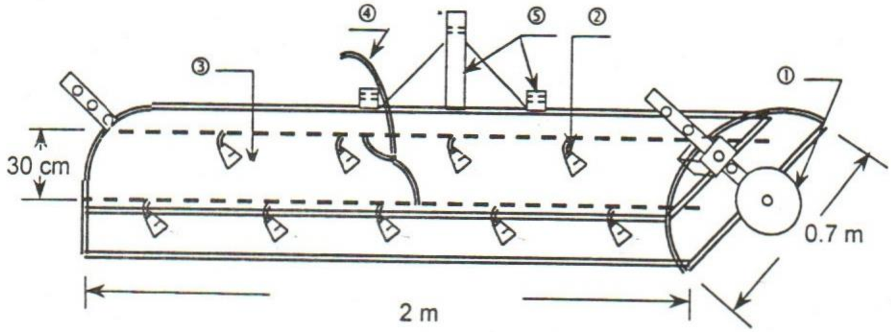

Fig. (1): Schematic of flame unit.
1- Deep wheel 2- Burner 3- Frame 4- Feeder pipe 5- Hitching point

Equipment: a tractor 60 hp was used for mounting gas cylinder, its equipment (pressure gauge gas regulator and feeder line) and trailing the flame unit.

The evaluation factors were:

1- Distance between burners: three different distances, namely 20, 30 and 40 cm (W_1, W_2 and W_3).

2- The burners were regulated in two positions (one row or two rows).

3- Three different heights of flame namely 15, 25 and 35 cm named h_1, h_2 and h_3 the flame height measured vertically from the nozzle of the burner to the soil surface.

4- The experiments were carried out under different gas pressure (5 - <15, 15 - <25, 25 - <35, 35 - <45 and 45 - <60 N/cm^2 named P1, P2, P3 and P4). Using gas regulator valve and it measuring by pressure gauge can change the gas pressure.

5- Four forward speeds of 1.8, 2.6, 3.4 and 4.6 km/h, named F_1, F_2, F_3 and F_4.

6- Flame angle: The angle between burner center and the horizontal was constant at 40 °c (according to EL-Nakib 1990).

7- Gas consumption rate: it was estimating by weighting the petrogas cylinder before and after testing (according to EL-Danasory 2000).

8- The weed control efficiency: it was estimated according to FAO (1994) by the following equation:

$$\eta = \left(\frac{n_1 - n_2}{n_1}\right) \times 100, \qquad \%$$

where: η =weed control efficiency, %

n_1 = number of weeds before treatment per square meter.

n_2 = number of weed after treatment per square meter.

9- Field efficiency (ηf): it determined by the following equation:

$$\eta_f = \frac{\text{Effective field capacity (EFC)}}{\text{Theoretical field capacit (TFC)}} \times 100 \qquad ,\%$$

10- Random 5 samples were taking from each experimental of soil at soil profile depth of (0-5.0) cm before and after treatments to determine the change in mechanical and chemical analysis of the soil (Tables 1, 2, and 3), nematodes and other elements. These tests were conducted in the laboratory at EL-Serw Agric. Res. station and microbiology Department, Faculty of Agric., Mansoura University.

11- Operation cost: cost was calculated according to the rent of tractor in EL-Serw district (10 LE/h) and gas price about 0.5 LE/kg.

Table 1: Soil mechanical analysis of experimental at EL-Serw Agric. Res. station

Particle size distribution				Texture Class
Course sand %	Fine san %	Silt %	Clay %	
1.62	12.22	20.10	66.06	Clayey

Table 2: Some chemical properties of soil samples

EC Ds/m	PH1:2.5 Soil suspension	MG^{++} Meq/L	Ca^{++} meq/L	NA^{+} Meq/L	Ksol Meq/L	Available (ppm)		
						Total N	P	Kex
4.8-5.6	8.4	4.3	4.7	11.6	0.13	31.2	7.5	230

Table 3: Some physical properties of soil samples

Bulk density g/cm^3	Total porosity, %	Soil MC %	Nematodes No. /250 gm. soil	Micro organisms No. /1 gm.soil
1.36	47.8	8.7	320	12×10^6

Problems faced during developing the flame unit

1- The first problem was extinction the burners under different forward speeds. Three types of combustion chambers have been tested and evaluated to select the best one for flame intensity distribution (Fig. 2).

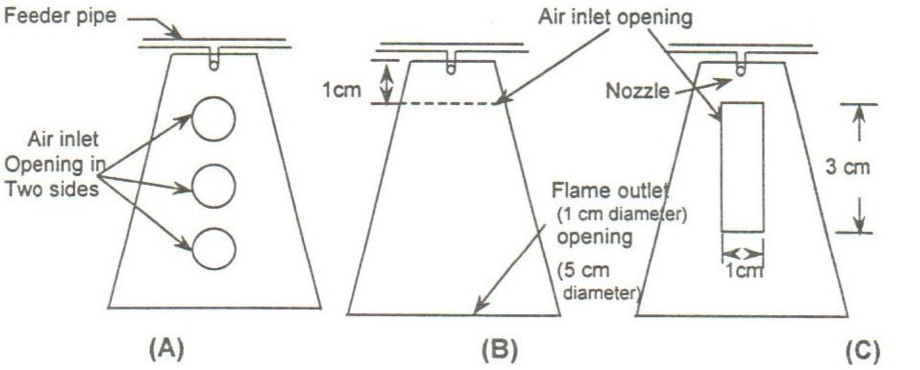

Fig. 2: Schematic of conical combustion chambers.

2-To avoid the difference in the flame unit height, two deep wheels were used for adjusting the flame height.

3-decrease the wide of flame (about 8 cm), it was solved by increasing the nozzle orifice diameter from (0.6 to 2.2 mm) to give flame width about 20 cm.

First position: burners spacing of 20cm

A- On one row:

Width = 180 cm

B- On two rows:

Width = 100 cm

Second position: burners spacing of 30cm

A- On one row:

Width = 270 cm

B-On two rows:

Width = 150 cm

Third position: burners spacing of 40cm

A- On one row:

Width = 360 cm

B- On two rows:

Width = 200 cm

RESULTS AND DISCUSSION

Effect of different types of burner design on flame width and shape on the soil surface

The first problem was extinction the burners under different forward speeds. This problem was solved by using different combustion chambers, which fixed on the nozzles {conical shape, 2 cm small diameter on the nozzle and the other 5 cm large diameter, and 4.7 cm^2, 4 cm^2 and 6 cm^2 area of air inlet opening in two sides of combustion chamber}, and covering the machine forward by using steel sheet. Increase with of flame at soil surface is target to increase the weed control efficiency. The laboratory experimental indicated that the width of flame was affected by the shape and area of inlet. Also the higher width of flame of 20 cm on the soil surface noticed at using combustion chamber No. (B) with (4 cm^2) small area of air inlet. The chamber (B) gave best flame intensity and distribution more than the other shapes of "A" and "C" which they have 14 and 16 cm flame width.

Effect of distance between burners and flame height on weed control efficiency

The results in Figs. 3 and 4 indicated that the weed control efficiency increased with decreasing both forward speed and distance between burners. But when burners were arranged in two rows the efficiency was greater than it was at one row. Also it was with 25 cm flame height higher than with 15 and 35 cm flame height.

However, it was noticed that the weed control efficiency in corn field higher than it was in the rice field, this due to the neutral growing methods and corn crop was planted in the rows. The highest values of weed control efficiency were 89 and 93 % when flame nozzles arranged in two rows with 20 cm spacing between them, 25 cm height from soil surface and 1.8 km/h forward speed. While the lowest values of weed control were 7 and 11 % when burner were arranged in one row with 40 cm spacing, 35 cm flame height and 4.6 km/h forward speed, respectively for rice and corn crop.

And also it was remarked that a little difference in weed control efficiency with 20, 30 and 40 cm burners spacing at constant of both forward speed of 1.8 km/m, and flame height (25cm) at arranged the burners in two rows in rice and corn fields respectively. The reason of increase weed control efficiency with 20.0 cm burners spacing is due to increase the area of cross fire of flames between burners lead to increase killing of rhizomes, bulbs and tubers of weeds which lie dormant in the soil.

Effect of gas pressure on weed control efficiency

Figure (5) shows that weed control efficiency in rice and corn fields under different gas pressure with constant forward speed of 1.8 km/h, flame height of 25 cm and burners spacing of 20.0 cm. Results data indicated that there was a direct relationship between gas pressure and weed control efficiency. On the other hand, it increased with increasing gas pressure for rice and corn fields and vice versa. The lowest value of weed control efficiency was 19 and 24 % at gas pressure 5 - < 15 N/cm^2 using burners in one row. While the highest value of it was 89 and 93 under gas pressure of 45 – 60 N/cm^2 using burners in two rows for rice and corn fields, respectively.

Effect of using flame unit on untarget soil properties.

Data presented in Table (4) shows that the laboratory measurements of soil samples the resulting could be summarized in three stages:

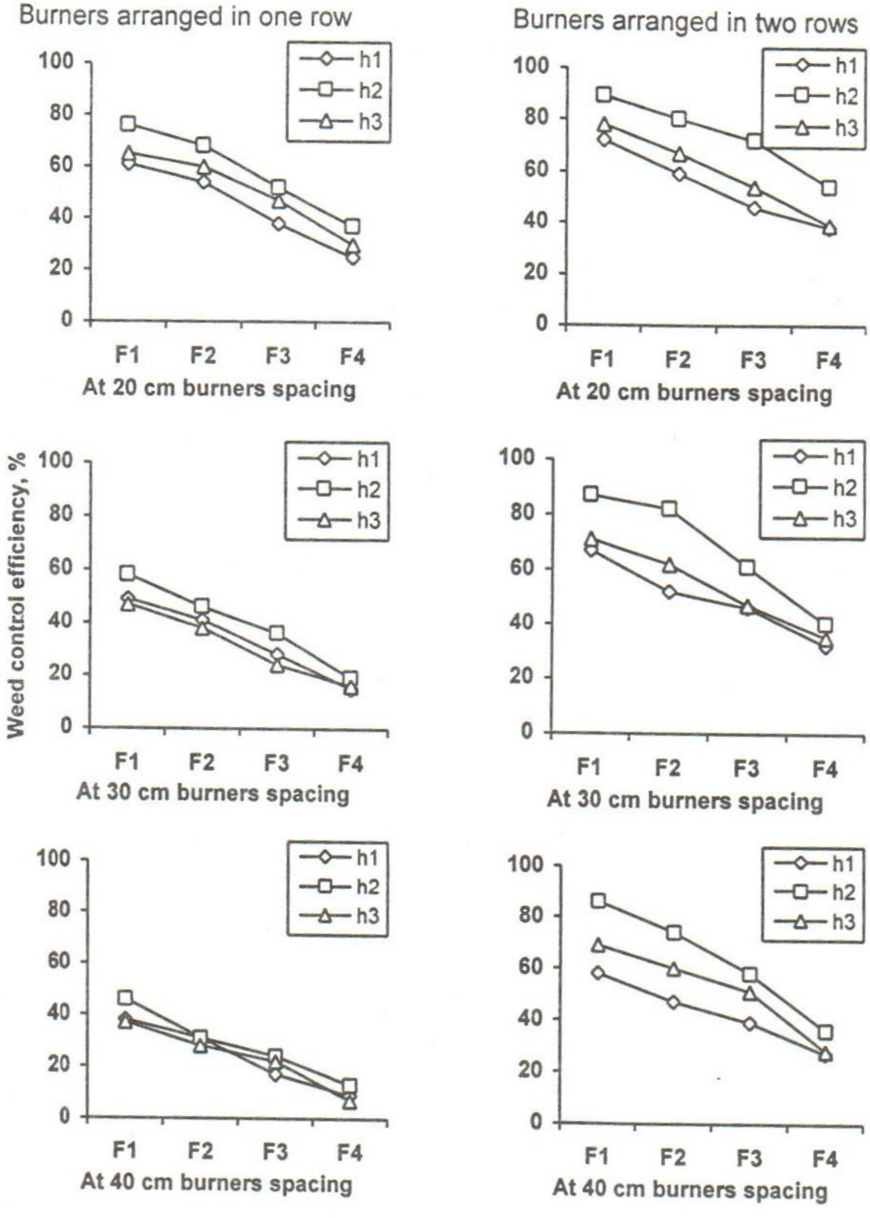

Fig. 3: Effect of flame height, burners spacing arranged in one row and two rows on weed control efficiency in rice field (at 45-60 N/cm^2 gas pressure).

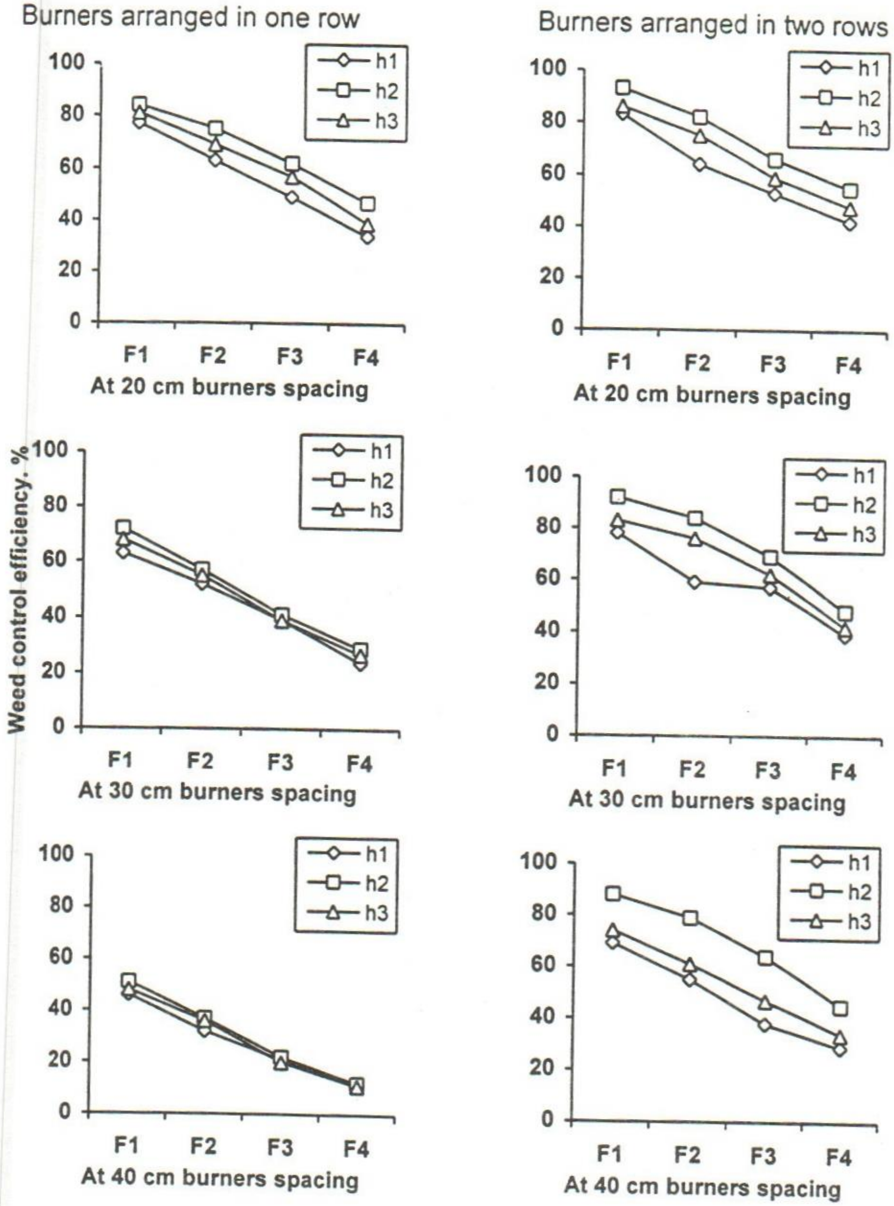

Fig. 4: Effect of flame height, burners spacing arranged in one row and two rows on weed control efficiency in corn field (at 45-60 N/cm^2 gas pressure).

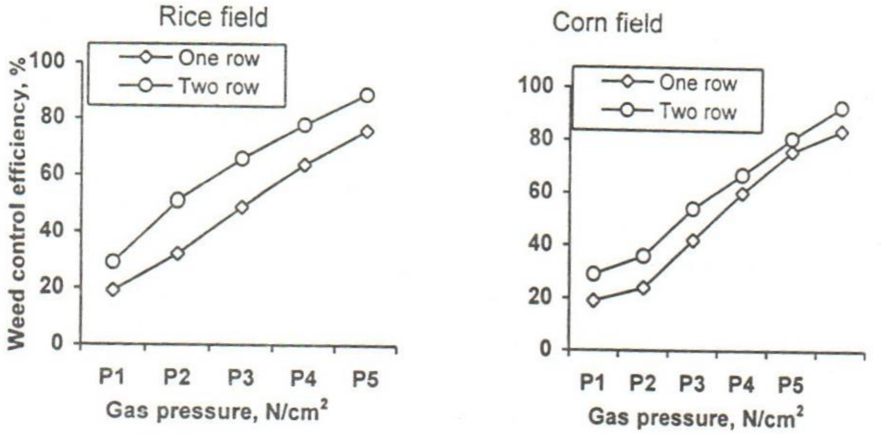

Fig. (5): Effect of gas pressure on weed control efficiency

Table (4): The percentage of change on un-target soil properties.

Treatment	Change procedures												
	Positive Change		Limited or no change (relatively constant)						Negative change				
	Element type												
	Nematodes number Loss %	A.P Excess %	Bulk density Loss %	P.H Loss %	Soil Porosity Loss %	Organic matter Loss %	E.C Loss %	Ca^{++} Loss %	Total N Loss %	kex Loss %	Na^{+} Loss %	M.o Loss %	K sol. Loss %
F1w3	100	22	-	0.1	-	0.97	0.2	0.4	8	12	10	14	16
F2w3	93	17	-	0.1	-	0.42	0.1	0.2	5	7	6	9	11
F3w3	76	9	–	0.1	–	0.28	0.1	–	2	4	3	6	7
F4w3	58	4	–	–	–	–	0.1	–	1	4	1	2	4

40 cm burners spacing
25 cm height of burners above soil surface

First stage: positive change: Nematodes number and available phosphorus (AP) percentage as comparing with control sample, both of those elements required to increase crop yield. Data show that increasing of both dead nematodes and available phosphorus with decreasing forward speed of flame unit. The highest values were 100 % of dead Nematodes were and 22 % available phosphorus achieved at 1.8 km/h forward speed. While the lowest values of Nematodes losses were 58 % and at 4.8 km/h forward speed. The reason excess of available phosphorus due to loosing phosphorus compounds resulting to increase heat concentration. (according to Ibrahim *et al.*, 1997).

Second stage: this stage relatively constants whereas was no change or very null change on some soil elements. No change in bulk density and soil porosity, while limited change of organic matter, PH, EC(Hydraulic conductivity) and ca^{++}. The later elements may be in changeable.

Third stage: This stage is not preferable because there was negative change on some soil elements, such as total nitrogen (N), exchangeable potassium (K_{ex}), sodium (Na^{+}), micro-organisms number (M.o) and soluble potassium (K_{sol}). The percentage loss of them decreased with increasing flame forward speed. The highest loss values were (8, 12, 10, 14, 11 and 16%) obtained at 1.8 km/h. flame forward speed. While the lowest loss values of losses were (1,4,1,2,4) obtained at 4.8 km/h flame forward speed for the previous soil elements, respectively. For compensate these losses the fill should be planting by legume crops or using green manure after using flame weed control.

Effect of different factors on total cost of weed control with flaming unit

The results in Table (5) shows that the gas consumption rate and total cost of flaming unit were affected by some factors such as burners position, spacing its and forward speed.

Data indicated that the time required (h/Fed.), gas consumption rate (kg/Fed.), gas cost (LE/Fed.) and the total cost (LE/Fed.) at low forward speed, small burners spacing when burners were arranged in two rows was higher than it with high forward speed, greater burners spacing when burners arranged in one row. On the other hand the higher values of total cost was 47.6 LE/Fed. with 1.8 km/h forward speed, 20.0 cm burners spacing when burners arranged in two rows. While the low values of total cost of flaming unit was 5.7 obtained at 4.8 km/h forward speed, 40.0 cm burners spacing when burners were arranged in one row. The cost of weed control by using flame unit equal 14.3 % form manually cost at the best operating condition (25 cm flame height, 40 cm burners spacing, 1.8 km/h flame forward speed at burners arranged in two rows).

Table 5: Effect of different factors on total cost of weed control with flaming unit.

Treatments	Burners arrangement							
	one row				two rows			
	Time Requ. h/Fed.	Gas Cons. Kg/Fed.	Gas Cost L.E/Fed.	Total Cost L.E/Fed.	Time Requ. h/Fed.	Gas Cons. Kg/Fed.	Gas Cost L.E/Fed.	Total Cost L.E/Fed.
F1w1	1.79	12.6	6.3	24.2	3.52	24.7	12.4	47.6
F2w1	1.38	9.7	4.9	18.7	2.61	18.4	9.2	35.3
F3w1	0.98	6.9	3.5	13.3	1.96	13.8	6.9	26.5
F4w1	0.82	5.8	2.9	11.1	1.50	10.6	5.3	20.3
F1w2	1.12	7.7	3.9	15.1	2.08	14.6	7.3	28.1
F2w2	0.81	5.8	2.9	11.0	1.46	10.3	5.2	19.8
F3w2	0.62	4.2	2.1	8.3	1.10	7.8	3.9	14.9
F4w2	0.48	3.4	1.7	6.5	0.89	6.3	3.2	12.1
F1w3	0.95	6.8	3.4	2.9	1.70	12.5	5.9	22.9
F2w3	0.69	4.9	2.5	9.4	1.28	9.0	4.5	17.3
F3w3	0.47	3.3	1.7	6.4	0.87	6.1	3.05	11.8
F4w3	0.42	3.0	1.5	5.7	0.76	5.4	2.7	10.3

Tractor rent = 10.0 L.E/h **Gas price = 0.5 L.E/kg**
Cost of manually weed control was 160 L.E/Fed.

CONCLUSION

This study was aimed to develop and evaluate the performance of the flame unit for controlling weed in reclaimed fields after tillage operation and before planting.

The best operating condition of flame unit was found at 25 cm flame height, 40 cm burners spacing, 1.8 km/h flame forward speed and when burners arranged in tow rows. The previous parameters gives 86 and 88 % of flaming weed control efficiency for rice and corn feilds at 22.9 LE/Fed. This cost was about 14% of manual weed control cost. The advantges of this machine are: small, light, carried by any tractor size, and used the gas cylinder as working materials, for these reasons it will suit most weed control opeation and field interprices

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تطوير وتقييم وحدة لهب لمقاومة الحشائش في الأراضي المستصلحة

عبد المحسن لطفي
معهد بحوث الهندسة الزراعية

الحشائش تعتبر أهم المشاكل الزراعية في إنتاج المحاصيل فى الأراضي حديثة الإستصلاح حيث أنها تعتبر منافس قوى للمحاصيل الزراعية في الضوء والماء والغذاء، مما يؤدى إلى نقص كمية وجودة المحصول. كما أن استخدام مبيدات الحشائش تؤدى إلى زيادة تلوث الأرض والغذاء والبيئة بالإضافة إلى الارتفاع الكبير في أسعارها. كما أن أرتفاع أجور العمالة في بعض المناطق الصناعية مثل محافظة دمياط بدرجة مرتفعة مقارنة بالمناطق الأخرى، كل هذه العوامل السابقة كانت سبباً في إجراء هذا البحث لتطوير وحدة لهب بسيطة التصنيع منخفضة التكاليف، لإستخدامها فى قتل بذور وريزومات ودرنات وبصيلات الحشائش. وقد أجريت التجارب بمحطة البحوث الزراعية بالسرو محافظة دمياط، وقد تم تقييم الآلة باستخدام ٩مواقد غاز مرتبه في صف واحد أو صفين مع دراسة تأثير المسافات البينية بين المواقد ٤٠، ٣٠، ٢٠ سم وثلاث إرتفاعات للمواقد عن سطح الأرض وهى ٣٥، ٢٥، ١٥ سم عند سرعات مختلفة لتقدم وحدة اللهب لإمكانية تحديد كثافة اللهب القاتلة للحشائش.

وقد تم تقييم وحدة اللهب المطورة من حيث كفاءة مقاومة الحشائش، ومدى تأثير عوامل التربة وبعض الكائنات الموجودة بالتربة باللهب ثم التقييم الإقتصادى للألة .

وقد كانت نتائج التجارب كالأتى:

١ــ تأثير استخدام وحدة اللهب على مقاومة حشائش التربة:

أــ تزداد مقاومة الحشائش بترتيب المواقد في صفين وخفض المسافة بينها عند سرعات تقدم منخفضة وإرتفاع٢٥ سم للموقد من سطح الأرض

ب ــ وقد وجد أن أعلا كفاءة للمقاومة هى ٨٦، ٨٨ % لحقول الأرز والذرة على التوالي عند سرعة أمامية١,٨كم /ساعة ومسافة ٢٠ سم بين المواقد وترتيبها في صفين وعلى ارتفاع ٢٥ سم من سطح الأرض.

ج ــ بينما كانت أقل كفاءة للمقاومة هى ٧، ١١ % لحقول الأرز والذرة على التوالي عند سرعة أمامية ٤,٨ كم/ساعة لوحدة اللهب عند وضع مواقد اللهب على مسافة ٤٠ سم وارتفاعها ٣٥سم من سطح الأرض عندما تكون المواقد مرتبه في صف واحد .

د- تزداد كفاءة مقاومة الحشائش بزيادة ضغط الغاز مع كل عوامل الدراسة السابقة.

٢ــ تأثير اللهب على بعض خواص التربة الغير مستهدفة:

يمكن دراسة تأثير اللهب على خواص التربة فى ثلاثة مراحل:

أــ المرحلة الأولى: (تأثير إيجابى) ذات نتائج إيجابية مرغوبة وهى القضاء على النيماتودا بنسبة كبيرة جدا بالإضافة إلى زيادة نسبة الفوسفور الصالح للامتصاص وكانت أفضل النتائج هي القضاء على النيماتودا بنسبة ١٠٠% وزيادة نسبة الفوسفور بمعدل ٢٢%عند سرعة أمامية ١,٨ كم/ساعة وتنخفض هذه النسب بنقص كثافة اللهب.

ب ــ المرحلة الثانية: (غير مؤثر) عناصر لم تتأثر مثل الكثافة الظاهرية والمسامية وعناصر تأثرت بنسبة طفيفة يمكن إهمالها وكانت هذه العناصر هي رقم الحموضة والمادة العضوية والتوصيل الكهربي والكالسيوم .

جــ ــ المرحلة الثالثة: (تأثير سلبى) عناصر انخفضت بنسب متفاوتة وهى ذات نتائج سلبية غير مرغوبة حيث انخفضت نسب كل من النتروجين والبوتاسيوم والصوديوم والكائنات الحية الدقيقة وتقل نسبة التخفيض بزيادة سرعة التقدم. ويمكن إعادة توازن هذه العناصر بالتربة وذلك باستخدام التسميد الأخضر أو السماد البلدي أو زراعة المحاصيل البقولية (Ibrahim *et al.*, 1997).

٣ــ التقييم الإقتصادى:

وجد من حساب تكاليف تشغيل الآلة أنه عند أقل سرعة تقدم ١,٨ كم/ ساعة ومسافة بين مواقد الغاز ٤٠ سم وإرتفاع فوانى الحقن ٢٥ سم من سطح الأرض والمواقد مرتبة فى صفين، أعطت كفاءة مقاومة الحشائش ٨٦، ٨٨ % للأرض المنزرعة بالأرز والذرة علي التوالى، بتكاليف ٢٢,٩ جنية للفدان ولكنه بإنقاص مسافات مواقد اللهب إلى ٣٠سم، ٢٠ سم عند نفس إرتفاع اللهب وسرعة التقدم إرتفعت تكاليف مقاومة الحشائش إلى ١ر٢٨ ، ٦ر٤٧جنيه للفدان على التوالى. ومن الإختبارات والمقارنات للنتائج المتحصل عليها وجد أن تكاليف المقاومة للحشائش عند مسافات لفوانى الحقن ٤٠، ٣٠، ٢٠سم عند نفس الظروف السابقة ٣ر١٤%، ٦ر١٧%، ٨ر٢٩% من تكاليف المقاومة اليدوية فى كلا الأراضى المنزرعة بمحصولى الأرز والاذرة