

CULTIVATION PERFORMANCE AS INFLUENCED BY THE CULTIVATOR SHAPE SHARES

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ABSTRACT

Until now in Egypt, there are no common systems to mechanize the inter-row cultivations. A few attempts were carried out to test and evaluate the maize cultivation. This paper aims to evaluate the cultivation performance as influenced by three cultivator share shapes. There are L-Knives with deflected vertical edge that inclined to the direction of motion (S_1), L-Knives with flat vertical edge, which inclined at an angle of 160 degree and it set up at angle of 5 degree in relation to the soil surface (S_2), and the two half sweep share (S_3). The sweep is longitudinal fractionated in two equal parts that fixed each one in left or right cultivator bar. The three shape shares and three travelling angles (0° , 5° and 10°) are conformed as independent variables. The percentages of weed control, the percentage of injured plants and the rate of change in the area of ridges (Pa%) were carried out as independent variables. The maximum percentages of weed control were 91.2; 94.00 and 88.7% obtained at (0° , 5° and 10°) of travelling angle respectively and share shape of L-knives with flat vertical edge that inclined at an angle of 160 degree (S_2). It is recommended to keep the travelling angle in range of zero to 5 degree to increment the percentage of weed control and decrement the percentage of injured plant. The rate of change in area for the ridge profiles decreased as the travelling angles of cultivator shares increased.

INTRODUCTION

Cultivation is an operation that requires some kind of tool that stirs the surface of the soil to a shallow depth in such a manner that young weeds will be destroyed and crop growth promoted (Smith, 1984). While Hunt (1983) consider the cultivation as refers to tillage operation performed after seeding. Although, weed elimination is the primary purpose of cultivation, the secondary purposes are preparing the soil to retain rainfall, aeration, and incorporation of fertilizer and pesticides and providing plant support. Smith (1984), mentioned that there are numerous types of shovels and sweeps used for stirring the soil and killing weeds. Shovels are available in widths up to about 8 or 9 cm but sweeps can obtain in width ranging from 15 to 60 cm. The type of soil, crops, and weeds influence the shovel or sweep used.

All cultivation trials have shown the importance of removal the weeds at least once per crop and at the correct time (Benites *et al.*, 1983). The combination between herbicide residues and mechanical weed control were conducted by Miller and Carter (1976). The two type of cultivator namely; the sweep or a rolling cultivator performed equally well at using to weed control and herbicide residues in the soil. For inter-culturing operations in row crops, precision tiller and sweep cultivator are effective and economical under conserved soil moisture condition; rod weeder and sweep cultivator can be used with advantage.

The effects of the inter-row cultivations depth in the zone of the lateral roots 6-8 cm a way from the row on root growth was studied by Karimov (1983). It was suggested that blade of cultivators should be adjusted to

produce different depths, shallow near to the root zone and deeper away from it, in order to avoid damage to the roots. Awady (1986) constructed a rotavator to operate with two to four tine rotors which changeable engines ranging in power. The big power and 4-rotor arrangement are suitable for orchard cultivation, while the small power and 2-rotor arrangement are suitable for inter-row cultivation. New designs of high-speed sweeps have the crown and wings set flat to skin under the soil at a shallow depth without throwing excessive amounts of soil. Ismail and Hemida (1992) were investigated three-shape types of inter-row cultivation. The results of comparison showed an agreement theoretical height of cultivation with the actual and the effect of share type and its angles are studied to determine the best distribution of the ridge profile shape. The relationship between the probability density function and the actual height of cultivated profile was identified. On the other hand, Hemida and Ismail (1992) developed a cultivator for inter-row cotton cultivation. Two shares were added in both sides of the main sweep at different angles (15°, 20° and 25°) to improve the weed cutting efficiency among rows. Two additional small wings were fixed on both sides of the beam to improve covering on the uncut weeds. The experimental results on the above-developed cultivator indicated that the highest value of weed control is 92.44% at share angle of 20°, apex angle of 106° and cultivation depth of 6 cm.

This study was carried out to determine the optimum operation condition of three shape types of cultivators and, at the same time, to minimize the percentage of injured corn plants and maximize the amount of weed control.

MATERIALS AND METHODS

To control weeds and pulverize soil to a depth of 2-6 cm, the inter-row cultivator was designed and manufactured at Agri. Engineering Department. Faculty of Ag. Mansoura Univ. Three different shapes of shares were connected with the shank, to conform a cultivator. The rectangular steel bar with cross-section 100x100 mm, which equipped with three hitch points, is considered as main frame. Tool beam on which the cultivator shares are attached by sliding linkage is considered as main part. Three unite of cultivators were arranged on the frame. Each unite have three elements tools of cultivator share. The median tool is fixed as constant tools for all treatments during carrying all field experiments but, the two other share are:- L-Knives with deflected vertical edge (S₁) or L-Knives with flat vertical edge (S₂) and or the two half sweep share (S₃). The (S₁) Knives have vertical edge that inclined to the direction of motion (Fig. 1-a). The (S₂) have a vertical edge, which inclined at an angle of 160 degree and it set up at angle of 5 degree in relation to the soil surface (Fig. 1-b). The half sweep share (S₃), the sweep is longitudinal fractionated in two equal parts that fixed each one in left or right cultivator bar (Fig. 1-c). The ground angle of share not exceeds of degree. The all treatments were carried out at Kafer El-Thopaneia Gharbia Governorate. Inter-row cultivation were carried out on the corn crop with 60 cm distance between rows that mechanically planted in the flat soil and the ridge of profile was constructed during first cultivation.

The experimental procedure

The experimental procedure was as follows: -

- 1- The percentage of weed control and cultivator efficiency is computed for each trial at 1.5 m/s forward speed.
- 2- Soil moisture content was determined according to the standard method of ASAE (1983) before the first and the second cultivation. There were 21.7 and 23.16% respectively.
- 3- The first and the second cultivation are carried out after 4 and 6 weeks from planting respectively.
- 4- The protective belt width is adjusted and kept constant at 5 cm from the center of plant to the first point of cultivator share.

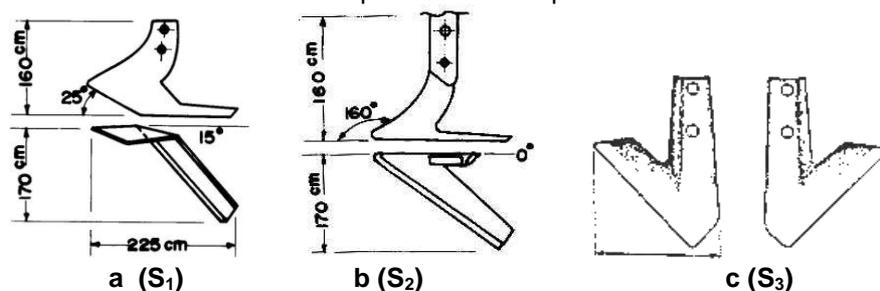


Fig. 1: The different shape shares of cultivator

Tested factors

Tester factors were conducted to study the effect of the following factors during the first and the second cultivation:- Three different shapes of cultivator groups, and three travels angle 0°, 5° and 10° on the percentage of weed control, the percentage of injured plants and the change of the shape area of the cultivated profile ridge.

The percentages of weed control, two wooden frames (1mx 0.35m) were used to determine the quantity of standing weeds in gram before and after each treatment. The dry matter of weed was determined by oven drying at 60 degree for 18 hours (Jackson-1967). The efficiency of weeding in each treatment was calculated by using the following equation:-

$$\lambda_w = \frac{A - B}{A} * 100$$

Where:

- λ_w : The percentage of the killed weeds
- A : The dry mater of weeds directly before treatment, g/m²
- B : The dry mater of weeds directly after treatment, g/m²

The percentage of injured plants, Injured plants are calculated per 10m along for each treatment using the following equation:-

$$Lp = \frac{Sp_1 - Sp_2}{Sp_1} * 100$$

Where:

- L_p : percentage of injured plants.
- Sp_1 : Number of standing plants before cultivation.
- Sp_2 : Number of standing plants after cultivation.

The values of L_p were calculated after cultivation directly and after 5 days later.

The cultivated shape of the ridge, The cultivated cross-sectional profile is measured with a relief measurement apparatus according to Sohne et al. (1962). The cross-sectional area can be calculated from the cross-sectional elements using the trapezoids rule as given in the following equation: -

$$A = \frac{L}{2}(a + 2b)$$

Where:

- A: Total cross-sectional area, cm^2
- L: Constant horizontal distance, cm
- a: Sum of first and last ordinates, cm
- b: Sum of all ordinates excluding the first and last ones, cm.

RESULTS AND DISCUSSION

1- Weed control percentage (W_k %)

The percentage of killed weeds was used to evaluate the performance specification for three different shape of cultivator shares, "S₁", "S₂" and "S₃" and three travelling angles (0; 5 and 10 degree) at optimum cultivator speed (5.4 Km/h). It is evident from figure (2) that the highest percentages of killed weeds were recorded at travelling angle of 5° and S₂. They were 94.00 and 92.54% directly after the first cultivation and 5 days later after first cultivation respectively. While the lowest weeds percentage of killed weeds were 75.3 and 72.5% for S₃ and travelling angle of 10°. In general, the shape of cultivator share and travelling angle significantly influenced the percentage of killed weeds.

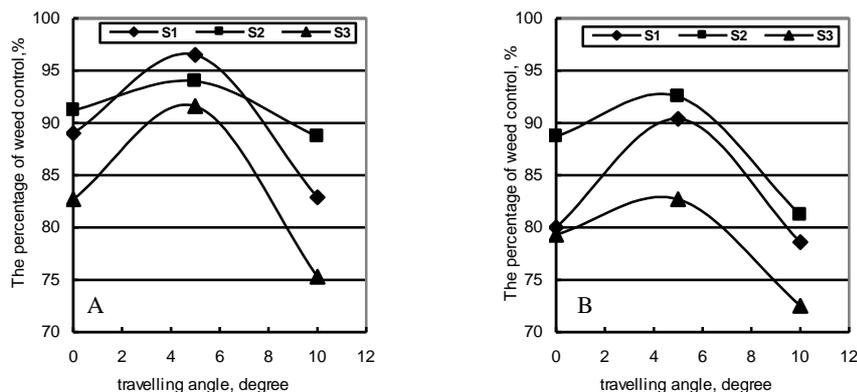


Fig. 2: The relationship between travelling angle and the weeds control
 A- after cultivation directly B- 5 days later after cultivation

Figure (3) illustrates the values of killed weed percentage at the second cultivation; the maximum percentage of killed weeds was reached (99.4%) using the share “S₂ “ with 5 degree of travelling angle. While the lowest values of killed weed is 83.52 for S₃ and 0 degree of travelling angle. Increasing the travelling angle from 0° into 5° increased the killed weeds percentage by 1.06; 1.08 and 1.13 times at using shares S₁, S₂ and S₃ respectively.

2 -The percentages of injured plants

The shares of cultivations should be operated as shallow as possible to prevent prying the roots of maize plants from injuring the plants. The percentage of injured plants was recorded after first cultivation directly and 5 days later (Fig. 4).

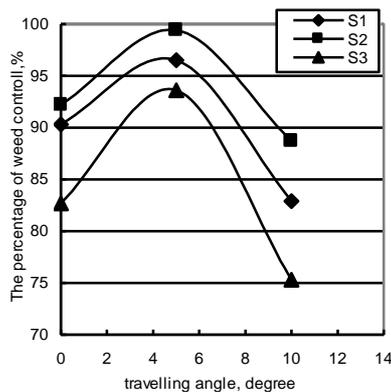


Fig. 3: The relationship between the travelling angle and weed control at second cultivation

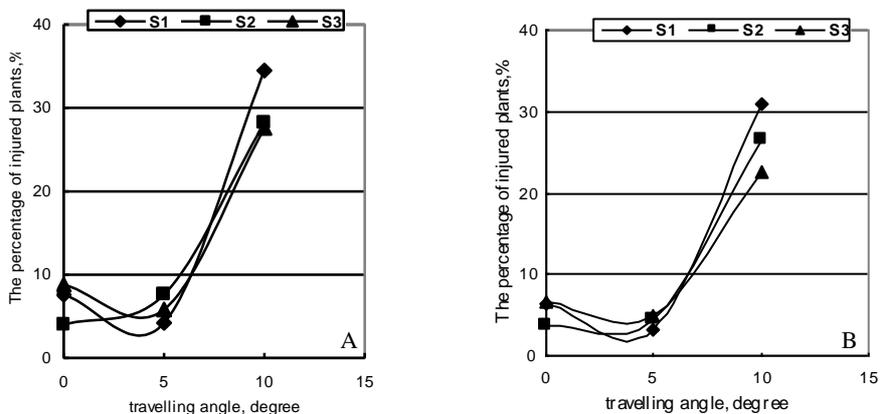


Fig. 4: The relationship between travelling angle and injured plants. A- directly after cultivation B- 5 days later after cultivation

Data collected on the percentage of injured plants as affected by shape of cultivator shares and travelling angle of shares at travelling speed of 5.4 Km/h and with 25 cm span between cutting shares are presented in Fig.(4).

The percentage of injured plants was increased as the travelling angle increases. At S₂ the total percentages of injured plants were 4.0; 7.6 and 28.2% at 0°; 5° and 10° of travelling angle respectively. In addition, it is clear that the percentage of injured plants after the first cultivation directly were more than that using cultivation after 5 days later for all treatments under study. For example, the percentage of injured plants after first cultivation directly and 5 day later from the first cultivation were 3.6; 4.4 and 26.54 % at 0° ,5° and 10° of travelling angle respectively at S₂.

Concerning the percentage of injured plants after the first cultivation, it is clear that the maximum percentage was produced using 10° of travelling cutting share angles. Data collected on the percentage of injured plants after the second cultivation is presented in Fig. (5). From above figure, the injured plant after second cultivation is very small. The optimum operations condition that recorded the lowest percentage of injured corn plants were S₂ of cultivating share types and 5° of travelling share angle. The interaction effect on the percentage of injured plants after 5 days from second cultivation too. Generally, it is clear that the total average percentage of injured plants after the second cultivation increased when using 5 degree (0.42%) compared with 10 degree (15.6%) of travelling angle at the same shape of share (S₂).

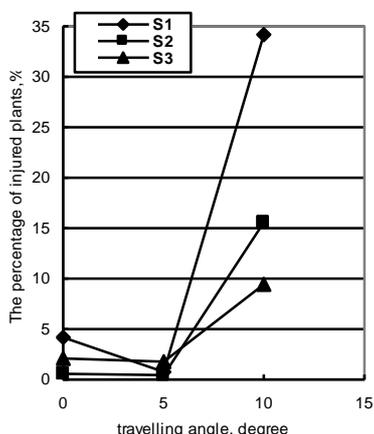


Fig. 5: The relationship between travelling angle and injured plants after the second cultivation

3- The shapes of the cultivated profiles ridge (Pa%)

During the first cultivation an experimental study on the rate of change in the area of ridges (Pa%) was carried out to evaluate the performance specification for three different shape of cultivator shares and three of travelling angle at optimum cultivating speed (5.4 km/h). It is evident from Fig. (6) that three shape of cultivator shares and three travelling angle have a effect on the rate of change in area for the ridge profiles (Pa%). The highest rates of changing in area for the ridge profiles (Pa%) were 96.2 and 48.94 for S₂ shape of cultivator share and 5° of travelling angle at the first and the

second cultivation respectively. The lowest rate of change in area for the ridge profiles (Pa%) were 84.6 and 38.96 for S₃ shape of cultivator share and 10 degree of travelling angle of cultivator share at the first and the second cultivation respectively.

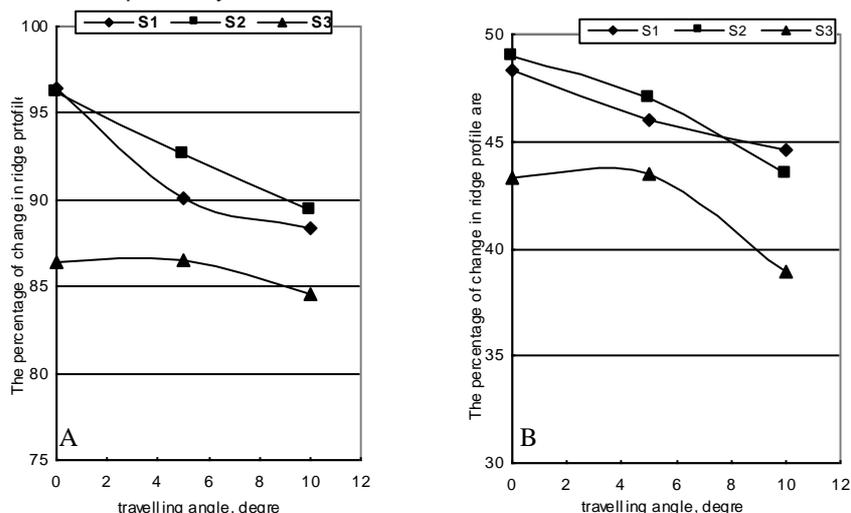


Fig. 6: The relationship between travelling angle and the percentage of change in ridge profile
A- after the first cultivation B- after the second cultivation

In general, these data indicated that the rate of change in area for the ridge profiles decreased as the travelling angles of cultivator shares increased. On the other hand, at constant travelling angle, the rate of change in ridge profiles area decreased as the shape of cultivator shares increased. At S₁, shape of cultivator shares the results indicated that, the highest rate of change in area for the ridge profiles were recorded using the zero degree of travelling angle. Second cultivation, data in Fig.(6-B) shows that, the three different shape of cultivator shares and three of travelling angles had effect on the rate of change in area for the profile ridges (Pa%). The highest rate of change in ridge profile area (Pa%) were 48.94; 46.89 and 43.5% at travelling angles of 0° ; 5° and 10° respectively and S₂ of share types.

CONCLUSIONS

From the previous discussions, it may be concluded that:

- 1- the maximum percentage of weed control were 91.2; 94.00 and 88.7% obtained at 0° ; 5° and 10° of travelling angle respectively and share shape of L-knives with flat vertical edge which inclined at an angle of 160 degree.
- 2- It is recommended to keep the travelling angle in range of zero to 5 degree to increment the percentage of weed control and decrement the percentage of injured plant.
- 3- the rate of change in area for the ridge profiles decreased as the travelling angles of cultivator shares increased. On the other hand, at constant

travelling angle, the rate of change in ridge profiles area decreased as the shape of cultivator shares increased.

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مواصفات العزيق كدلائل في أشكال أسلحة العزيق

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في مصر حتى الآن لا يوجد طرق منظومة لتنفيذ عملية العزيق بين الخطوط. قليل من الأبحاث التي أجريت لتقييم عزق محصول الذرة. اجري البحث لتقييم ثلاث أشكال مختلفة من أسلحة العزيق (سلاح عزق علي حرف زاوية حيث يميل الحرف القاطع ١٦٠ درجة- سلاح عزق علي شكل حرف زاوية يميل حرفة القاطع ٣٥ درجة- سلاح رجل بطة مقسوم طوليا حيث يوزع علي جانبي خط العزيق) بالإضافة إلى ثلاث زوايا ميل بالنسبة لاتجاه الحركة. تم تثبيت مجموعة العزق بحيث يوضع سلاح رجل بطة ثابت لكل المعاملات تحت الدراسة بين الخطوط المراد عزقها عل أن يوزع الأسلحة المختلفة بين جوانب الخط علي أن تكون المسافة الكلية بين الأسلحة ٥٠ سم وان المسافة (١٠ سم) المتبقية تمثل منطقة الدفاع. من النتائج تبين أن أفضل النتائج التي تم التوصل إليها هي استخدام السلاح الذي يميل حرفة القاطع بزوايا ١٦٠ درجه مع ميل السلاح بالنسبة لاتجاه الحركة بزوايا بين الصفر والخمس درجات. كما كانت أعلى نسبة من التحكم في الحشائش في حدود ٩١,٢% و ٩٤% و ٨٨,٧% عند ميل أسلحة العزيق بزوايا صفر - خمس - عشر درجات بالنسبة لاتجاه الحركة علي الترتيب.