DEVELOPMENT OF A PLASTIC MULCHING MACHINE

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ABSTRACT

The aim of this study is to develop, construct and evaluate a local plastic-mulching machine (mulcher) to prove beneficial for crop growth by modifying soil temperature, reduction in evaporation, weed competition, soil compaction and erosion. The developed mulcher consists of the main chassis of 1.0 x 1.30 m made of steel with three hitch-points. A furrow opener, warped steel tube for warping a plastic sheet, two adjustable wheels and a compressing wheel with manure hopper were mounted and fixed on the main chassis. Forward speed of 2.4 km/h and tilt angle of 450 with wheel adjusting depth of 20 cm showed the optimum results under different treatments which can be summarized in the following points:

1- *Soil covering depth (ridge height, cm) for subsurface mulch was 29 cm.*
2- *Tractor wheel slip of 5.1 and 3.2 % for subsurface and surface mulch, respectively.*
3- *Fuel consumptions were 5.1 l/h, for subsurface mulch and 4.60 l/h, for the surface mulch under the same conditions.*
4- *Covering width for surface mulch was 21 cm for both sides of the plastic sheet.*
5- *Uniformity covering efficiency was 98 % for subsurface mulch and 92 % for surface mulch.*
6- *Power requirements and energy were 14.11 kW, 24.75 kiwi. h/fed., and 12.73 kiwi. and 21.70 kiwi. h/fed., respectively for subsurface and surface mulching.*
7- *Total costs decreased totally by 80.4% when applying the new mulcher.*

INTRODUCTION

Because of the rapidly increasing population in Egypt and the urgent need to increase farmland reclamation and cultivation of new lands with raising the efficiency of farming lands of old in terms of providing and rationalizing the consumption of water by using pressurized modern

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irrigation systems and raise the efficiency of the use of water and chemicals through them (chemigation) and decrease different factors losses to maintain the drop of water and food necessary for plants cultivated. So it was necessary cooperation between the Agricultural Research of Irrigation Engineering with Agricultural Research of Mechanization Engineering to develop machines used to gain access to higher efficiencies in irrigation systems to maintain the greatest amount of irrigation water by reducing its losses and face the possibilities of derogation share of Nile water coming to Egypt from their source countries Nile Basin.

The interest prevailing in the field of environmental pollution from the agricultural output of burning waste and crop residues and the use of pesticides and herbicides, which negatively affects the public health, and because of the high cost in modern irrigation tended studies to develop new alternatives to mitigate pollution and contribute greatly to solving the problem of shortage irrigation water and reduce the use of pesticides and herbicides and preserve the environment.

Through follow-up field in the sandy areas show the farmers an individual slice of plastic to cover the soil cultivated by hand and known colloquially in the name of (bottom mulch) or an individual slice the plastic on the back of the terraces manually (upper mulch) and agriculture them after the addition of organic fertilizer , or injection layer of asphalt under the surface of the sandy soil consists insulating layer to prevent the entry into force of water as to render appropriate moisture content in the range of roots. Drip irrigation is extended irrigation line up or down mulch and outfitted on the same distances of agriculture to eliminate weeds and reduce evaporation and provide irrigation water. It also leads to the upper mulch a vital role in cold regions save the soil temperature which stimulates biological processes within the scope of the roots.

Therefore, this study was conducted to apply the method of automatically mulch in sandy soil in two phases in the village of sound - Abu Hammad and a village in the eastern province - in order to develop automation system of mulch in agriculture soil covered with plastic machine automatically by the subject of the study are as follows:

1 - Automated mulch bottom lines in the soles of agriculture with the addition of organic fertilizer and then covered agriculture instead of layer of asphalt on the bottom surface of the soil, and thus preserve the scope of the roots moist appropriate degree.

2 - Straighten mulch loft automatic slide the plastic on the back of the terraces after processing and then holes at distances of agriculture recommended in order to prevent the growth of weeds and soil surface heating in winter and in summer to reduce evaporation.

The study thus contribute significantly to rationalize the use of water for irrigation, fertilizers, chemicals and raise their efficiency and thus increase production and quality of crop and also with substantially reducing weeds and environmental pollution resulting from the use of chemicals. In this context, mulching with plant residues and synthetic materials is a well-established technique for increasing the profitability of many horticultural crops **(Duranti and Cuocolo, 1989; Gimenez et al., 2002).**

Djigma and Diemkouma (1986) found that the black polyethylene mulch yielded 3.3times higher than soil without mulch in eggplant and 2.3 times in tomato, when grown during the relatively cool season sown in September and harvested in January. In a trial carried out during the hot season, the use of plastic mulch had an adverse effect on vegetables and decreased their yields significantly. **Douglas and Sanders (2001)** stated that the advantages of using plastic mulches are: increasing soil temperature from 4 to 5 ºC under black mulch, 5 to 8 ºC with infrared transmitting mulch (clear green), or 8to 10 ºC at a 5 cm depth under clear mulch, reducing soil compaction, reducing evaporation, reducing weed problems, earlier crops and increasing growth. **Lekasi (2001)** used polyethylene and banana residues as mulches and organic inputs for cabbage production. Surface mulching with banana residues was not effective in weed suppression or moisture conservation but increased earthworm population densities. Plastic mulching, on the other hand, increased cabbage yields by 14.9 $t.ha^{-1}$ over the un-weeded treatment and improved soil moisture status.

Abdulrazzak (2008) mentioned that **t**here are different spray pumps to spray different materials such as a liquid chemical fertilizer, weed control herbicide and bacteriological herbicide, but not asphalt materials. Hence spray equipment was designed to spray or inject asphalt products under soil surface depend on tractor's air pump using sweep plow or cutting plow. The designed equipment consists of tank sitting on the plow frame, plastic tube, and aluminum tube connected with plow's wings for Nozzles, Nozzles and sweep plow. This equipment is connected with tractor's air pump to supply the system with pressure to spray asphalt solution throw nozzles as a spray in order to cover soil. The designed equipment can also spray liquid fertilizers, weeds and biological herbicides when the diameter of Nozzles is adjusted. Asphalt product which used consist of asphalt materials , clay and dissolved materials .It used to prevent deep percolation to keep root zone wet for plant .It also long term used material without any side effect. Asphalt membrane was product from asphalt materials too.

Mulching may prove beneficial for crop growth because of complex change in soil environment through modifying soil temperature, reduction in evaporation, weed competition, soil compaction and erosion. Plastic mulch is a product used, in a similar fashion to mulch, to suppress weeds and conserve water in crop production. Under plastic mulch, soil properties like soil temperature, moisture content, bulk density, aggregate stability and nutrient availability have been improved. Therefore, the objective of this study was to apply the mulch mechanically in sandy soil and investigate the suitable characteristics performance of the developed unit for mulching subsurface and surface plastic sheet under Egyptian conditions.

MATERIALS AND METHODS

The developed mulcher was constructed at local workshop in Sharqia Governorate. The filed experiments were conducted during the winter season at a local farm at Al-Sowa district (قرية الصوة), Sharqia Governorate, Egypt.

1-Materials

The tractor used: The developed mulcher is carried on a 30 hp (about 22.4 kW) Kubota tractor.

The developed mulcher: The specifications and photographs of developed mulcher in Fig. 1. The developed mulcher consists of the following parts:

1- Chassis**:** The chassis made of rectangular cross-section steel of 7.0 x 5.0 cm. The dimensions of chassis are 130 cm length, 100 cm width and 70 cm height. Chassis is provided with standard three-hitch points.

2- Furrow opener**:** The furrow opener 47cm width with 65cm length made of sheet steel with thickness of 5 mm and rectangular steel-shank with dimensions of 7 x 2 cm. The furrow opener was connected to the chassis to set a furrow of 47 cm width which was the bed of plastic mulch.

3- Steel bar for warped plastic-sheet: A steel tube of 105 cm fixed on two ball-bearings to facilitate the motion was used for warping the plastic sheet on.

4- A plastic sheet: A plastic sheet of 1.0 x 10 m (for each treatment) was wrapped on the steel bar (3) to be spread in furrows as a bed of the ridge.

5- Adjustable wheels**:** Two adjustable rubber wheels with different changeable tilt angles of 28 cm diameter were attached to set plastic mulch spread and prevent folding.

6- Covering blades: For covering plastic mulch with soil, two steel covering blades made of steel with different changeable tilt angles of (30 x 30 cm) were mounted.

7- Compressing wheel: A compressing wheel of 39 cm diameter was fixed to keep mulch spread in the center of the furrow with different changeable heights for compressing mulch down.

8- Manure hopper: A cylindrical hopper of 30 cm diameter and 45 cm height made of steel was mounted on the main chassis in front of the compressing wheel and between the two adjustable wheels depth to buried manure simultaneously while setting the ridge up. An agitator was added at the bottom of the manure hopper to facilitate manure motion. The agitator system takes its movement from the compressing wheel by two sprockets.

9- Most of the attachments could be changeable to adjust the optimum characteristics for mulcher performance and facilitate the treatments proceeding under different studied parameters of tilt angles of the adjustable wheels and compressing wheel. The mulcher has maximum dimensions of 150 x 110 cm with 135 cm maximum height. The mulcher dimensions are shown on Fig. 6. This machine is one of the most popular Plastic Mulch Layers because it is compact, versatile, and will adjust to fit a wide range of applications and there are many options available.

2 - Methods

- The experimental procedure and test factors

2.1 The first experiment: It was conducted during the winter season at a local farm at Al-Sowa district, Sharqia Governorate, Egypt. Soil of experimental site was sandy loam in texture, low in available N, P and K. Sandy soils are poor in elements and water. Growers in sandy areas are objected to inject asphalt materials or spread a subsurface plastic layer to hold water and conserve the manure (subsurface mulch). This action is manually operated. This manually process is difficult, slow and no uniform in addition to high cost.

Twenty-seven treatments replicated 4 times were used in split-split plot design with combination of subsurface and surface mulch for each experiment as main plots and tilt angles of covering blades scheduling treatments (20, 30 and 45 degrees) as sub plots with three wheel adjustable depths of 10, 15 and 20 cm. All these treatments were under different forward speeds of 1.2, 1.8 and 2.4 km/h.

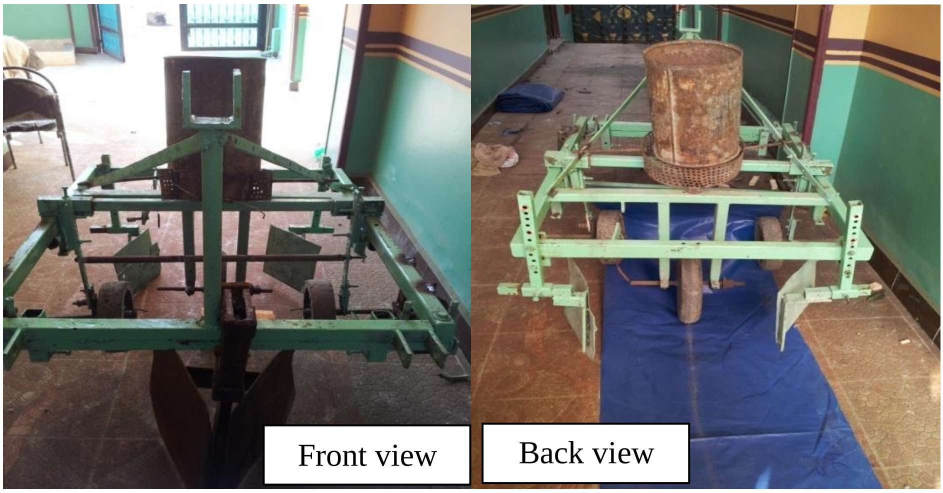

Fig. 1: Photographs of the developed mulcher.

1- Chassis, 2- Three-hitching points, 3- Furrow opener, 4- Steel pipe for warped plastic-mulch, 5- Two adjustable rubber wheels, 6- Two steel covering-blades, 7- Mulch compressing-wheel, and 8- Manure hopper

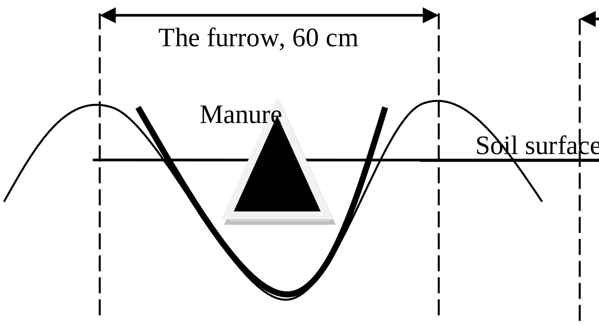

Fig. 2: The mulched furrow before covering

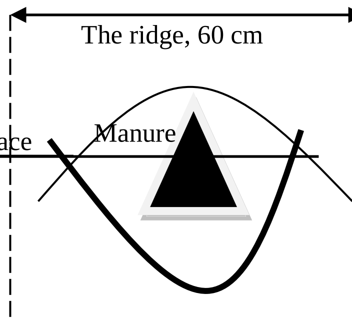

Fig. 3: The mulched furrow after covering.

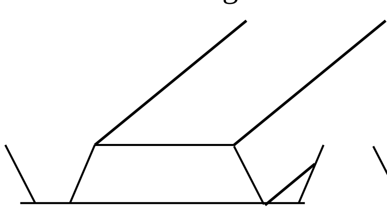

Fig. 4: The un-mulched ridge before covering.

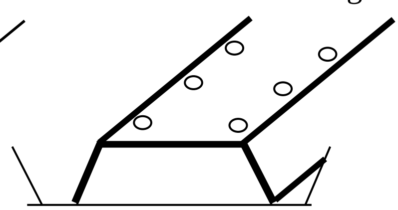

Fig. 5: The mulched ridge after covering

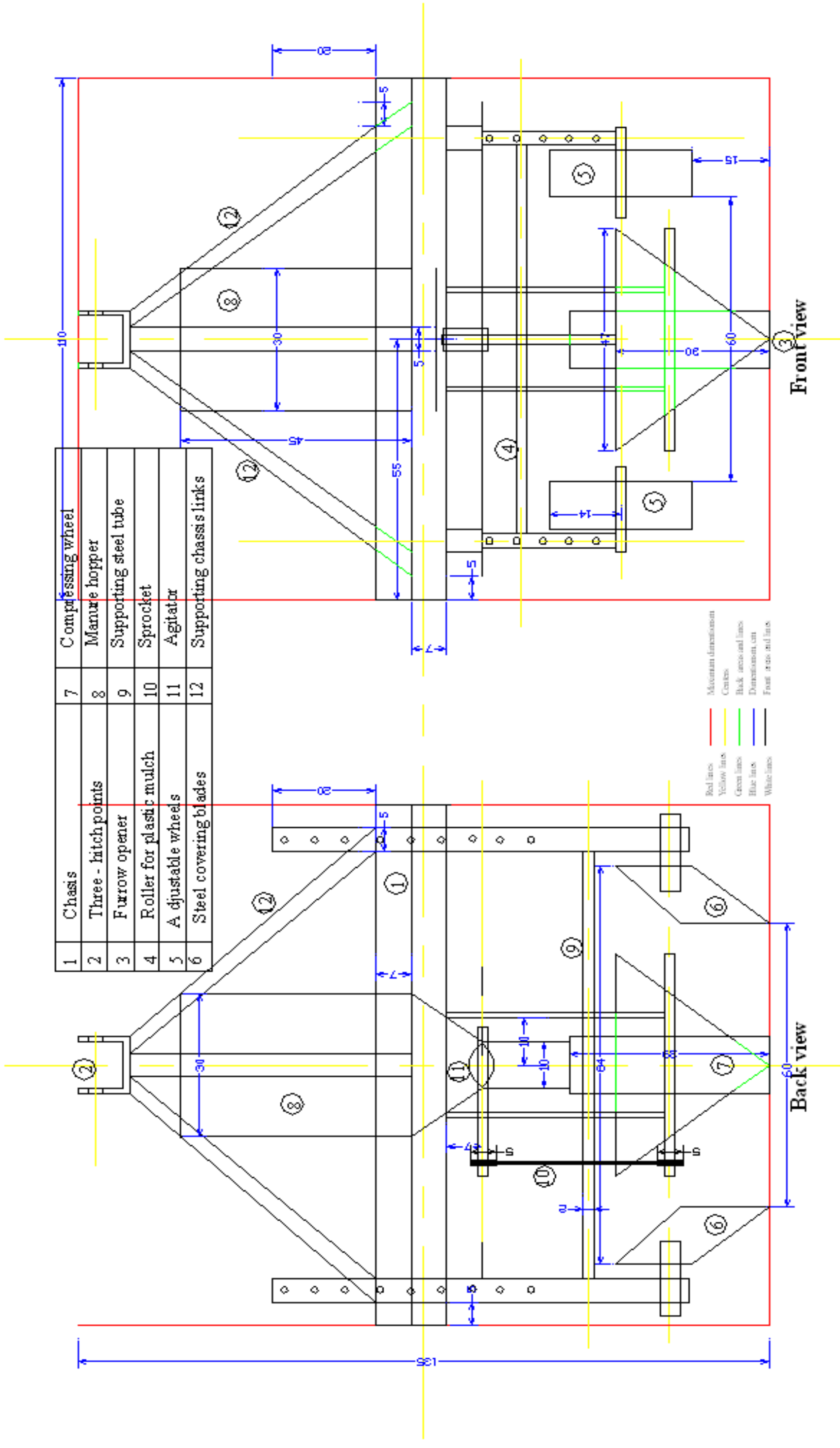

Fig. 6: Front and back view for the developed mulcher

In this experiment the furrow opener was used for setting up furrows then plastic sheet is spread as shown in Fig. 2. Manure hopper was filled up with manure which fallen smoothly in a plastic tube directly on the plastic mulch. In the same time the rear covering blades cover the plastic sheet and the manure as shown in Fig. 3. It means that the furrows became ridges and the ridges turned into furrows as shown in Figs. 2 and 3.

2.2 The second experiment: Ridges were firstly set by furrow openers and the trials were operated as mentioned in the first experiment but the compressing wheel, manure (fertilizer) hopper and the furrow opener were removed. Soil height on plastic mulch, mulch cover uniformity, efficiency of manure adding, tractor wheel slip, fuel consumption and power needed were measured for all treatments. In this experiment, firstly, the furrow opener is used for setting up ridges with width of 60 cm. Then mulcher is used for spreading the plastic sheet on the obtained ridges with width of 100 cm. On both sides of ridge, 20 cm of plastic sheet covered the ridge sides. Then holes of about 5 cm are made on the plastic sheet at the recommended distances for planting. Figures 4 and 5 show schematic diagrams for ridge before and after mulching, respectively.

It was conducted at the same period of the first experiment in the same site for mulching application on ridges (surface mulch). This surface mulching is very important nowadays for producing organic food. Soil surface is covered with a plastic sheet and so that seeds or hills are sown or cultivated in holes made on the plastic sheet. Therefore, weeds and herbs are died and prevented to grow. Heat is preserved and water evaporation could be prevented to save irrigation water consumption. Soil properties like soil temperature, moisture content, bulk density, aggregate stability and nutrient availability could be improved. This research was carried out mainly to apply these operations mechanically by developing a local mulcher to overcome the mentioned problems and encourage growers to invest in agricultural field. The developed mulcher is carried on a 30 hp (22.4 kW) Kubota tractor.

3- Measurements:

- **Soil depth (height) on subsurface mulch**: It was measured by using a metal ruler with length of 50 cm.

- **Soil width on surface mulch**: It was measured by using a metal ruler with length of 50 cm.
- **Slip ratio**: It was calculated according the distance with and without load.
- **Fuel consumption**: They were estimated by refilling the tractor tank with a slandered flask for the first and second experiments.
- **Uniformity of covering mulch**: It was evaluated according to the uncovered edged with mulch.

Equations:

The power and specific energy:

The following formula was used to estimate power consumption **(Hunt, 1983)**:

$$P = \frac{FCx\rho.fxLCVx427x\eta_{th}x\eta_{mec}}{3600x75x1.36}\,kW$$

Where:

FC= fuel consumption, L/h,

ρ.f= density of fuel, kg / L (for diesel = 0.85),

L.C.V= calorific value of fuel (10000 kcal / kg),

427= thermo-mechanical equivalent, J / kcal,

η_{th}= thermal efficiency of engine (≈ 35%for diesel engines) and

η_{mec}= mechanical efficiency of engine (≈80%).

The specific energy was calculated by using the following equation:

$$Specific\ energy(kW.h/fed) = \frac{Power\ requirement\ (kW)}{Effective\ field\ capacity(fed/h)}$$

The operation cost.

The hourly cost for machine operation was determined using the following equation **(Awady, 1978)**:

Hourly cost = P/H (1/A + I/2 + T + R) + (0.9W.S.F) + M/144

Where:

P = price of machine, L.E, H =yearly working hours, h/year,

A = life expected of machine, year, I = interest rate / year,

T = taxes, over heads ratio, R=repairs and maintenance ration,

0.9 =factor accounting for lubrication, W = power, hp,

S =specific fuel consumption (L/hp.h), F = fuel price, L.E. / L and

M/144 = monthly wage ratio, L.E,

The operating cost per fed was determined using the following equation:

$$Operating\ cost = \frac{hourly\ cost\ (LE/h)}{actual\ field\ capacity\ (fed/h)}$$

4 - Statistical analysis: All obtained data were tabulated throughout this study after replicated at least three times for each treatment and was analyzed statistically by using a computer program (Minitab Release 15) for estimating the probability at levels 1 and 5% while the graphs were drawn using the Microsoft excel window 2007.

RESULTS AND DISCUSSION

Effect of forward speed, compressing-wheel depth and tilt-angle of covering blades on soil-covering depth.

Fig. 7 shows the effect of forward speed, compressing-wheel depth and tilt angle on soil-covering depth. The soil-covering depth increased by increasing forward speeds, compressing-wheel depth and tilt angle of covering blades.

The maximum soil-covering depth of 29 cm was obtained by using forward speed of 2.4 km/h, compressing-wheel depth of 20 cm and tilt angle of 45 degree. Meanwhile, the minimum soil-covering depth of 12.7 cm was obtained by using forward speed of 1.2 km/h, compressing-wheel depth of 10 cm and tilt angle of 20 degree.

These results may be because of the sudden impact of covering blades which caused sand soil to move quickly over the mulch and consequently raised the ridge height. After statistical analysis it was found that there were significant differences between parameters of forward speed and tilt angles. Also, wheel depth showed a very significant difference according to ridge height ($p < 0.05$).

Effect of forward speed compressing-wheel depth and tilt-angle of covering blades on tractor wheel slip

Fig. 8 shows the effect of forward speed, compressing-wheel depth and tilt angle on tractor wheel slip. The tractor wheel slip increased by increasing forward speeds, compressing-wheel depth and tilt angle of covering blades.

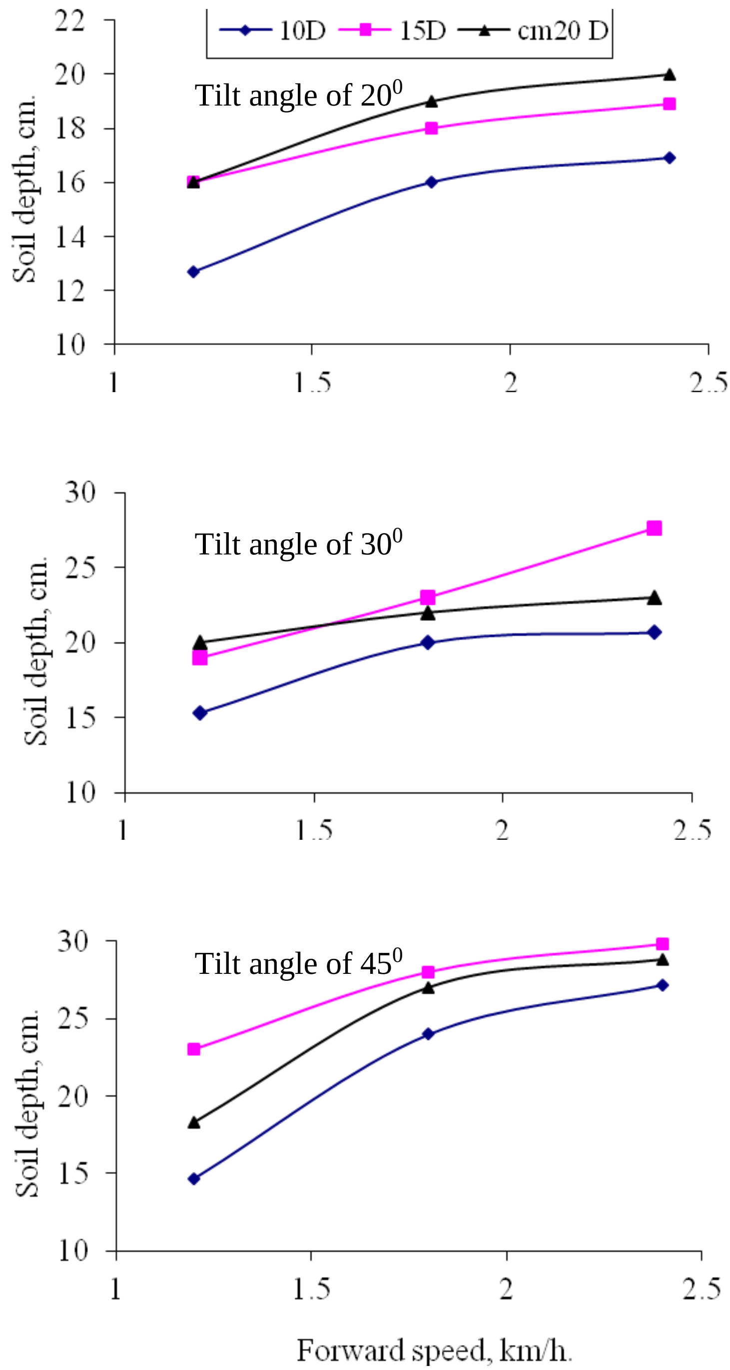

Fig. 7: Effect of forward speeds and compressing-wheel depth (D) on soil covering depth under different tilt angles for subsurface mulch

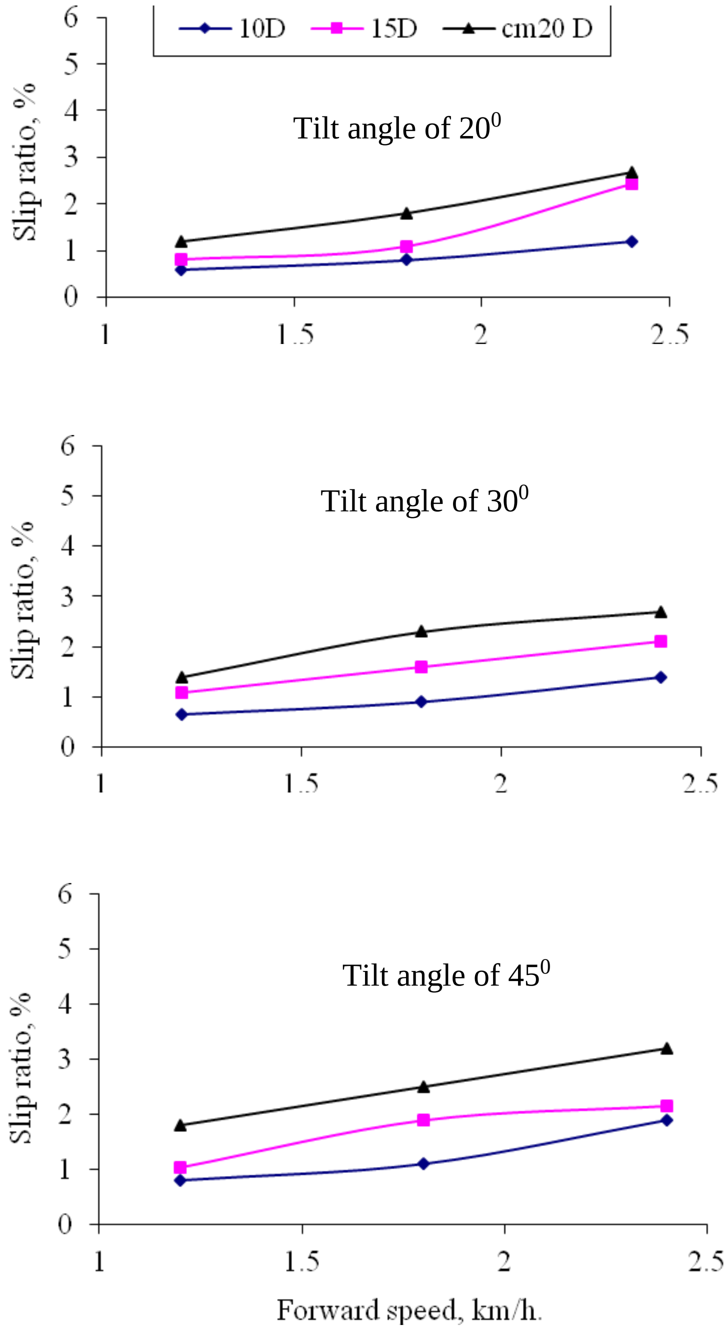

Fig. 8: Effect of forward speed and compressing-wheel depth, (D) on tractor wheel slip under different tilt angles for subsurface mulch

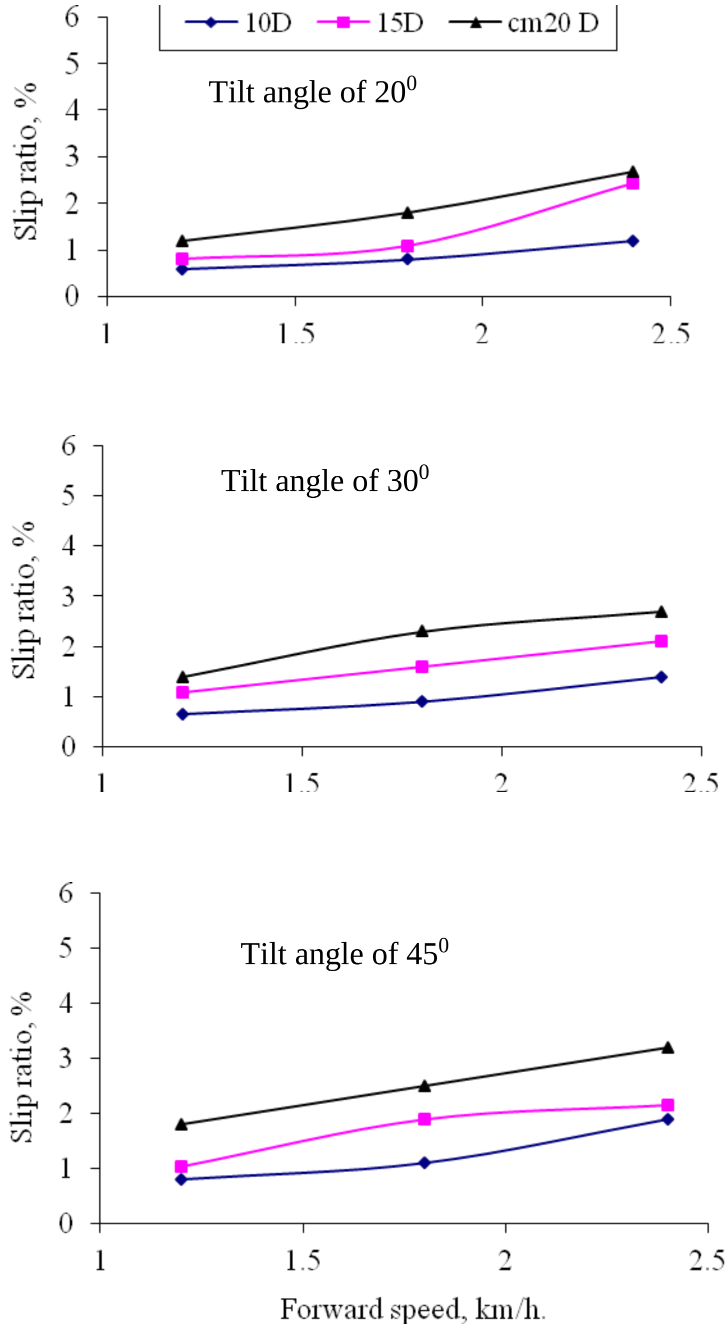

Fig. 9: Effect of forward and compressed wheel depth (D) on tractor wheel slip under different tilt angles, degrees for surface mulch

For subsurface mulching, the maximum tractor wheel slip of 5.9 % cm was obtained by using forward speed of 2.4 km/h, compressing-wheel depth of 20 cm and tilt angle of 45 degree. Meanwhile, the minimum tractor wheel slip of 2.2 % was obtained by using forward speed of 1.2 km/h, compressing-wheel depth of 10 cm and tilt angle of 20 degree. These results may be due to using furrow opener and the high amount of soil raised on the plastic sheet according to the high wheel depth of 20 cm which resulted in increasing tractor wheel slip to the mentioned results.

Meanwhile, for surface mulching (Fig. 9), the maximum tractor wheel slip of 2.7 % cm was obtained by using forward speed of 2.4 km/h, compressing-wheel depth of 20 cm and tilt angle of 45 degree. Meanwhile, the minimum tractor wheel slip of 1.8 % was obtained by using forward speed of 1.2 km/h, compressing-wheel depth of 10 cm and tilt angle of 20 degree. It was noticed that slip ratio were lower in case of surface mulching which may be attributed to the absence of furrow opener and also the manure (fertilizers) hopper. It was found that there were significant differences between parameters of forward speed and tilt angles. Also, wheel depth showed a very significant difference according to ridge height ($p < 0.05$).

Effect of forward speed, compressing-wheel depth and tilt-angle of covering blades on fuel consumption

Fig. 10 shows the effect of forward speed, compressing-wheel depth and tilt angle on fuel consumption. The fuel consumption increased by increasing forward speeds, compressing-wheel depth and tilt angle of covering blades.

For subsurface mulching, the maximum fuel consumption of 5.1 l/h was obtained by using forward speed of 2.4 km/h, compressing-wheel depth of 20 cm and tilt angle of 45 degree. Meanwhile, the minimum fuel consumption of 3.21, l/h was obtained by using forward speed of 1.2 km/h, compressing-wheel depth of 10 cm and tilt angle of 20 degree. These results may be due to using furrow opener and the rear covering blades had to push a high amount of soil raised on the plastic sheet according to the high wheel depth of 20 cm which consequently resulted in increasing fuel consumption to the mentioned results.

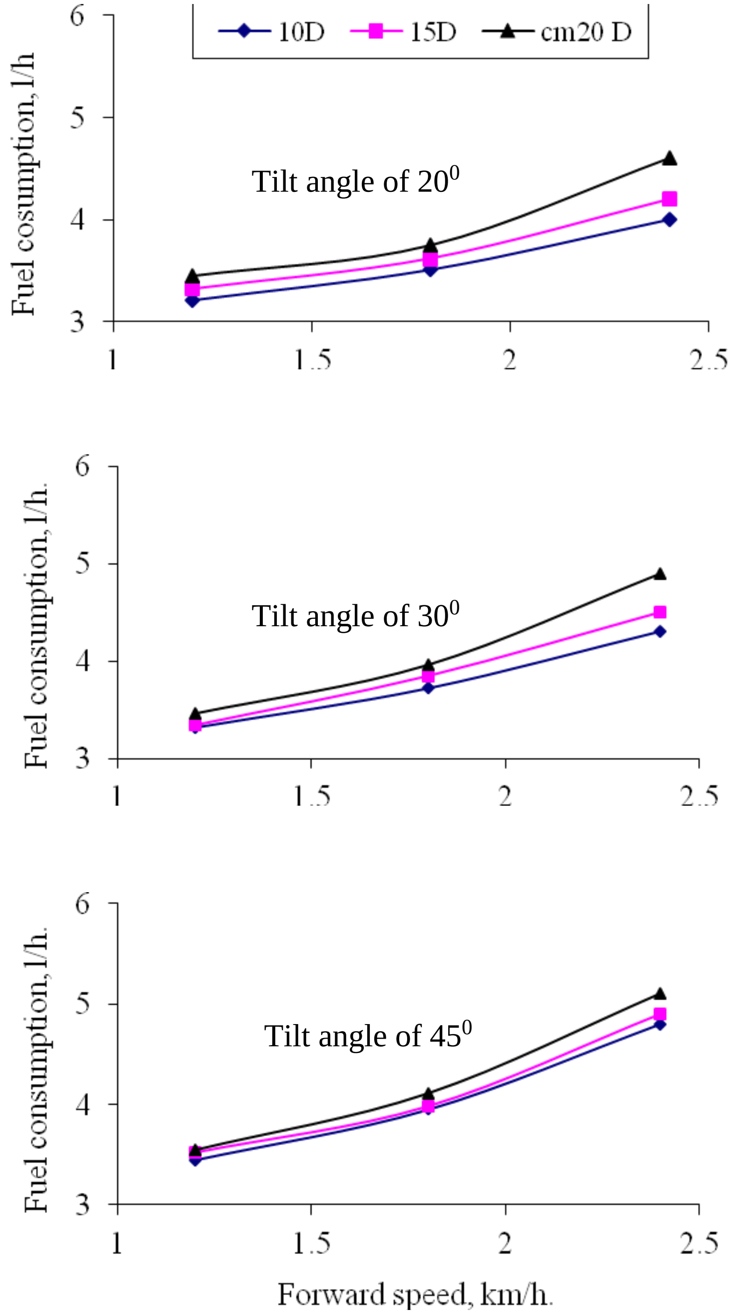

Fig. 10: Effect of forward speed and compressed wheel depth (D) on fuel consumption under different tilt angles for subsurface mulch

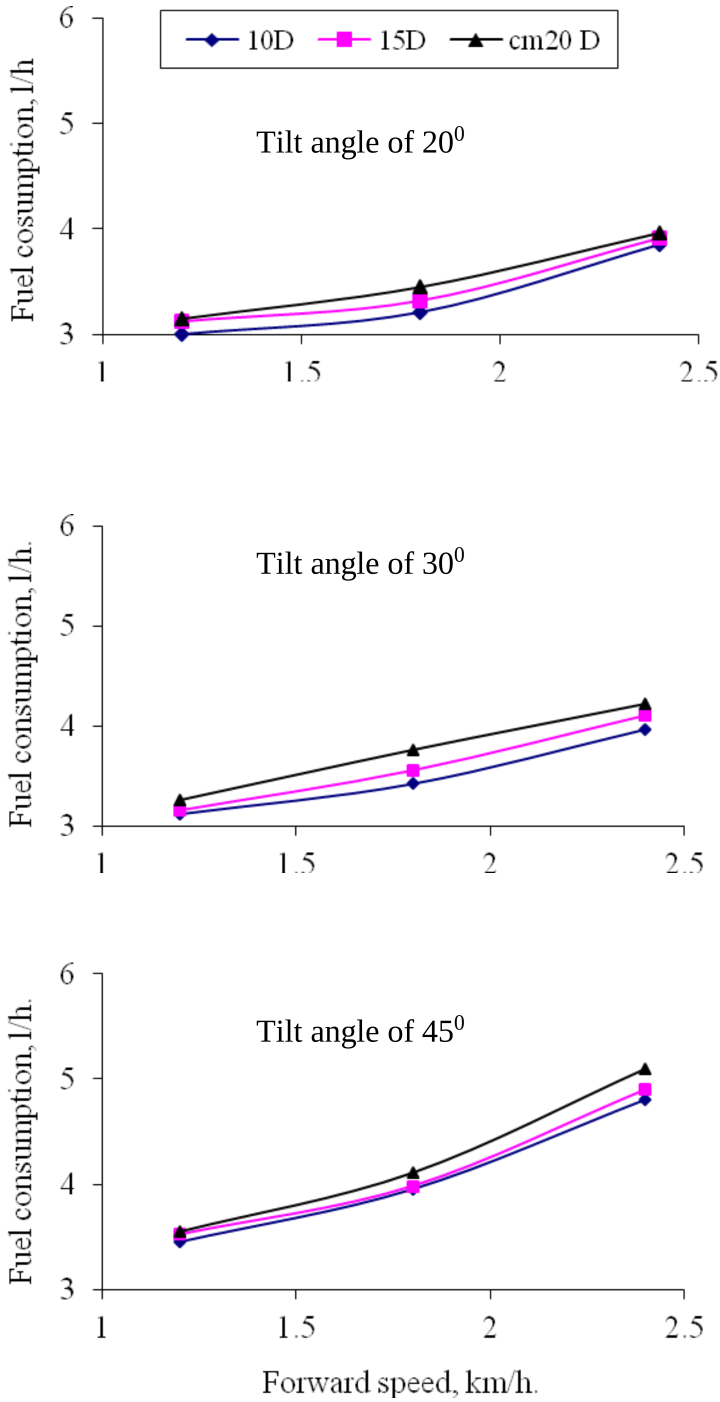

Fig. 11: Effect of forward speed and compressed wheel depth (D) on fuel consumption under different tilt

Meanwhile, for surface mulching (Fig.11), the maximum fuel consumption of 4.6 l/h was obtained by using forward speed of 2.4 km/h, compressing-wheel depth of 20 cm and tilt angle of 45 degree. Meanwhile, the minimum fuel consumption of 3.0 l/h was obtained by using forward speed of 1.2 km/h, compressing-wheel depth of 10 cm and tilt angle of 20 degree. The increment of results may be because of the increase of tractor wheel slip under high forward speeds and the increase of wheel depth which led to the excessive fuel consumption. Also, it was noticed that fuel consumption were lower in case of surface mulching which may be attributed to the absence of furrow opener and also the rear covering blades were adjusted to cover only both sides of the plastic sheet. It was found that there were significant differences between parameters of forward speed and tilt angles ($p < 0.05$).

Effect of forward speed and tilt angle of adjustable-wheel depth on soil covering width under different tilt angles of covering blades

In case of surface mulching, the compressing -wheel, manure hopper and the furrow opener were removed. The mulch width was 100 cm which is spread on the ridge by developed mulcher. Ridge 60 cm width and therefore 40 cm from plastic mulch is covered with soil on the two sides of plastic mulch. The two adjustable wheels hold 20 cm for both sides. This measurement depended on the width of plastic sheet covered with soil on both sides.

Fig. 12 shows the effect of forward speed, adjustable-wheel depth and tilt angle on soil covering width. The fuel consumption increased by increasing forward speeds, compressing-wheel depth and tilt angle of covering blades. The lowest value of covering width 7 cm was obtained with forward speed of 1.2 km/h and rear covering angle of 20 degree. While the highest value of 21 cm were obtained under forward speed of 2.4 km/h with rear covering blades angle of 45 degree. The sudden impact of covering blades with high forward speed of 2.4 km/h may be the main reason for achieving these results. It was observed that under forward speed of 2.4 km/h caused more mulcher vibration than under forward speed of 1.8 or 1.2 km/s with different tilt angles and adjustable wheel depth. This action resulted in some uncovering sides of plastic sheet. Data analyzed showed significant effect on all parameters ($p < 0.05$).

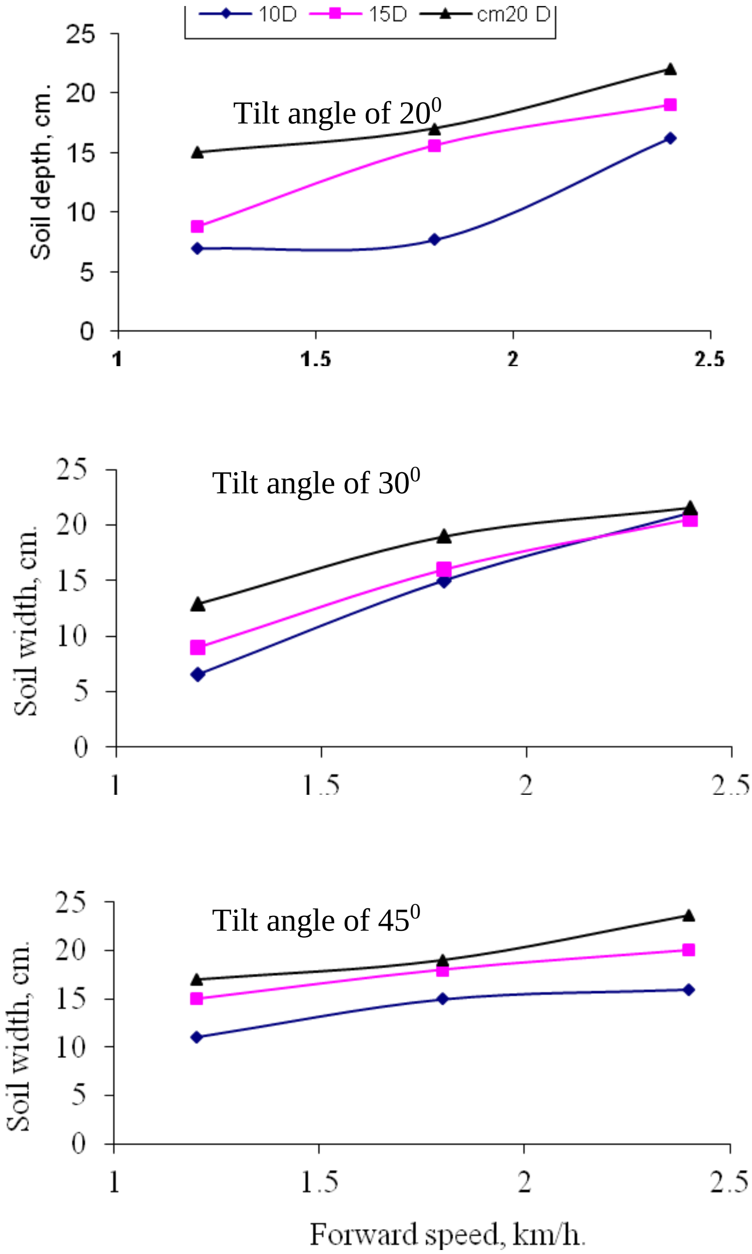

Fig. 12: Effect of forward speed, km/h on soil covering width, cm under different tilt angles, degrees for surface mulch

Uniformity of covering mulch (subsurface mulch) and Uniformity of spreading mulch (surface mulch):

Uniformity of covering mulch (subsurface mulch) and uniformity of spreading mulch (surface mulch) was evaluated by using calculating the covering and uncovering plastic sheet for the subsurface mulch and estimating the covering and uncovering the ridges for surface mulch. It was found that under forward speed of 2.4 km/h with 45 degree of tilt angle of covering blades 98% uniformity efficiency of the plastic sheet was achieved by covering with soil. Meanwhile, for the surface mulch it was illustrated that the uniformity efficiency of 92 % was obtained under the same operating conditions of 2.4 km/h of forward speed and 45 degree of tilt angle. The previous results for the two measurements were under adjusting wheel depth of 20 cm. similar trends were illustrated under forward speeds of 1.2 and 1.8 km/s under different test factors of 10 and 15 cm wheel depth and also under tilt angles of 20 and 30 degrees. However, the best results were shown with forward speed of 2.4 km/h with covering tilt angle of 45 degree under adjusting wheel depth of 20 cm.

Effect of forward speed, compressing-wheel depth and tilt-angle of covering blades on power requirements and energy

The effect of forward speed, compressing-wheel depth and tilt angle on power requirements and energy were calculated according to the mentioned equations. Power requirements and specific energy increased by increasing forward speeds, compressing-wheel depth and tilt angle of covering blades.

For subsurface mulching, power requirements and energy (14.11 kW and 24.75 kW.h/fed., respectively was obtained by using forward speed of 2.4 km/h, compressing-wheel depth of 20 cm and tilt angle of 45 degree. Meanwhile, power requirements and energy of 8.88 kW, 31.71 kW.h/fed., respectively were obtained by using forward speed of 1.2 km/h, compressing-wheel depth of 10 cm and tilt angle of 20 degree. All other tested parameters showed similar trends. These results may be due to using furrow opener and the rear covering blades had to push a high amount of soil raised on the plastic sheet according to the high wheel depth of 20 cm which consequently resulted in increasing fuel consumption to the mentioned results. Meanwhile, for surface mulching, power requirements and energy of 12.73 kW and 21.70 kW.h/fed., respectively were obtained by using forward speed of 2.4 km/h, compressing-wheel depth of 20 cm and tilt angle of 45 degree. Meanwhile, power requirements and energy of 8.30 kW and 29.64 kW.h/fed., respectively were obtained by using forward speed of 1.2 km/h, compressing-wheel depth of 10 cm and tilt angle of 20 degree. The increment of results may be because of the increase of tractor wheel slip under high forward speeds and the increase of wheel depth which led to the excessive fuel consumption.

The developed mulcher operating cost:

In manually methods, one feddan needs approximately 15 workers for applying mulch with wages of 50 LE for each worker with total costs of about 850 LE including the tractor and workers. While the calculation of the operating costs included fixed and variable costs were made for the tractor and the developed mulcher. The total fabrication cost of the modification in the developed mulcher including workshop cost was 1200 LE at 2013 price level. The developed mulcher needs a tractor of 30 hp if the furrow opener is used for setting furrows. The total operating costs for a 30 hp tractor and original mulcher were 90.14 LE/h and 5.04 LE/h, respectively. One feddan needs about 105 minutes (0.57 fed/h.) according to the actual field capacity under the chosen desirable forward speed of 2.4 km/h. It means that the total cost for preparing one feddan was about 166.55 LE. Comparing the total costs between manually and mechanically methods, it is clear that there is a great decrease in total costs by 80.4% when applying the new mulcher.

CONCLUSION AND RECOMMENDATIONS

It was concluded that using the mulcher under forward speed of 2.4 km/h with tilt angle of covering blades of 45 degree with the optimum adjustable wheel depth of 20 cm represented the optimum operating parameters which showed soil covering depth (ridge height, cm) of 29 cm , tractor wheel slip, for subsurface mulch, of 5.1 %, fuel consumption of 5.1 l/h, for subsurface mulch, 2.4 km/h and 4.60 l/h, for the surface mulch under the same conditions, covering width for surface mulch of 21 cm for both sides and uniformity covering efficiency of 98 % and 92 %for the surface mulch, respectively. Power requirements and specific energy of 14.11 kW, 24.75 kW.h/fed., and 12.73 kW and 21.70 kW.h/fed., respectively for subsurface and surface mulching were obtained under forward speed of 2.4 km/h. Total costs decreased totally by 80.4% when applying the new mulcher. So, in nutshell, plastic mulch may have an important application in boosting producing the organic food especially in water hunger areas or for those areas, which suffer from weeds.

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الملخص العربي

تطوير آلة لغطاء التربة البلاستيكى

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نظراً للتزايد السريع في عدد السكان في مصر والحاجة الملحة لزيادة الرقعة الزراعية بإستصلاح وإستزراع أراضي جديدة مع رفع كفاءة إستزراع الأراضي القديمة من حيث توفير وترشيد إستهلاك المياه بإستخدام نظم الري الضغطي الحديثة ورفع كفاءة إستخدام المياه والكيماويات من خلالها وتفليل عوامل الفقد المختلفة للحفاظ علي نقطة المياه والغذاء اللازم للنباتات المنزرعة, لذا كان لازماً التعاون بين بحوث هندسة تطوير نظم الري الحقلي مع بحوث هندسة الميكنة الزراعية لتطوير الآلات المستخدمة للوصول لكفاءات أعلي في إنشاء شبكات الري للحفاظ علي أكبر قدر من مياه الري بتقليل فواقدها ومواجهة إحتمالات إنتقاص حصة مياه النيل القادمة لمصر من منابعها لدول حوض النيل.

وبالإهتمام السائد في مجال التلوث البيئي من الناحية الزراعية الناتج من حرق المخلفات وبقايا المحاصيل واستخدام المبيدات الحشرية ومبيدات الحشائش مما يؤثر سلباً على الصحة العامة، ونظراً لارتفاع التكلفة فى الري الحديث اتجهت الدراسات إلى استحداث بدائل جديدة تخفف من نسبة التلوث وتسهم بشكل كبير فى حل مشكلة نقص مياه الري وتقلل من استخدام مبيدات الآفات ومبيدات الحشائش وتحافظ على البيئة.

ومن خلال المتابعة الميدانية فى المناطق الرملية تبين قيام المزارعين بفرد شريحة من البلاستيك لتغطية التربة المنزرعة يدوياً والمعروفة عامياً بإسم (الملش السفلي) أو فرد شريحة البلاستك على ظهر المصاطب يدوياً (الملش العلوي) والزراعة عليها بعد إضافة السماد العضوى، أو حقن طبقة من الأسفلت تحت سطح التربة الرملية فتتكون طبقة عازلة تمنع نفاذ الماء بدرجة تجعل المحتوى الرطوبي مناسباً فى نطاق الجذور. ويتم الري بالتنقيط بمد خط الري أعلي أو

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أسفل الملش وتجهيزه على نفس مسافات الزراعة بغرض القضاء على الحشائش وتقليل البخر وتوفير ماء الري. كما أن يؤدي الملش العلوي دوراً حيوياً فى المناطق الباردة بحفظ درجة حرارة التربة مما ينشط العمليات الحيوية فى نطاق الجذور.
لذلك أجريت هذه الدراسة لتطبيق طريقة الملش آلياً فى الأراضى الرملية علي مرحلتين فى قرية الصوة – مركز أبو حماد وإحدى قرى محافظة الشرقية - بهدف تطوير ميكنة نظام الملش فى الزراعة بتغطية التربة بالبلاستيك آلياً بواسطة الآلة موضوع الدراسة كالتالي:

١- ملش سفلي آلي في باطن خطوط الزراعة مع إضافة الأسمدة العضوية وتغطيتها ثم الزراعة كبديلاً عن الطبقة الأسفلتية أسفل سطح التربة ، وبالتالي نحفظ نطاق الجذور رطباً بدرجة مناسبة.

٢- ملش علوي آلي بفرد شريحة البلاستيك على ظهر المصاطب بعد تجهيزها ثم عمل ثقوب على مسافات الزراعة الموصى بها وذلك بهدف منع نمو الحشائش وتدفئة سطح التربة في شتاءاً وتقليل البخر صيفاً.

وبالتالي تسهم الدراسة بشكل كبير فى ترشيد إستخدام مياه الري والأسمدة والكيماويات ورفع كفاءتها وبالتالي الزيادة الإنتاجة للمحصول كماً وجودة مع التقليل بقدر كبير من الحشائش والتلوث البيئي الناتج عن إستخدام الكيماويات.
وقد تم اختبار أداء الآلة المطورة عند ثلاث سرعات للجرار كوبوتا ٣٠ حصان (≈٢٢,٤ كيلووات) على الترتيب ١,٢ ، ١,٨ ، ٢,٤ كم/س مع ثلاث زوايا لأسلحة التغطية على الترتيب ٢٠ ، ٣٠ ، ٤٥ درجة مع الأفقى – اتجاه العمل – وذلك مع ظبط عمق عجل الضبط على أعماق ١٠ ، ١٥ ، ٢٠ سم.
تم تقييم الآلة بعدد من القياسات أهمها ارتفاع التربة فوق الملش السفلي ونسبة الانزلاق واستهلاك الوقود وكذلك تم قياس نسبة التغطية على جوانب الملش العلوى وانتظامية فرد ملش البلاستيك فى الحالتين ، وتم تقدير السعة الحقلية بعد إستخدام الآلة المطورة عند المعاملات المختلفة,
وقد اوضحت النتائج أن أنسب متوسط لسرعة تشغيل للآلة ٢,٤ كم/س وكذلك أفضل زاوية تغطية فى الحالتين زاوية ميل ٤٥ درجة. كما أن عمق عجل الضبط ٢٠ سم أعطى أفضل النتائج مع المعاملات المختلفة تحت نفس ظروف سرعة التشغيل وزاوية الميل. وكانت أفضل النتائج للملش لغطاء التربة ٢٩ سم بنسبة انزلاق ٥,١ و ٢,٢ % بالنسبة للملش السفلى والملش العلوي على الترتيب كما كان استهلاك الوقود ٥,١ لتر/ساعة و٤,٦ لتر/ساعة وكذلك القدرة المطلوبة والطاقة النوعية (١٤,١١ كيلوات ، ٢٤,٧٥ كيلووات.ساعة/ف) و(١٢,٧٣ كيلوووات ، ٢١,٧٠ كيلووات.ساعة/ف) تحت نفس ظروف التشغيل بالنسبة للملش السفلى والمالش العلوي على الترتيب. كذلك كان أفضل غطاء لجوانب الملش العلوي ٢١ سم تحت سرعة ٢,٤ كم/ساعة وكانت كفاءة التغطية بالآلة ٩٨ و٩٢ % بالنسبة للملش السفلي والملش العلوي على الترتيب وكذلك انخفضت التكاليف الكلية بتشغيل الآلة عن النظام التقليدي (اليدوي) بنسبة ٨٠,٤% تحت أنسب المعاملات.