J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 5 (1): 19 - 30, 2014

A PROTOTYPE CULTIVATOR TO SUIT UTILIZING PIECES OF RICE STRAW FOR WEEDS CONTROL

Shetewy, M. A.*; T. H. El-Shabrawy [**] and R. G. Salim [***]

*** Chairman of Agric. Structures and environmental control Eng. Dept. Fac. of Agric., Al-Azhar Univ.**

**** Dept. Fac. of Agric., Al-Mansoura Univ.**

***** Agric. Eng. Res. Inst. Agric. Res. center**

ABSTRACT

Disposal of agricultural waste such as rice straw, as well as weed control are among the most common problems faced Egyptian farmers**.** Where using the chemical control of weeds and the burning of rice straw cause serious damage to the environment. This study was achieved on tomato crop because of considering one of the most important vegetable crops in Egypt and the most sensitive to the growth of weeds that is essential breadwinner of the white fly, which publishes serious viral diseases of the crop. The main objectives of this study were to search the effect of adding rice straw pieces while cultivating operation. To obtain this aim manufacture of cultivator consists of two units, the first one (front four shares, two protector disks), the second adding rice straw pieces unit (hopper, feeding drum, directing tube and press wheel). Where the rice straw is biodegradable material, Cover rice straw pieces as mulches on ridge bottom avoiding tomato rows and the improving the profile of ridge bottom are a suitable choice for sustainable agriculture because they improve weed control and tomato crop performance. Also to investigate weed control and improving by using rice straw pieces cover. The rice straw pieces were the effective cover crop for suppressing weeds. After preparing the rice straw to suitable pieces aboveground biomass was placed in strips as dead mulch into which the tomato was transplanted in one row. Weed density and total weed aboveground biomass were assessed after15 and 30 days from tomato transplanting to evaluate the effect of cultivating with adding of rice straw pieces on weed control. The adding of rice straw pieces suppressed weeds in density and aboveground biomass compared to the conventional system. to evaluate the proto type manufactured cultivator, The equipment was tested under different operating conditions, at lengths of rice straw pieces (1.8, 2.5, 3.7 and 4.1 cm) rotor speed (63.7, 75.4, and 84.1 rpm) and three depths of press wheel (2, 3 and 4 cm). The results showed that the optimum length of rice straw pieces of 1.8 cm, rotor speed 84.1 rpm and depth of cultivating press wheel was 4.1 cm respectively due to its ability to level soil loosening, weed control, and ridge forming between rows and reconsolidate the soil led to improving of tomato crop yield.

INTRODUCTION

Salim (1996) mentioned that, using the flame as thermal sterilizing of soil to control of pests can reduce the chemical applications that increase environmental pollution, especially as an alternative method for methyl bromide used in sterilizing new reclaimed soil that causes cancer and is forbidden by the United Nations. He added that, the flaming application is a considerably better method than mechanical, which diffuses the weeds rhizomes in the soil. Also, he showed that all nematodes died and the highest effect on weeds was at 0.25 m space between beams, 0.05 m flame depth and the first level of forward speed (1.54 km/h).

Weston, (1996) and Ohno et al., (2000) reported that, the improvement of the chemical–physical characteristics of the soil Concerning weed control, the use of cover crops and mulches can reduce the germination and the development of the weed seeds. *Hiltbrunner et al., (2007)* showed that doubling the seeding density for directly drilled winter wheat from 300 to 600 kernels/m^2 significantly increased the grain yield by about 0.6 Mg/ha, on the average of three studied environments. Furthermore, choosing the right variety for the main crop may contribute towards the development of a living mulch system with white clover and winter wheat with a satisfactory grain yield. However, research is lacking in this regard for living mulch systems, but the importance of using the appropriate main crop variety in mixed cropping systems. Also, they added that, one of the most important characteristics of modern agriculture is the use of large quantities of artificial fertilizers and agrochemicals which enable us to increase crop production greatly and the use of natural fertilizers, and the adoption of ecological pest control such as those obtained by cover crops and mulches.

Anzalone et, al. (2010) mentioned that, Three years of field trials have been carried out in Zaragoza, Spain, using different biodegradable mulch materials in processing tomatoes. The aim was to evaluate weed control with several biodegradable mulches as alternatives to black polyethylene (PE) mulch. The treatments were rice straw, barley straw, maize harvest residue, absinth wormwood plants, black biodegradable plastic, brown Kraft paper, PE, herbicide, manual weeding, and un weeded control. Assessments focused on weeds and on crop yield. A laboratory study showed that 1 kg/m^2 of organic mulch was sufficient to cover the soil for rice, barley straw and maize harvest residue. The most abundant weed species in the field were purple nutsedge, common purslane, common lambsquarters, and large crabgrass and a change in weed composition was observed between treatments and years. Most weed species were controlled by the mulching materials except that purple nutsedge was controlled only by paper mulch. The other species were well controlled by PE and biodegradable plastic and also by some of the organic mulch treatments. Best weed control and lowest weed biomass were achieved by paper followed by PE and biodegradable plastic. The best organic mulch was rice straw and the worst weed control was from absinth wormwood. Tomato yield was highest for PE followed by paper, manual weeding, biodegradable plastic, and rice straw and was clearly related to weed control. Paper, biodegradable plastic, and rice straw are potential substitutes for PE and herbicides. *Campiglia et, al. (2010)* reported that, cover crops and mulches are a suitable choice for sustainable agriculture because they improve weed control and crop performance. They investigated weed control and nitrogen supply by using different winter cover crop species which were converted into mulches in spring. Also, they carried out a 2year field experiment where a tomato crop was transplanted into four different types of mulches coming from winter cover crops [hairy vetch (*Vicia villosa* Roth.), subclover (*Trifolium subterraneum* L.), oat (*Avena sativa* L.), and a mixture of hairy vetch/oat)] and in conventional treatment (tilled soil without mulch). The mixture of hairy vetch/oat cover crop produced the highest aboveground biomass (7.9 t/ ha of DM), while the hairy vetch accumulated the highest N in the aboveground biomass (258 kg N/ha). The oat cover crop was the most effective cover crop for suppressing weeds (on average 93% of weed aboveground biomass compared to other cover crops). After mowing the cover crop aboveground biomass was placed in strips as dead mulch into which the tomato was transplanted in paired rows. Weed density and total weed aboveground biomass were assessed at 15 and 30 days after tomato transplanting to evaluate the effect of mulches on weed control. All mulches suppressed weeds in density and aboveground biomass compared to the conventional system (on average 80% and 35%, respectively). The oat was the best mulch for weed control but also had a negative effect on the marketable tomato yield (15% compared to the conventional treatment). *Amaranthus retroflexus* L. and *Chenopodium album* L. were typical weeds associated with the conventional treatment while a more heterogeneous weed composition was found in mulched tomato. Legume mulches, in particular hairy vetch, gave the best marketable tomato yield 28% higher than the conventional system both with and without nitrogen fertilization. This research shows that winter cover crops converted into dead mulch in spring could be used successfully in integrated weed management programs to reduce weed infestation in tomato crops. The tomato is one of the most important vegetable crops from an economic point of viehinhem .screw worldwide, and in Egypt the crop is grown on about 515,000 feddan (*Statically distribution of Agriculture Ministry–Egypt, 2012*).

Therefore, the main objectives of this study were (1) to verify the effects of the cover pieces of rice straw on weed suppression; (2) to examine the effect that organic mulches can have on the tomato yield and quality; (3) To study the possibility of utilizing the above method under the Egyptian new reclaimed land and to suit large holding farms of investment companies using available power tiller on farms as trailed machine; (4) to evaluate the performance of three variables factors at different levels. Weed control efficiency.

MATERIALS AND METHODS

The field experiments were conducted in a field at El-Baramon village El-Dakahlia Governorate. The field experiments were carried out in a clay loam soil on the tomato crop variety sermpie. The chemical and mechanical properties of the experimental soil are summarized in table (1).

Table (1): The chemical and mechanical analysis of the field soil.

Particles size distribution (%)				Soil Texture	pH	$CaCO_3$ %
Clay	Silt	Fine sand	Coarse sand			
45.8	39.3	13.1	1.8	*Clay loam*	8.1	1.35

Theoretical considerations:

Generally mean of labor forward speed (1 $\pm$0.06 m/s), speed ratio 1:3 between ground wheel and drum of horizontal belt and width of row 0.7 m. while dimension of hopper (trapezium shape), at upper 0.6*0.8 m^2, at bottom 0.6*0.3 m^2 and the height of hopper 0.65 m . These dimensions give the volume of hopper 22.5 kg as follows:

Area of upper dimensions (0.6*0.8 m^2) + Area of bottom dimensions (0.6*0.3 m^2) x height of hopper (0.65 m) = 0.041 (41 m^3) x 0.55 (density of rice straw, kg/m^3) = 22.5 kg

Theoretical field capacity = 0.7 m x 3600/4200 = 0.6 fed./h

Actual field capacity = 0.6 x 0.60 = 0.36 fed/h.

$$Q = \frac{L * n_1 * 4200}{3.14 * D * n_2 * W}$$

Where:

Q = feed rate of rice straw pieces (398.2 kg/fed.).

L = the amount of the resulting pieces rice straw after one roll of feeding drum (0.21 kg).

D = the actual diameter of the wheel of the ground (0.3 m).

$\mathbf{n_1}$ = number of feeding drum rolls/m^2 (4.5).

$\mathbf{n_2}$ = number of ground wheel rolls/m^2 (1.5).

W = the theoretical operation width of the cultivator (width of row) (0.7 m).

V (m/s)	L (m)	D (m)	Rg/d	A.fc (fed/h)	Tf (h/fed)	Qh (kg/h)	Q (kg/fed)
1.0	0.94	0.31	1 – 3	0.36	2.77	143.35	398.2

V = general mean of labor forward speed (m/s).
Lm = Length of one roll on ground from wheel of a prototype cultivator (2πr = 0.94 m).
Dm = Length on ground of one roll to drum of horizontal feeding drum (0.31m).
Rg/d = ratio between one roll of ground wheel and one roll of horizontal feeding drum (1 -3)
Th.fc = Theortical field capacity (0.66 fed/h).
A.fc = Actual field capacity (0.36 fed/h).
Tf = Time consumed for one feddan (2.77 h).
Qh = quantity of pieces rice straw in one hour (143.35 kg).

The developed a prototype cultivator:-

The developed prototype cultivator was constructed and fabricated at the local workshop in Mansoura city. It's manufactured as proto-type one unit cultivator suitable cultivation of one row and consists of various developed parts as shown in fig (1)

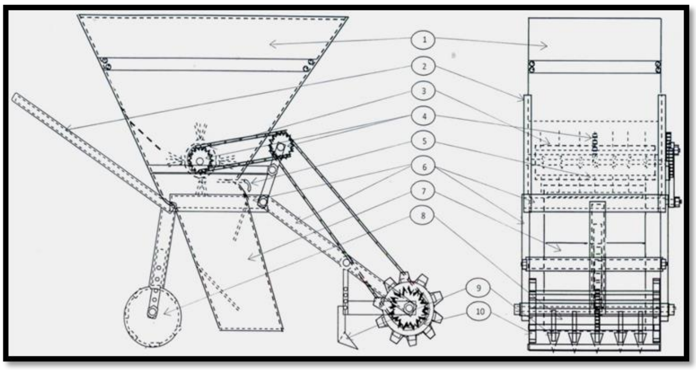

Fig. (1): A schematic diagram for developed cultivator with developed parts.

1) Rice straw hopper
2) Cultivator payment arm
3) Feeding drum
4) Transmission gears
5) Hopper gate
6) The cultivator frame
7) Rice straw directing tube
8) Press wheel
9) Cultivating shares
10) Protection wheel arm

To evaluate the developed proto-type cultivator , field experiments was carried out as a comparative study between weeds cultivation process with and without rice straw mulches and its affecting on weeds control between planting rows as shown in fig(2)

Fig. (2 (A and B)): The developed cultivator during field experiments

The studied factors as follows:-

1) Lengths of rice straw pieces Ls (Ls_1= 1.8, Ls_2= 2.5, Ls_3= 3.7 and Ls_4= 4.1 cm.)
2) Feeding drum rotor speed Rf (Rf_1=63.7, Rf_2=75.4, and Rf_3=84.1 rpm) by using the Tachometer device fig (3).
3) Three depths of press wheel Dp (Dp_1= 2, Dp_2= 3 and Dp_3= 4 cm.).

4) Using the cultivator shares in cultivation process without adding rice straw pieces as a control factor (Wrs)

There are two fixed factors (14.5% moisture content of rice straw and depth of cultivating shares at 4 cm)

Fig (3): The Tachometer device used to determine drum Rotor speed (r.p.m) while working

Experimental measurements

1) Weeds number in square meter (controlled weeds %)

Weed control rates were determined per m2 where the number was taken using a quarter meter wooden frame that throw randomly in the treated area after 30 days from the irrigation after application of treatments. The numbers of weeds including the all area of ridge up to the interlayer distance between tomatoes plants. Salim (1996).

2) Furrow profiles

The ordinates and furrow cross – section profiles were measured and draw after each pass using by using the profile-meter shown in Fig (4).

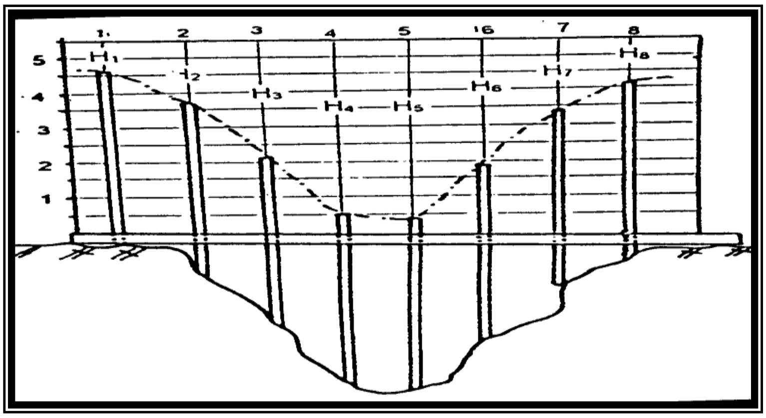

Fig (4): The profile-meter used for determine the furrow profile Tomato ridge physical properties.

In addition the data for describing the physical properties included the ridge profile and properties of surrounded soil. Fig (3.1) clarify the general `

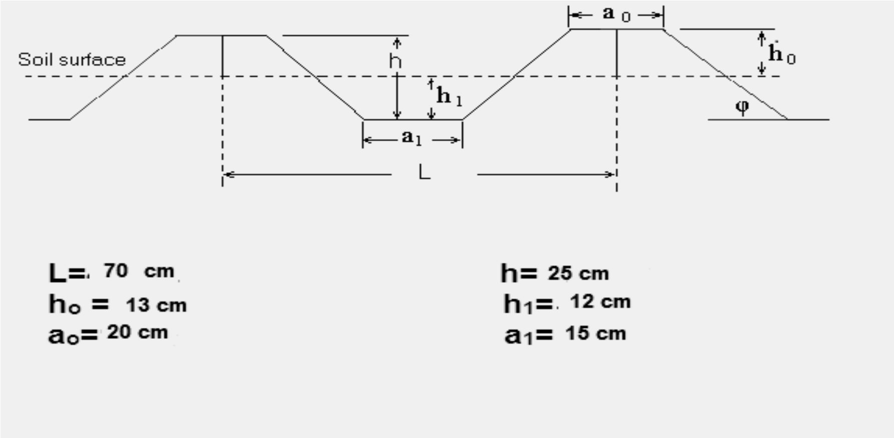

Fig (5): General geometry of studied tomato ridge.

RESULTS AND DISCUSSION

1) Controlled weeds %

Data were graphically in figs. (6 A,B and C), generally, showed that the controlled rate decreased with increasing lengths of rice straw pieces (L_s) and increased with increasing of feeding rotor speed (R_f) and depth of press wheel (D_p). This meant that there was an indirect relationship between lengths of straw pieces and controlled rate for weeds. On the other hand, length of straw piece of 1.8 cm achieved a superior productivity (controlled rate) over the three others treatments. Also, mentioned data showed the existence of an influence on percentage of controlled weeds at all treatments under study as compared with control samples. In other words, the interaction among all the same mentioned treatments under study caused an impression on controlled weeds percentage. The largest controlled weed percentage was 93.95 % and was obtained at a length of rice straw pieces of (Ls_1=1.8 cm), feeding rotor speed of (Rf_3=84.1 r.p.m) and depth of press wheel (Dp_3 = 4 cm). The smallest controlled weed percentage (70.46 %) was obtained at a length of rice straw pieces of (Ls_4=4.1 cm), ($Rf_{1=}$ 63.7 r.p.m) of feeding rotor speed and (Dp_1 = 2 cm) of press wheel depth. One could say that controlled weed percentage decreased with increasing lengths of rice straw pieces (L_s) and increased with increased of feeding rotor speed (R_f) and depth of press wheel (D_p). This could be as a result of lessening the thickness and accumulative of rice straw pieces cover with decreasing lengths of rice straw pieces (L_s), increasing the depth of press wheel and increasing of feeding rotor speed. This may be led to decreasing ventilation and lighting that available for weeds which led to die of them and vice versa. Where without adding rice straw (Wrs) the controlled weeds was 60.9% that the less than the lowest ratio with adding rice straw pieces.

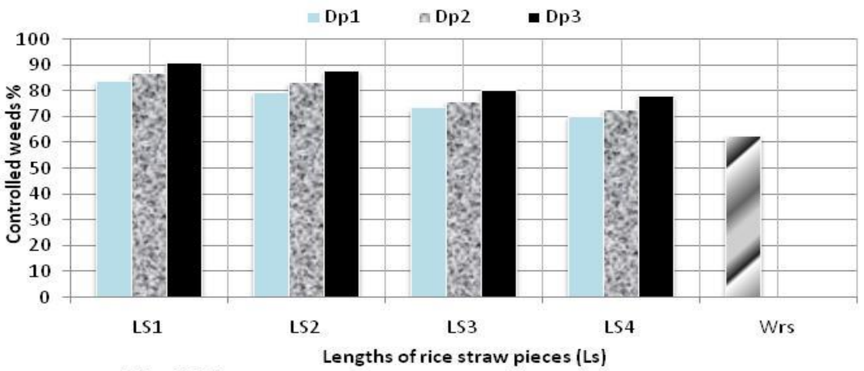

Fig. (6A): Controlled weeds % at depths of press wheel, lengths of rice straw with feeding rotor speed (Rf1) and without adding rice straw pieces (Wrs)

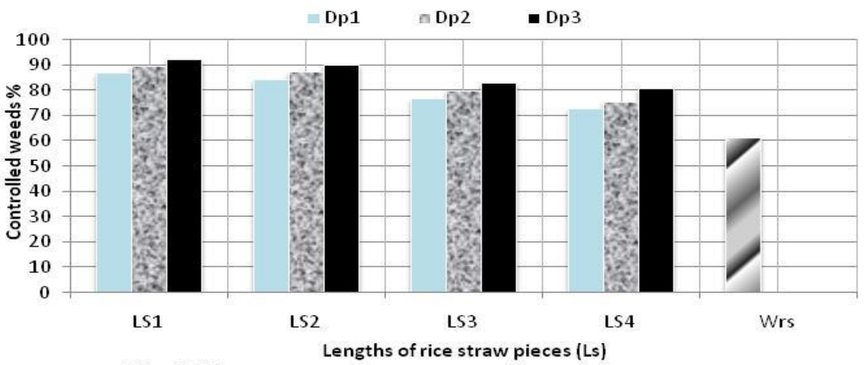

Fig. (6B): Controlled weeds % at depths of press wheel, lengths of rice straw with feeding rotor speed (Rf2) and without adding rice straw pieces (Wrs)

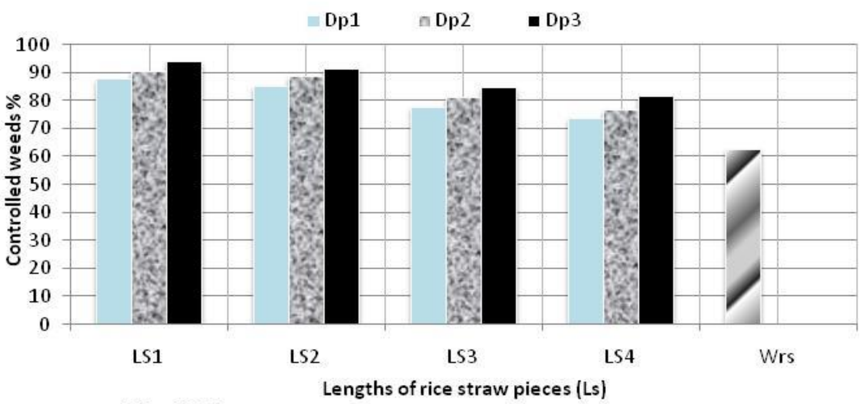

Fig. (6C): Controlled weeds % at depths of press wheel, lengths of rice straw with feeding rotor speed (Rf3) and without adding rice straw pieces (Wrs)

2) Furrow profiles

From mentioned above histogram data of the controlled weeds (%) the lowest length of rice straw pieces give the highest ratio of controlled weeds so all profiles were drawn at Ls_1 and different levels from Rf and Dp. Data were graphically in figs. (7 A, B and C), one can said that the optimum Furrow profiles achieved at lowest lengths of rice straw pieces (L_s) and the highest of feeding rotor speed (Rf) and depth of press wheel (Dp). On the other side, drawn data in mentioned figures caused flow curves. This means that there was an indirect relationship between lengths of straw pieces and furrow profiles. On the other hand, length of straw piece of 1.8 cm achieved a superior productivity (optimum regular furrow profiles) over the three others. Also, mentioned data showed the existence of a significant influence on regular of furrow profiles at all treatments under study as compared with control samples. In other words, the interaction among all the same mentioned treatments under study caused a significant impression on regularity of ridge profile. The optimum furrow profiles was achieved at feeding rotor speed of (Rf_3=84.1 r.p.m) and depth of press wheel (Dp_3 = 4 cm). The irregular furrow profiles were obtained at $Rf_{1=}$ 63.7 r.p.m) of feeding rotor speed and (Dp_1 = 2 cm) of press wheel depth. One could noticed that the bottom of furrow profiles regular with increment of feeding rotor speed (R_f) and depth of press wheel (D_p). This could be as a result of lessening the thickness and accumulative of rice straw pieces cover with increment depth of press wheel and increasing of feeding rotor speed. This may be led to using protection wheel that caused positive affecting on furrow sides shapes.

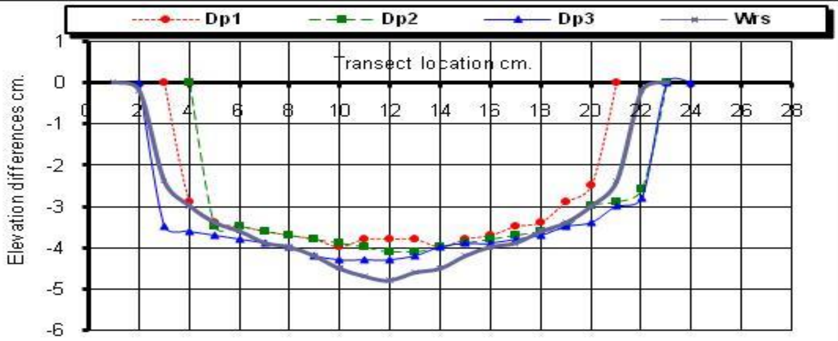

Fig (7A). The furrow cross – section profiles at Ls1 and Rf1 and control treatment (Wrs)

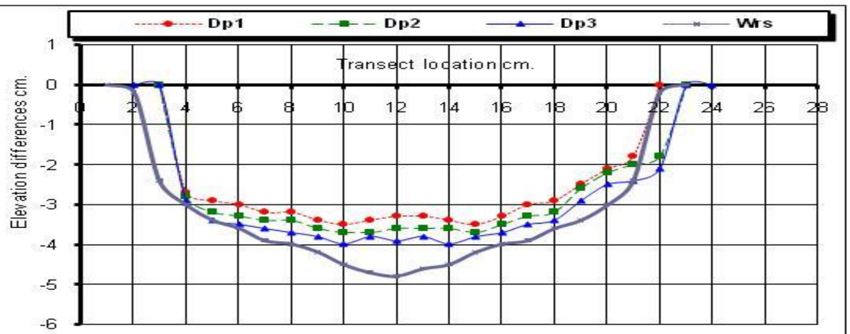

Fig (7B). The furrow cross – section profiles at Ls1 and Rf2 and control treatment (Wrs)

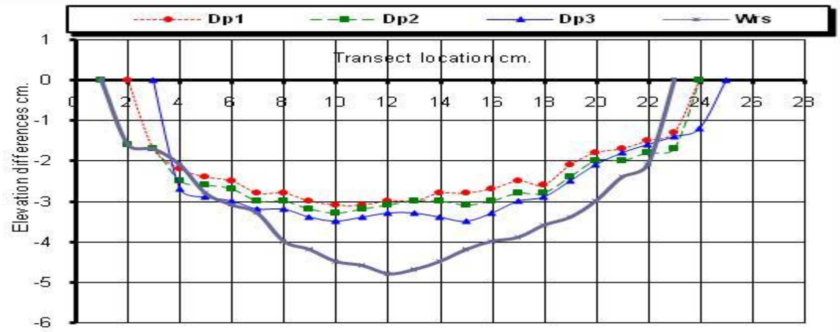

Fig (7c). The furrow cross – section profiles at Ls1 and Rf3 and control treatment (Wrs)

3) Productivity

One can noticed that, general mean productivity of one feddan from tomatoes in the winter season, 13.5 tons / feddan without using manufactured cultivator... in case cultivating using the manufactured cultivator without the addition of straw pieces obtained general mean productivity 14 tons / feddan, while at using the cultivator manufactured in cultivating and add a straw pieces as cover to control of the weeds achieved general mean production 15.5 tons /feddan.

CONCLUSION

1. The results showed that farmers can be used the manufactured prototype cultivator for cultivating and adding the rice straw pieces to control weeds in tomato crop to achieve the high yield of tomato..
2. The optimum operating conditions of manufactured prototype cultivator were found to be as follows:

- Length of rice straw pieces of 1.8 m, feeding rotor speed of 84.1 r.p.m and depth of press wheel 4 cm.
- That constructed the optimum furrow profiles by increasing feeding rotor speed from 63.7 to 84.1 r.p.m and increasing tomato yield by about the recorded data for traditional methods without a prototype cultivator.
- The results of this study may recommend that using the new prototype cultivator to be suiting small holdings that spreading in Egyptian countryside.
- In new reclaimed land a prototype cultivator can be developed as multi rows (four rows as minimum) trailed machine cultivator by tractor.

REFERENCES

Anzalone, A. A. ; Cirujeda, J. ; Aibar, G. and Zaragoza, C. (2010) “Effect of Biodegradable Mulch Materials on Weed Control in Processing Tomatoes” Weed Technology 24(3):369-377. 2010. http://dx.doi.org/10.1614/WT-09-020.1 Accessed: October 9, 2009.

Campiglia , E. ; Mancinelli , R. ; Radicetti, E. and Caporali, F. (2010) “Effect of cover crops and mulches on weed control and nitrogen fertilization in tomato (*Lycopersicon esculentum* Mill.) crop protection Vol. 29 (4) pp.354-363. Dipartimento di Produzione Vegetale, Università della Tuscia, via S.Camillo de Lellis, 01100 Viterbo, Italy.

Hiltbrunner, J. ; Streit , B. and Liedgens, M. (2007). Are seeding densities an opportunity to increase grain yield of winter wheat in a living mulch of white clover? *Field Crops Research*, 102: 163–171.

Ministry of Agriculture (2012). Agricultural economy central management. Statistical distribution of vegetables and fruits area in the Governorates.

Ohno, T. ; Doolan , K. ; Zibilske, L. M. ; Liebman, M. ; Gallandt, E. R. and Berube, C. (2000). Phytotoxic effects of red clover amended soils on wild mustard seedling growth. *Agric. Ecosyst. Environ.* 78, 187-192.

Salim, R. G. (1996). Development of Mechanical Flame Unit for the Soil Pests' Control. Master of Science Thesis –Agric. Eng. Dept.– Faculty of Agriculture. Mansoua Univ., Egypt.

Weston, L. A. (1996). Utilization of allelopathy for weed management in agroecosystems. *Agron. J.* 88, 860-866.

نموذج لعزاقة تناسب استخدام قطع قش الأرز لمكافحة الحشائش

محمد أحمد شتيوى* ، طارق حسنى الشبراوى ورضا جمعه سالم*****

*** قسم هندسة المنشآت الزراعية والتحكم البيئى بكلية الهندسة الزراعية – جامعة الأزهر بالقاهرة.**

****قسم الهندسة الزراعية- كلية الزراعة- جامعة المنصورة**

*****معهد بحوث الهندسة الزراعية**

يعتبر نمو الحشائش فى المحاصيل الزراعية عائل أساسى للحشرات كاالذبابة البيضاء والتى تقوم بنشر امراض فيروسية خطيرة للمحصول مما يؤثر على إنتاجية المحاصيل بالسلب. وحيث ان الطرق المعتادة لمقاومة الحشائش مثل المكافحة الكيميائية ضارة للبيئة ومكلفة. وكذلك فإن مشكلة التخلص من قش الأرز من أهم المشاكل الزراعية التى تواجه مصر حاليا ومن ثم كان التفكير فى تصنيع نموذج لعزاقة تقوم بعمل عزيق وإضافة قطع قش الأرز وضغطه بين الخطوط المنزرعه وبذلك فهى تساهم فى التخلص من جزء من قش الأرز بإستغلاله فى عملية مكافحة الحشائش وتم إجراء التجارب على محصول الطماطم حيث يعتبر من اكثر محاصيل الخضر حساسية لنمو الحشائش كمصدر للذبابة البيضاء. ويتم إضافة القش كغطاء واقى من الحشائش حيث يؤدى ذلك لمنع الضوء والتهوية عن الحشائش مما يسبب القضاء عليها وينتهى الأمر بالقش المقطع بعد تحلله كسماد للتربة على المدى البعيد. أجريت التجارب بقرية البرامون بمحافظة الدقهلية. . وتم إجراء التجارب تحت العوامل المتغيرة التالية :

1- أطوال قطع القش: 1.8 و 2.5 و 3.7 و 4.1 سم.
2- السرعة المحيطية لدرفيل التلقيم :63.7 و 75.4 و 84.1 لفة/ دقيقة.
3- أعماق عجلة ضغط القش : 2 و 3 و 4 سم.

وتم دراسة تأثير هذه المتغيرات على كفاءة مقاومة الحشائش و شكل الخط بعد المعاملة. أوضحت النتائج أن أفضل ظروف للتشغيل تحققت عند أقل طول لقطع القش 1.8 سم وأكبر سرعة لدرفيل الدراس 84.1 لفة/ دقيقة واكبر عمق لعجلة ضغط القش 4 سم حيث كانت كفاءة مقاومة الحشائش 94 %، فى حين ان استخدام العزاقة بدون اضافة قطع قش الأرز ساهمت فى مقاومة الحشائش بكفاءة لا تتعدى 60.2% كما أعطت هذا المعاملات شكل خط جيد كما لعبت دروع وقاية المحصول الملحقة بالألة دورا مهما فى ذلك. وتوصى الدراسة بتعميم هذه الفكرة وتطويرها إلى ألة مجرورة متعددة الوحدات تناسب المساحات الكبيرة فى الأراضى الجديدة.

قام بتحكيم البحث

أ.د / عماد الدين امين عبد الله	**كلية الزراعة – جامعة المنصورة**
أ.د / سمير احمد طايل	**كلية الهندسه الزراعية – جامعة الازهر**

506 506