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STUDY OF THE EFFECT OF SPEED, DEPTH OF THE CULTIVATION AND THE NUMBER OF TIMES THE SPRING – LOADED CULTIVATOR PASSES ON SOME TECHNICAL PARAMETERS OF THE CULTIVATOR AND ON WEED CONTROL

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ABSTRACT

This study was conducted at the Agricultural Research Station in Abu Ghraib located in the Department of Horticulture in a silty clay loam soil in the fall season of 2019. The aim of this study was to investigate the effect of the depth, speed and the number of passes of the spring - loaded cultivator on slippage percentage, practical field productivity, weed control percentage and weed inhibition percentage. The design of randomized completed plots with three replications was used. The cultivation was performed at speed (3.25 and 6.50) km / hr., and with cultivation depth at (10 and 15) cm, and with two number of cultivator passes (one pass and two passes in one line). The results of this study showed that the second speed (6.50 km/hr.) had a significant effect on practical productivity, weed control percentage and weed inhibition percentage. While for the cultivation depth, there were no significant differences between the two levels of the cultivation depth on the practical productivity and on the slippage percentage. However, the depth of 15 cm achieved higher weed control percentage and weed inhibition percentage. Also, the results showed there were no significant effects for the number of passes on the studied characteristics except the practical productivity. The one pass per line showed higher Practical productivity than two pass per line which support the idea of unnecessity of using more than one pass per line for mechanical weed cultivation.
***Keywords*:** spring- loaded cultivator, slippage percentage, practical productivity, weed control percentage, weed inhibition percentage.

Introduction

Weed causes many losses in all aspects of agriculture. The losses caused by the weed are reduction in yield, the reduction in the quality of agricultural products, mechanical damage, and the increase in the cost of agricultural production (Al–Jubouri, 2002). Weeds reduce the quantity and the quality of the agricultural production besides of their effects in increasing the cost production (Al-Jubouri and Hassawi, 1985). The productivity per unit area depends on the plants in which they grow. If the weed plants are dominant then the weight of the weed is the highest and if the growth of the weed is controlled, the productivity increases with the weight of the crop plants (Al–Baldawi and Al-Naqib, 2011).

The main goal of the cultivation process is to get rid of weeds that compete with the crop in the growth requirements of water, food and sunlight (Al-Tahan and Al-Naema, 2000).

Weed can be controlled mechanically by using one of cultivator's types. The primary function of a cultivator is to destruction the weed in the field. Mechanical cultivation is the most important and economical method for controlling weed (Kepner, 1983). The cultivators loosen the root system of the weed and raise it to the surface of the soil, where the sun kills it (Shippen and Turner, 1973). The type and the size of cultivators depends on the acreage, the kind of crop, soil type and conditions, rainfall, type of farming practiced and the kind of power available .The implements for mechanical weed control classified into main groups : hoes and harrows; and mowers and strimmers (Rueda-Ayala *et al*., 2010).

Regulating the depth of the cultivation is important to ensure that the weed is uprooted from its roots, knowing that the further depth of the cultivation does not lead to the uprooting of the roots of the weed, but rather to dismantle the root zone and then find better conditions for its growth and reproduction (Hussain and Ezzat, 1978). Fey *et al*. (2020) studied the efficiency of adapted automatic row hoe for weed control in organic soybean they concluded that automatized hoeing is an alternative method to the mechanical control of weeds.

Cloutier *et al*. (2007) clarified that despite the emergence of pesticides in the twentieth century and the beginning of their widespread use, the cultivators continued to be used in the fight against the weed, as the cultivators contributed to the effective control of the weed.

Moitzi *et al*. (2014) indicated that increasing the working depth in tillage process, the drawbar pull rises and slippage. Al–jarrah found in the study of the performance of rotary cultivator on some physical properties of soil and field performance criteria that speed 2.22 km/hr gave significance in the weed control percentage than 4.95 km/hr speed.

Mohammed *et al*. (2007) studied the effect of tow types of cultivators on weed control and the yield for apricot orchard in grdarasha field and they found that harrow disc with speed 6 km/hr and depth of (8 – 12 cm) recorded the highest ratio of weed control (85.24%) than cultivator with tine chisel. Mohammed (2019) evaluated two types of row cultivators in weed control for corn and sunflower and he found that the system (sweep + two disc) had the highest level of percentage of weed control and weed cut per squared meter, also the found that the forward speed with 7 km /hr achieved highest level of percentage of weed control and weed cut per square meter than 5 km / hr.

The objectives of the study

The objectives of this study are:

1. to study the technical indicators of the machine unit under field conditions.
2. evaluate the performance of a spring-loaded cultivator on the weed control.

Material and Methods

Field Experiment

A field experiment was conducted at the Agricultural Research Station in Abu Ghraib affiliated to the Horticulture Department in the fall season of 2019 using a spring loaded cultivatore with a tractor (Massey Ferguson 440 Xtra). The experiment was carried out using the (design of the experiment) to study three factors, which included: The first factor was the tractor and it was at two levels, the first speed was 3.25 km / hour and the second speed was 6.50 km / h. The second factor was the cultivation depth with two levels, the first depth was 10 cm and the other was 15 cm and the third factor is the cultivator passes which was two levels, the first with one passage for the cultivator and the second with two passes (back and forth) with three replications so that the total of the experimental units is 24 experimental units. The size of the plot unit was 60 square meters (20 x 30). The process of submerging the land with water was carried out using surface irrigation to ensure the growth of weed, then it was left for a period of time and after the appearance of the weed, the cultivator was used to control weed.

Table 1 : Weed types in the field

Type of weed	Scientific name	Family name
Dwarf Mallow	Malva parviflora	malvaceae
Swobane	Chenopodium murale	chenopodiaceae
Wild Beets	Beta vulgaris	chenopodiaceae
Milk Thistle	Silybum marianum	compositae

Fig. 1 : (a) before treatment, (b) after treatment

Cultivator with spring loaded tines

Cultivator with spring loaded tines was used for hoeing weed in the field experiment. A tine hinged to the frame and loaded with a spring so that it swings back when an obstacle is encountered, is called spring loaded line. Each of the tine of this type of cultivator is provided with two heavy coil springs (Fig. 2), pre-tensioned to ensure minimum movement except when an obstacle is encountered. The springs operate, when the points strike roots or large stones by allowing the tines to ride over the obstruction, thus preventing damage. The width of the cultivator is 2.8 meter, the distance between the front tines and the rear tine is 0.50 meter and the spacing between tines is 0.50 cm and the tine width is 0.20 meter. The cultivator is mounted on three-point hydraulic linkage of the tractor.

Fig. 2 : spring loaded cultivator used in the experiment

The studied characteristics

Machine performance parameters

1. The slippage percentage:

First, the theoretical forward velocity of the machine unit was calculated by measuring the time required to travel a distance of 20 meters on untilled land for the machine unit, with making the cultivatore in contact with the ground and according to the selected speed, taking into consideration leaving a distance of 10 meters from the beginning of the field line to reach the specified speed. Then the theoretical speed was calculated using equation (1) :

$$V_t = 3.6 \times \frac{D}{T_t} \ldots\ldots(1)$$

Where:

V_t : Theoretical speed …..Km / hr.

D: The distance….m

T_t : The theoretical time ….sec

For the practical speed, the actual time for each treatment was measured according to the depth and speed determined for each treatment, taking into consideration leaving a distance of 10 meters from the beginning of the field experiment line to reach the prescribed speed and depth. Then the practical speed was calculated using equation (2):

$$V_p = 3.6 \times \frac{D}{T_p} \ldots\ldots(2)$$

Where :

V_p : practical speed ….km/hr.

T_p : practical time …..Sec

After calculating the theoretical and practical speed of the machine unit, the percentage of slippage was calculated using equation (3):

$$S\,\% = \frac{V_t - V_p}{V_t} \ldots\ldots(3)$$

Where :

S% : the percentage of slippage

2 . Practical productivity

The practical productivity was calculated using equation (4)

$$P_p = 0.4 \times W_p \times V_p \times S\_t \ldots\ldots(4)$$

Where:

P_t: Practical productivity …d /hr.

W_p : The practical machine width …m

S_t : Time efficiency coefficient

Weed control

1. **Weed control percentage :** Weed samples were collected from each experimental unit using squares method for an area of one square meter, and then the percentage of weed reduction was calculated from equation (5):

$$\text{weed control percentage} = \frac{\text{weed count in unweeded plot} - \text{weed count in treated plot}}{\text{weed count in unweeded plot}} \times 100 \quad \ldots(5)$$

2. Weed inhibition percentage

Weed samples were collected for each experimental unit and placed in perforated paper bags in an electric oven at a temperature of 75 c° for a period of 48 hours for the purpose of drying and until the weight was fixed, then the samples were weighed after drying and then the percentage of inhibition was calculated using equation (6):

$$\text{Weed Inhibition percentage} = 100 - \frac{A}{B} \times 100 \ldots(6)$$

where :

A : The dried weight of weeds in treated plot

B : The dried weight of weeds in unweeded plot

Data Analysis

Since there were three studied factors including the traveling speed with two levels (3.25 and 6.50 km.h^{-1}), the cultivation depth with two levels (10 and 15 cm), and the number of passes per line with two levels (one and two passes per line), there were eight treatments. Three-way ANOVA was performed to investigate the effect of each factor individually and the effect of the interactions between the factors. Three replicates per treatments were used. Each replicate was a plot of 20×2.8 m^2. In this research, the practical productivity (Donum.h^{-1}), the slippage percentage (%), weed control percentage (%), and weed inhibition percentage (%) were investigated.

Results and Discussion

Practical productivity (Donum.h^{-1})

The statistical analyses showed a highly significant difference of the practical productivity between the two levels of the traveling speed [F(1,16), p = 3.6×10^{-13})] where the 6.50 km.h^{-1} traveling speed exceeded the 3.25 km.h^{-1}. This result was expected because the traveling speed is a main factor that contributes in calculating the effective capacity.

Moreover, there were no significant difference between the two levels of the cultivation depth [F(1,16), p = 0.65)]. Also, there was highly significant difference of the Practical productivity between the two levels of the number of passes per line [F(1,16), p = 3.8×10^{-13})], where the 1 pass per line showed higher Practical productivity. This result was expected because the time required to complete one donum is approximately multiplied by the number of passes per line which decreases the effective Practical productivity.

The interactions among these three factors revealed that there were no significant differences among the interactions [$F(1,16)$, $p = 0.07$)].

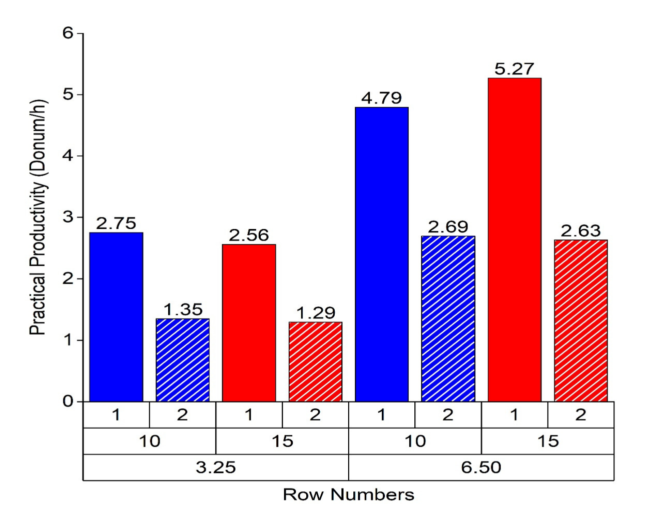

Fig. 3 : Practical productivity (Donum.h^{-1})

Slippage Percentage (%)

The analyses showed that there were no significant effects of any of the three studied factors on the slippage percentage. This result encourages to use the higher speed of 6.5 km.h^{-1} and maybe to investigate higher speeds considering the positive effect of the traveling speed on the field capacity.

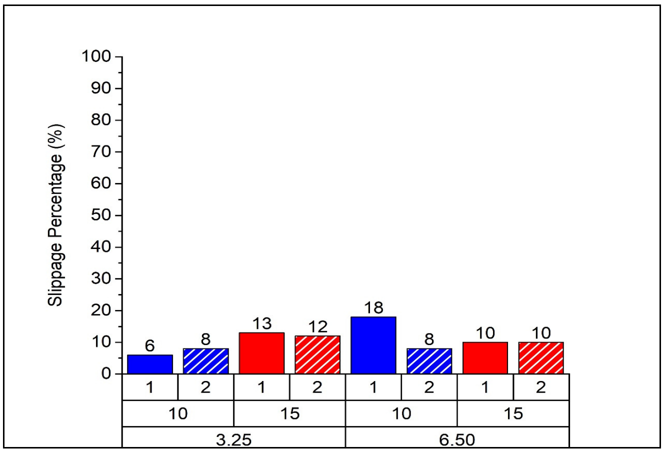

Fig. 4 : Slippage percentage (%)

Weed Control Percentage (%)

The traveling speed showed highly significant effect on the weed control percentage [$F(1,16)$, $p = 0.003$)] where the traveling speed of 6.5 km.h^{-1} achieved higher weed control percentage. Similarly, the cultivation depth showed significant effect [$F(1,16)$, $p = 0.01$)] where the depth of 15 cm achieved higher weed control percentage. The number of passes per line did not show a significant effect on the weed control percentage which support the idea of unnecessity of using more than one passes per line.

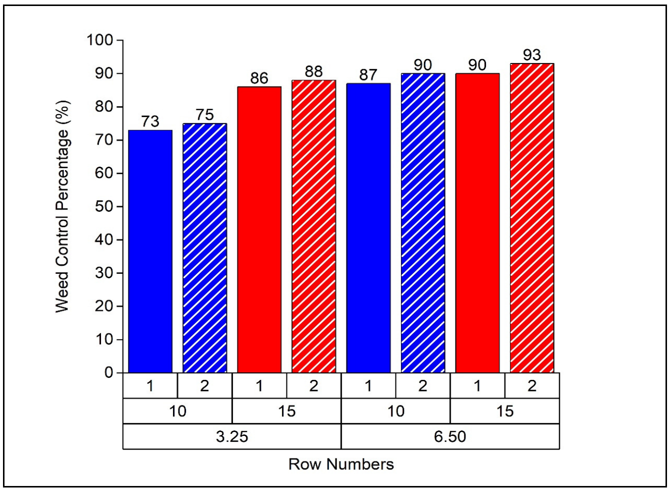

Fig. 5 : Weed control percentage (%)

Weed Inhibition Percentage (%)

The traveling speed had a significant effect [$F(1,16)$, $p = 0.03$)] on the weed inhibition percentage where the 6.5-km.h^{-1} speed achieved higher weed inhibition percentage. Similarly, the cultivation depth had a significant effect [$F(1,16)$, $p = 0.003$)] on the inhibition percentage where 15-cm cultivation depth achieved higher inhibition percentage. The number of passes per line did not show a significant effect on the weed inhibition percentage.

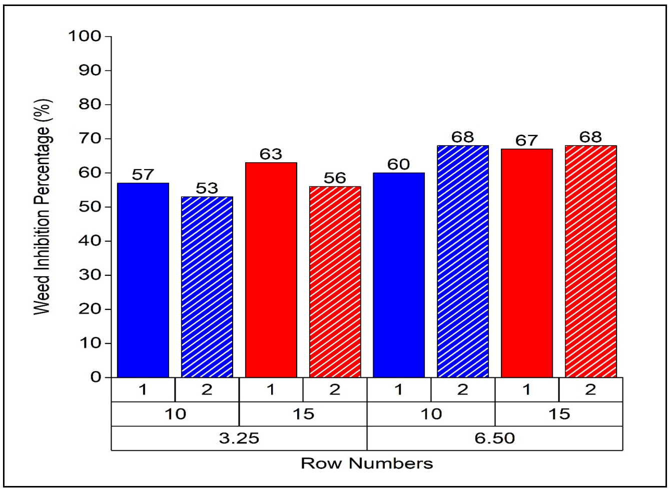

Fig. 6 : Weed inhibition percentage (%)

Conclusions

- From this study, we can conclude that using the spring – loaded cultivator for weed control can be achieved using speed of 6.5 km/hr. with cultivation depth 15 cm and one pass per line.
- Additional research is needed to investigate the incorporation of weed cultivation frequency and timing on weed control.

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