J. Agric. Sci. Mansoura Univ., 33 (9): 6561 - 6576, 2008

EVALUATION PERFORMANCE OF INTER-ROW CULTIVATION SYSTEMS USING A LOCALLY CONSTRUCTED AND MODIFIED HIGH CLEARANCE TRACTOR PROTOTYPE

El-Shaikha,M.A.[1]; M.M.Abo-Habaga[1];H.El.Abd-Alla[1];M. A. Mostafa[1] and W. F. A. El-Metwally[2]

1- Agric., Eng., Faculty of Agric, Mansoura University.

2- Rice Mechanization Center, Kafr El-Sheikh.

ABSTRACT

The main objective of this study is to evaluate and quantify the relative effectiveness of the different mechanical inter-row cultivation systems using the modified high clearance tractor prototype with inter-row cultivator. To achieve the objective of this study, the field performance configurations of eight different cultivation systems for inter-row cultivator, were prepared using three shapes of cultivation tools (blades), namely; shovel blade, sweep blade and ridger, each shape was provided with tow different sizes called a_1,a_2 for shovel blade shape, b_1,b_2 for sweep blade shape and c_1,c_2 for ridger shape. Four different levels of cultivation speeds namely; 5.11, 6.23, 7.09 and 8.16 km/h were used to evaluated the performance of the cultivation systems under study. The field tests was conducted at research farm of Rice Mechanization Center, Agric. Eng. Res. Institute, Kafr El-Sheikh Governorate, during corn crop growing seasons 2007 and 2008. From the obtained results it was concluded:

At a given cultivation speed of 5.11 km/h the maximum values of damaged corn plants percentage of 3.91 and 4.08 % obtained with sys 7 and sys 8, respectively. While the minimum values of damaged corn plants percentage of 3.45 and 5.56 % were obtained with sys1 and sys 2, respectively. The increment percentage in the weeding efficiency for any given inter–row cultivation systems was ranged from 2.4 % to 3.9 %, from 2.6 % to 4.7 % , and from 3.2 % to 4.3 % by increasing forward speeds from 5.11 to 6.23 km/h, from 6.23 to 7.09 km/h and from 7.09 to 8.16 km/h, respectively. The maximum values of field capacity of 1.84, 1.94, 2.00 and 2.05 fed/h were obtained for cultivation system 1 compared with 1.81, 1.92, 1.97 and 2.00 fed/h due to using cultivation system 8 at different levels of forward speeds of 5.11, 6.23, 7.09 and 8.16 km/h respectively. It could be observed that increasing forward speed the values of the total draft power and total energy requirement of each inter-row cultivation system was increased.

INTRODUCTION

Mechanical weed control allows farmers to reduce or even eliminate herbicide use, and contribute to a better environment. Mechanical weeding is not widely use in Egypt while hand tools still providing a satisfactory weed control.

Klooster (1982) reported that the inter-row implements have been designed that control weeds within the crop row by directing soil along the row to cover small weeds. The mechanical weed control is one tool in an integrated weed management system. Weeding is an important agricultural unit operation. Delay and negligence in weeding operation affect the crop yield up to 30 to 60 percent (Duane *et al.*, 1999).

Pullen and Cowell (1997) reviewed the merits of six different mechanical weeding mechanisms, and quantified their performance in controlling inter-row weeds at different growth stages and at different tractor speeds. Weed control was not necessarily better at earlier weed stages and weeding too early often missed late germinating weeds. Increasing forward speed did not improve the performance of all the implements equally. Mbanje et al. (2001) evaluated the animal drawn weeders with ducks foot tines are best for light soils but difficult to control on heavier soils where reversible tines should be used. The energy required to pull a weeder depended on the tool used, the width and depth of soil disturbance but all were within the draught power capacity of oxen. They recommended that the cultivation pattern of operation should avoid sharp turns on the headlands and should allow time for cultivated rows to dry out a certain extent before the draft animals trample the soil on the subsequent runs. A recommended pattern is to move along alternate sets of five rows, starting at one side of the field and continuing to the other side.

Mechanical weeders range from basic hand tools to sophisticated tractor driven or self-propelled devices. Tractor implements may include cultivating tools such as hoes, harrows, tines and brush weeders, cutting tools like mowers and strimmers, as well as implements like thistle-bars that can do both. Some implements are front-mounted, whilst others are rear-mounted or carried on specific tool bars. Some of the rear-mounted machines, may require a second operator to steer as close to the crop rows as possible, others have computer controlled vision guidance systems that adjust the steering automatically(Anon, 2003).

Terpstra and Kouwenhoven (1981) found that in the path of the hoe , weeds were uprooted, 57 percent being killed by incorporation in the soil and 33 percent by desiccation on the surface. The effect of wetting after cultivation was to decrease the number of weeds killed from 90 to 78 percent. Soil cover of 15 mm depth killed small weeds and a covering of 20 mm killed larger plants. Increasing the working depth from 25 to 40 mm gave only a small increase in the number of weeds killed. At high speeds the depth of soil cover increased, improving the weed kill. Tractor speed at different stages of crop and weed development is important for weed control but the effect may be influenced by other factors. Good weed control was obtained by harrowing at 5 km/h but the direction of harrowing did not matter. Harrowing depth was important in maintaining good weed control at later crop stages. At the 3-leaf crop stage, harrowing at 2 or 4 cm depth gave a 40 and 60% reduction in weed biomass respectively. Late harrowing at 2 or 4 cm deep at the 6-leaf crop stage gave a 30 and 40% reduction in weed biomass respectively (Rydberg, 1995).

Jones *et al.*, (1996) found that burial to 1 cm depth was the most effective treatment, closely followed by cutting at the soil surface. Plants need to be buried totally to be controlled but plant size, angle and growth habit influence the depth of covering required. Bowman (1997) indicated that the main control actions of the cultivation machines are cutting and burial. There are different types of blades available and various mounting methods. They cut weeds off at the root and are effective against tap-rooted weeds. If the hoe operates too deeply, established fibrous rooted weeds may re-grow in moist soil. Increasing the working depth has been shown to do little to improve weed kill, but higher forward speed increases soil covering of weeds and reduces survival. Some weeds are uprooted while others are buried. Increasing the working depth does little to improve weed kill, but higher forward speed increases soil covering of weeds and reduces survival (Pullen and Cowell, 1997). For the destruction of re-growth and weeds, fit the cultivator with duckfoot. To break down large clods and furrow slices, fit the cultivator with reversible tines and attack the clods while the soil is still moist. Increasing the working depth from 10 to 30 mm doubled the number of uprooted plants. However, the impact of uprooting has been shown to cause higher mortality than soil covering in weeds harrowed at or 3-4 days after emergence. Increased working depth and forward speed in a drier soil give increased soil covering (Kurstjens, 2002).

Demes *et al* (1990) mentioned that a high clearance tractor was developed for multi uses such as chemical weed control, spraying, leaf fertilizing of high crops using a spraying/spreading frame of 18 m width; injection of liquid nitrogen into the soil simultaneously with inter-row cultivation; inter-row spraying of high crops and liquid nitrogen fertilizer distribution on the soil surface, using an inter-row sprayer and cutting out of male row hybrid maize using a row cutter mechanism. Lara-Lopez (1996) indicated that the using of high clearance tractor in field operations include primary and secondary tillage, planting, row crop cultivation, spraying and local transportation. The tractor was primarily designed for primary tillage and cultivation on the row crops such as corn and sorghum.

Pullen (1999) reported that hoe weeders such as the sweep and the duckfoot are used only to control weeds in the inter-row space. The sweep are mainly 'A' or 'L' shaped when viewed in plan and has been used to control the weeds by cutting their roots just below the surface. The operating depth is normally about 25 mm. The duckfoot share may be mounted on individual parallelogram linkages or fitted to individual spring tines. They work deeper, are more aggressive and cause more soil disturbance than the sweeps and are not suitable for narrow row widths. Alexandrou, et al. (2001) evaluated four different weeding mechanisms on the corn and soybean fields for weed control at three growth stages, between and within rows, at two different speeds. Canola was chosen as the weed and cultivation took place at 2-leaf, 5-leaf and 8-leaf stage of growth. Their results indicated that, sweep and row cultivators were the most effective in reducing the number weed plants between rows. Ridger sweeps is usually considered a primary tillage operation for ridging or re-ridging rows, it is also widely used for weed control. The ridger destroys weeds mainly by covering them with soil. It also has a pulling effect at the place where the share cuts the soil in the furrow. When the ridger is being used for weeding it should operate at a shallower depth than when it is being used for primary tillage. If the crop is still small, the ridger has to operate at a very shallow depth to avoid covering the plants (Walsh *et al.* 2002).

MATERIALS AND METHODS

The main objective of this study is to evaluate and quantify the relative effectiveness of the different mechanical inter-row cultivation systems using the modified high clearance tractor prototype with inter-row cultivator. The modified high clearance tractor prototype was locally modified, constructed, and tested in workshop of Rice Mechanization Center (RMC), Agric. Eng. Res. Institute during 2007 and 2008 years.

High clearance tractor prototype and inter-row cultivator

The modified high clearance tractor prototype was constricted and fabricated to suit inter-row crop cultivator mounting or other post growing practice machine in addition to use it as well as a self propelled sprayer in separate operation or in combination with cultivation operation. The main components of the modified high clearance tractor are shown in Fig. (1).

The main frame was made from steel beam with vertical clearance of 910 mm from the ground surface to allow grown plants for passing smoothly during moving the tractor above it with a minimum damage of plants and carry tractor engine and other components of the tractor. The distance between the wheel tracks is flexible to allow adjusting it for running in a different row widths. The overall width, length and height of main frame is 225, 150 and 150 cm, respectively.

A Yanmar diesel engine, water cooled, 4-cycle, 3 cylinder diesel engine of 29 hp / 3000 rpm (21.36 kW) was used as a source of power. The engine was connected with HST (hydro-static transmission system) for transmitting power from engine to tractor wheels and PTO using. A mechanical steering unit was used in the front wheels to steer the tractor at road and field operations. The high clearance tractor was equipped with a modified hydraulic three-point lift system which consists of the upper link, the right and the left lower linkages to hitch the inter-row crop cultivator and other machines may be jointed with it.

The inter-row cultivator was used in the present study consists of frame, shanks and blades as shown in Fig (1). The frame of the cultivator was fabricated from squared section (6×6 cm) of steel beam with 240 cm length to carry out shanks and cultivation tools. It was equipped with three point hitching device to mount it with tractor. Three spring steel shanks with a squared cross section 2.5×2.5 cm were fixed with frame by steel clamp with two bolts for each. There are three different shapes and two sizes for each cultivation tool (blade) shape were used in this study with inter-row cultivator, namely; shovel, sweep and ridger shapes as indicated in Table (1).

1	Front wheel	8	Hydraulic piston
2	engine	9	Upper link
3	Steering wheel	10	Shank
4	Driver seat	11	rear wheel
5	Fuel tank	12	Cultivation tool
6	Sprocket and chain	13	Cultivator frame
7	Upper hitch point		

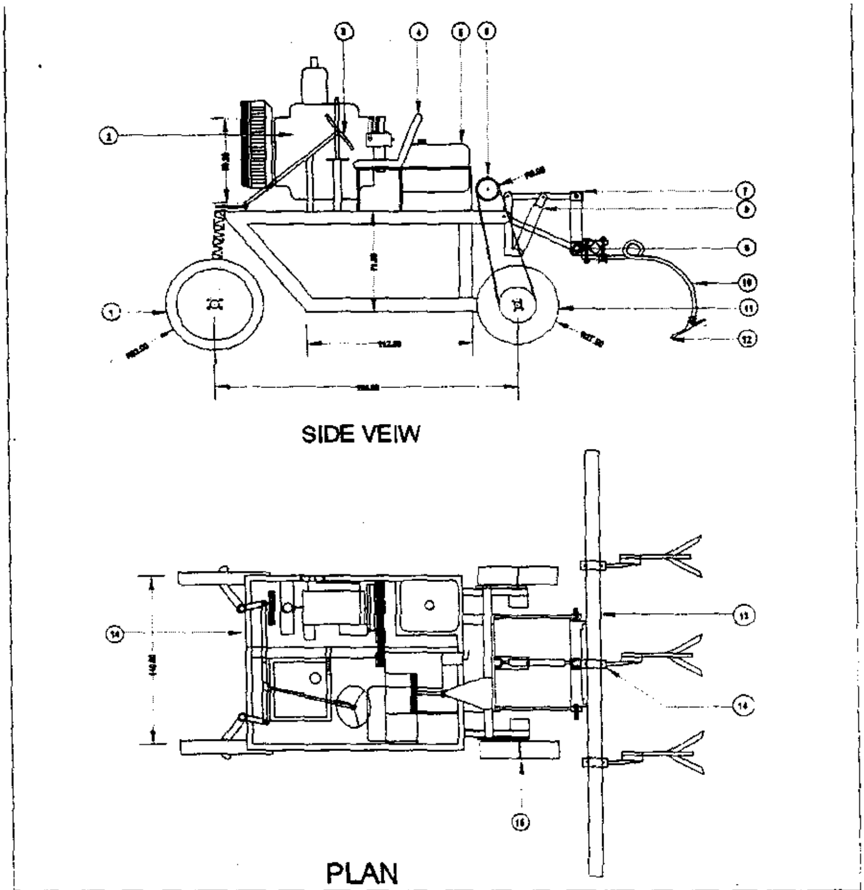


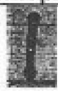
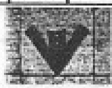
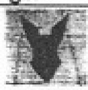
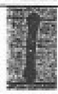
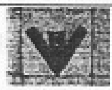
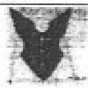
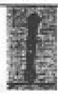
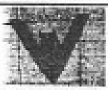
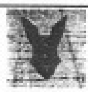
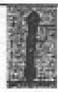
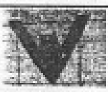
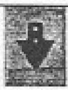
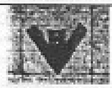
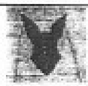
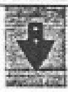
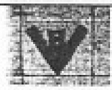
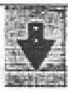
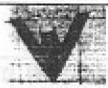
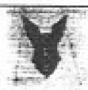
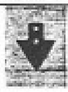
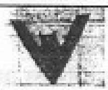
Fig. (1): **Side view and plan of the modified tractor mounting inter row cultivator.**

Experimental variables and procedure

The experimental work was carried out at research farm of Rice Mechanization Center, Agric. Eng. Res. Institute, Kafr El-Sheikh Governorate, during corn crop growing seasons 2007 and 2008. The experimental area about 3 feddans were good seedbed prepared and precise planting of corn crop to provide uniform test conditions for successful inter-row cultivation. The corn seeds were planted on row spacing of 70 cm on flat soil without ridge forming between rows.

To achieve the objective of this study, eight different inter-row cultivation systems were prepared using three shapes of cultivation tools (blades), namely shovel blade, sweep blade and ridger. Each shape was provided with two different sizes called a_1, a_2 for shovel blade shape, b_1,b_2 for sweep blade shape and c_1,c_2 for ridger shape as shown in Table (1).

Table (1): The soil moisture content, plant characteristic at different cultivation stages and the combination of cultivation blade shapes and sizes were used in the suggested eight inter-row cultivation systems.

Growing stage	1st stage	2nd stage	3rd stage
Plant age, day	14	21	28
Plant height, cm	12.15	21.13	47.5
Stem diameter, cm	0.59	1.03	1.41
Soil moisture content, %	31.53	25.34	20.15
Blade shape	**Shovel shape**	**Sweep shape**	**Ridger**
Cultivation system 1	Size a_1 	Size b_1 	Size c_1 
Cultivation system 2	Size a_1 	Size b_1 	Size c_2 
Cultivation system 3	Size a_1 	Size b_2 	Size c_1 
Cultivation system 4	Size a_1 	Size b_2 	Size c_2 
Cultivation system 5	Size a_2 	Size b_1 	Size c_1 
Cultivation system 6	Size a_2 	Size b_1 	Size c_2 
Cultivation system 7	Size a_2 	Size b_2 	Size c_1 
Cultivation system 8	Size a_2 	Size b_2 	Size c_2 

The arrangement of different combination from blade shapes and sizes were done to suit corn plant characteristics in each growing stage of corn plants and soil moisture contents in the growing stage. Therefore, the shovel shape blade with its two sizes was used in first stage, while the sweep shape blade with its two sizes was used in the second stage. However the ridger shape with its two sizes was used in the third stage. Four different levels of cultivation speeds, namely: 5.11, 6.23, 7.09 and 8.16 km/h were used to evaluated the performance of the cultivation systems in this study.

Measurements

To evaluate the field performance of suggested eight different inter-row cultivation systems, different parameters like weeding efficiency, damaged plants %, field capacity and efficiency, total draft power consumption and total cultivation energy requirement for each cultivation system were measured

1- Weeding Efficiency

Weeding efficiency was determined by manually removing the weeds between the crop rows in an area of $1m^2$ on the experimental plots before and after cultivation operations. The collected weeds were counted and recorded. The process was repeated in 5 randomly selected locations for each cultivation system under study. The weeding efficiency (η_W) was determined from the following relation according to Olawale and Philip (2006):

$$\eta_W = \frac{W_1 - W_2}{W_1}$$

Where, η_W = weeding efficiency.

W_1 = total number of weeds present in between two crop rows in unit area before the cultivation operation.

W_2 = total number of weeds remaining immediately after the cultivation operation in the same area.

2- Damaged plants

The damaged plants due to mechanical cultivation were counted from some rows for a certain distance immediately after cultivation to determine the amount of damaged corn plants. The percentage of damaged corn plants was computed according Tiwari et al, (1993) by using the following equation:

$$D\,\% = \frac{P_t}{P_d} \times 100$$

Where, D = Damaged plants, % .

P_d = the total number of corn plants within an adjusted distance before cultivating operation;

P_t = the total number of injured plants immediately after cultivating operation within the same adjusted distance.

3- Cultivation draft force

A spring dynamometer was used to measure the cultivation draft force. It was calibrated before and after experiments. The modified high clearance tractor was attached with inter–row cultivator using the suggested eight different inter row cultivation systems to measure the total cultivation draft force. The modified high clearance tractor mounting cultivator was pulled (as a dummy machine) by a 38.5 kW auxiliary Yanmar tractor. Then the cultivation draft force was measured by a dynamometer. The average dynamometer readings were recorded at four different levels of forward speed. The total draft force was calculated for each cultivation system including draft forces for each component in the system.

4- Power Consumption and energy requirement

The total power consumed by each inter-row cultivation system under study was calculated as follows:

$$P_{cs} = (F \times V) / C$$

Where: P_{cs} = Power consumption (kW)

V = cultivation speed (km/h)

F = total cultivation draft force (kN)

C = constant (3.6)

The total energy required (E_R) for each inter-row cultivation system under study was estimated using the following equation:-

$$E_R = \frac{P_{cs}}{A_{fc}}$$

Where: E_R = total energy required (kW.h/fed)

A_{fc} = actual field capacity (fed/h)

5- Field Capacity and Efficiency

The theoretical, actual field capacities and efficiency of inter row cultivator for each cultivation system were calculating according to Kepner et al. (1986) method under different cultivation speeds in the study.

6- Soil analysis

The mechanical analysis of the experimental field were determined by taking random twenty samples at an average depth of soil layer 0–30 cm and mixed together. Soil mechanical analysis carried out at Soil Department, faculty of Agric., Kafr El-Sheikh University. The soil samples were analyzed according to the USDA method (Yong and Warkentin, 1975).

Clay %	Slit %	(Clay +Slit) %	Sand %	Caco3 %	Organic matter %	Soil type
53.32	17.63	70.95	29.05	1.3	1.71	Clay

RESULTS AND DISSCUTION

Damaged plants

The percentage of injured plants or damage corn plants occurred from cultivation operation during testing the of modified tractor with the inter-row cultivator system. It was calculated with respect to the number of undamaged plants within adjusted distance. The damage percentage was determined for each component of suggested inter-row cultivation systems and different forwarded speeds of 5.11, 6.23, 7.09 and 8.16 km/h .

The obtained results of the total damaged plants for each inter-row cultivation system was illustrated in Fig.(2) and indicated that, all cultivation systems under study resulted in different values of damaged plant percentage, however, this effect was differed according to the cultivation tool shape of each system and soil moisture content at the cultivation proceeding time in each stage of the cultivation system. It could be concluded that , the damaged and broken corn plants percentage was increased with heavier cultivation systems which contains cultivation tools of sweep b_2 , and ridger c_2 than other cultivation systems. At a given cultivation speed of 5.11 km/h the maximum values of damaged corn plants percentage of 3.91 and 4.08 % obtained with heavier cultivation systems of sys 7 and sys 8, respectively. While the minimum values of damaged corn plants percentage of 3.45 and 5.56 % were obtained with lighter cultivation systems of sys 1 and sys 2, respectively.

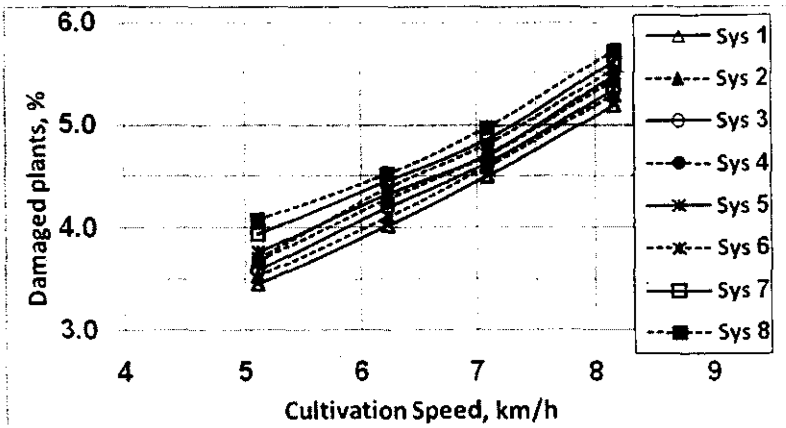


Fig. (2): Effect of different inter-cultivation system and forward speeds on the damaged corn plants.

Comparing the effect of the cultivation systems on the damaged plants percentage under different forward speeds of 5.11, 6.23, 7.09 and 8.16 km/h. It can be concluded that, increasing the forward speed increased the damaged plants percentage for any given cultivation system under study. Increasing forward speed form 5.11 to 6.23 km/h increased the damaged plants percentage by 10.78 % and 16.52 % for cultivation sys1 and cultivation sys8, respectively. While increasing forward speed from 6.23 to 7.09 km/h increased the injured plants percentage by 10.39 % and 11.44 % for cultivation sys1 and cultivation sys8, respectively, The corresponding increment rate of damaged plants percentage due to increased forward speed from 7.09 to 8.16 km/h were 15.33 % and 14.62 % for cultivation sys1 and cultivation sys8, respectively.

Therefore, it could be recommended that using any given inter-row cultivation system at any forward speed up to 7.09 km/h to avoid the increment rate in damaged plants percentage than 5 % as shown Fig.(3). The contribution effects of the cultivation tool shape and size for each component in inter-row cultivation systems on the damaged corn plants percentage was illustrated in Fig. (3) from the data shown in this figure it could be cleared that the cultivation blade shape of ridger (C) contribute with highest percentage on the total injured corn plants followed by cultivation blade shape of sweep (B) and cultivation blade shape of shovel (A) With respect to contribution effect the size of each cultivation blade shape, it could be noted that the small size of shovel (a_1), sweep (b_1) and ridger (c_1) gave the lower values of damaged plants percentage than that obtained with the sizes of shovel (a_2), sweep (b_2) and ridger (c_2) at any given forward speed under study. Also, in general the effect of each cultivation blade shape and size in suggested inter- row cultivation system under study on the damaged corn plants percentage was greatly influenced by the growing stage of corn crop and soil moisture content.

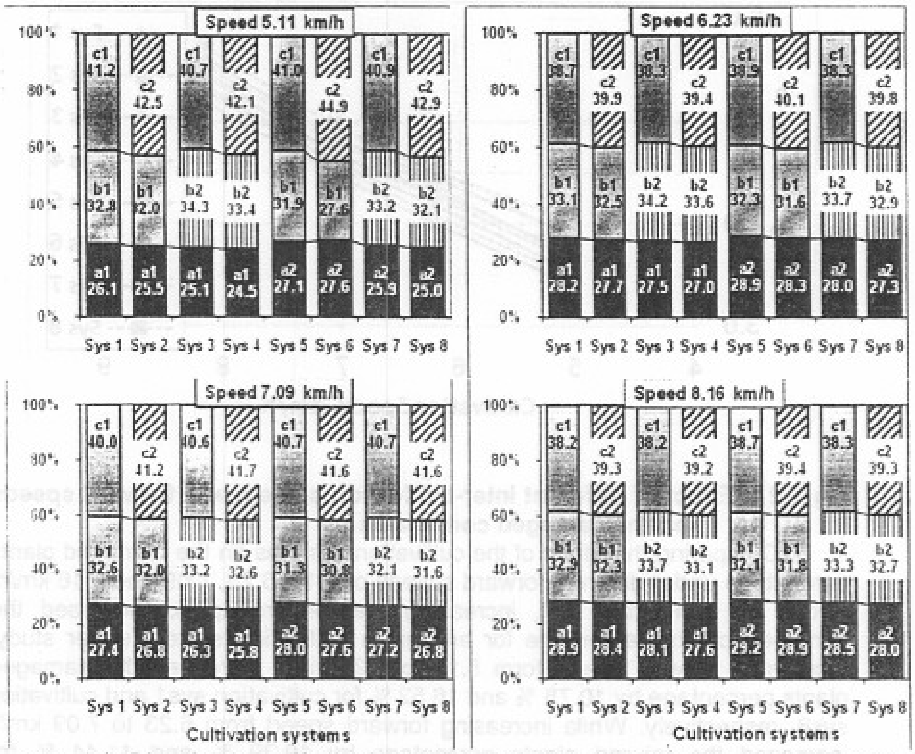


Fig. (3): Distribution effect of blade shape and size on the total damaged plants percentage for each cultivation system.

The average percentage values of the affects of cultivation blade shape and size of shovel (a_1 and a_2) were ranged from 26 % to 27 % compared with the total damaged corn plants percentage for each cultivation system at different levels of forward speed under study. However the average percentage values of the effects of cultivation blade shape and size of sweep (b_1 and b_2) were ranged from 31 % to 33% on the damaged corn plants from the total damaged plants percentage for each cultivation system. While the cultivation blade shape and size of ridger (c_1 and c_2) contributed 39-40 % from the total damaged corn plants for each inter row cultivation system at any given forward speed under study.

Weeding efficiency

The effects of the inter-row cultivation systems on the weeding efficiency between corn rows and within row under different forward speeds of 5.11, 6.23, 7.09 and 8.16 km/h was illustrated in Fig (4). The obtained results indicated that, the weed control efficiency differ significantly between the inter row cultivation systems at any given forward speed. It could be observed that, the highest values of the weeding efficiency were obtained with inter row cultivation system 8 followed by system 4, system6, system 2, system 7, system 3, system 5 and system 1 which gave the lowest values of weeding efficiency at any given forward speed under study. This result may be due to the different shape and size of cultivation tool for each cultivation system.

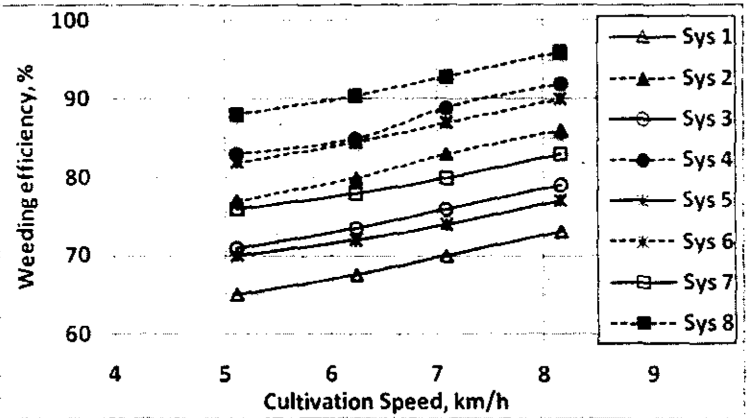


Fig. (4): Effect of different inter-row cultivation systems and forward speed on weeding efficiency.

With respect of the effect of forward speed on the weeding efficiency, it could be mentioned that, increasing forward speed improved the weeding efficiency of any given cultivation system. The increment percentage in the weeding efficiency for any given inter–row cultivation systems was ranged from 2.4 % to 3.9 %, from 2.6 % to 4.7 % , and from 3.2 % to 4.3 % by increasing forward speeds from 5.11 to 6.23 km/h, from 6.23 to 7.09 km/h and from 7.09 to 8.16 km/h, respectively. These results means that, high kills achieved at the higher forward speeds were because of the design of the rear blade , which threw the soil to cover all growth weeds within row.

Weeding efficiency of the sweep shape sizes was higher than that obtained with shovel shape, because the weeding control of the sweep shape was mainly achieved by cutting the weeds below the surface and gave shallow depth, however, the shovel shape gave higher soil throwing and uprooting weed which decreased the killing action of weeds. Same trend was happened with big size of shovel and sweep tool which gave higher weeding efficiency than obtained with small size of shovel and sweep tool.

The contribution values of the effect cultivation blade shape and size on weeding efficiency for any given of inter-row cultivation system at different levels of forward speeds are shown in Fig. (4). By using inter-row cultivation system 8, which contains shovel (a_2) + sweep (b_2) + ridger (c_2) in comparison with inter-row cultivation system1 which, contains shovel (a_1) + sweep (b_1) + ridger (c_1), it could be observed that the weeding efficiency was increased by 31% to 35% for a given levels of forward speeds. This increment percentage may be due to the big sizes of each cultivation blade shape which make it more aggressive effect on weeds than small sizes. In other words, weed control was mainly achieved by combination of big size of sweep (b_2) which caused uprooting and burial, in addition to the effect of the big size of ridger (c_2), where move the soil to cover most growing weeds between rows or within row. This action was less effective after using shovel shape size (a_1) and (a_2) than sweep shape size (b_1) and (b_2).

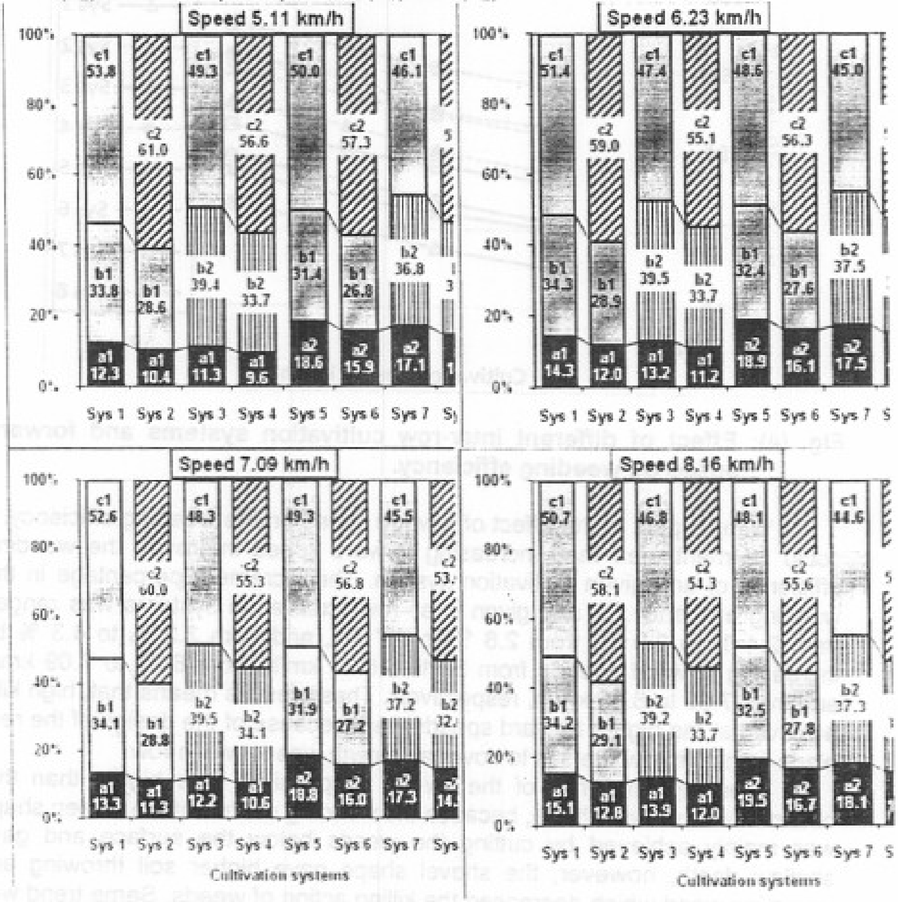


Fig. (5): Distribution effect of the cultivation tool shape and size on weeding efficiency for each cultivation systems.

A major advantage of the sweep shape was that soil disturbance caused by the blades was small , even at the high speeds. Thus the risk of it covering a crop, even on narrow row spacing would not be great. The ridger was more aggressive than the sweep because of the shape of the blade, where the weed control was achieved by a combination of uprooting and burial weeds. By increasing the forward speeds the action of all blades on weeding efficiency was increased. Possibility at the higher speeds there was more movement of the soil as it flowed increasing in affects of all blades to separate more weed plants.

Field capacity and efficiency

Field efficiency of any given inter-row cultivation system is the ratio of effective field capacity to theoretical field capacity expressed as percent. It includes the effects of time lost in the field and failure utilize the full width of the machine. The obtained data of actual field capacity and efficiency for inter-row cultivation systems under study at four different levels of forward speeds were plotted in Fig. (6). From these results it is clear that, by increasing forward speed the theoretical and actual field capacities increased, while the field efficiency decreased. These results may be due to the unproductive time (turning and adjusting time) which almost was similar in the theoretical and actual field capacities for both forward speeds were used. Generally , the values of actual field capacity for any given inter row cultivation system was increased by an average of about 5.4 %, 3.1 % and 2.5 % due to increasing forward speed from 5.11 to 6.23 km/h, from 6.23 to 7.09 km/h and from 7.09 to 8.16 km/h, respectively.

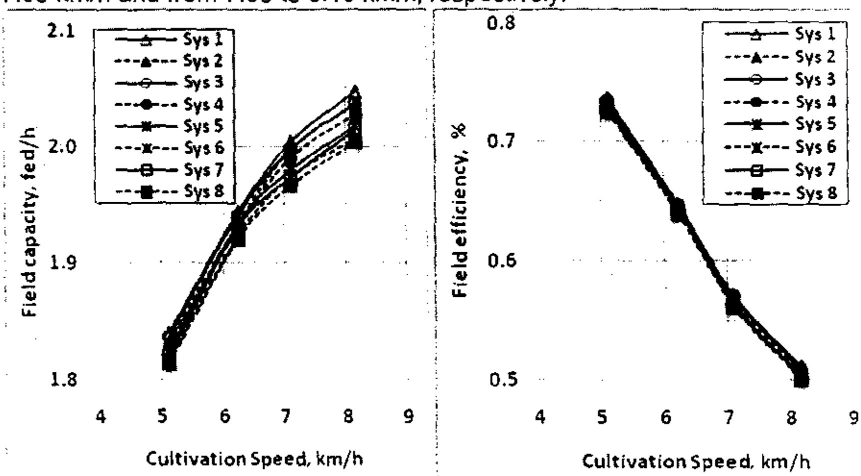


Fig. (6): Effect of forward speed on the field capacity and efficiency for different cultivation systems.

The maximum values of field capacity of 1.84, 1.94, 2.00 and 2.05 fed/h were obtained for cultivation system 1 compared with 1.81, 1.92, 1.97 and 2.00 fed/h due to using cultivation system 8 at different levels of forward speeds of 5.11, 6.23, 7.09 and 8.16 km/h respectively, The field efficiency was slightly affected with changing the combination of each inter row cultivation system and highly affected with forward speed increase. Similar trend was obtained for any given inter-row cultivation system under study .

By using the heavy cultivation tool such as sweep shape or ridger instead of lightly cultivation blade of shovel, the actual field capacity was decreased. Therefore, using the inter-row cultivation system 1 to system 4 resulted an slightly increment in field capacity than that obtained by using system 5 to system 8. This results may be due to increasing wheel slippage resulted from using heavy combination of inter-row cultivation system which decreased forward speed and consequently, increasing the actual cultivation time, therefore the actual field capacity was decreased. The obtained values of field capacity were ranged between 0.74, 0.65, 0.57 and 0.51 % for using inter row cultivation system1 compared with 0.73, 0.64, 0.56 and 0.50 % for using inter row cultivation system8 due to changing forward speed between 5.11, 6.23, 7.09 and 8.16 km/h, respectively.

Power Consumption and Energy Requirement

The total power consumed and energy required for different inter-row cultivation systems under study at different levels of forward speed were measured, calculated and plotted in Fig. (7). The obtained results indicated that the total draft power consumption and energy requirement were highly affected by using different shape and sizes of cultivation blades in each cultivation system. The values of total draft power and energy requirement were differed between cultivation system according to its combination. It could be observed that the highest values of total power consumption of 11.18, 13.1, 15.52 and 17.14 kW and total energy requirements of 6.11, 6.79, 7.8 and 8.46 kW.h/fed were obtained with inter-row combination system 4 followed by system 2, system 8, system 6, system 3, system7, system 1 and system 5 with respect of to the effect of forward speed on total draft power and total energy requirement,

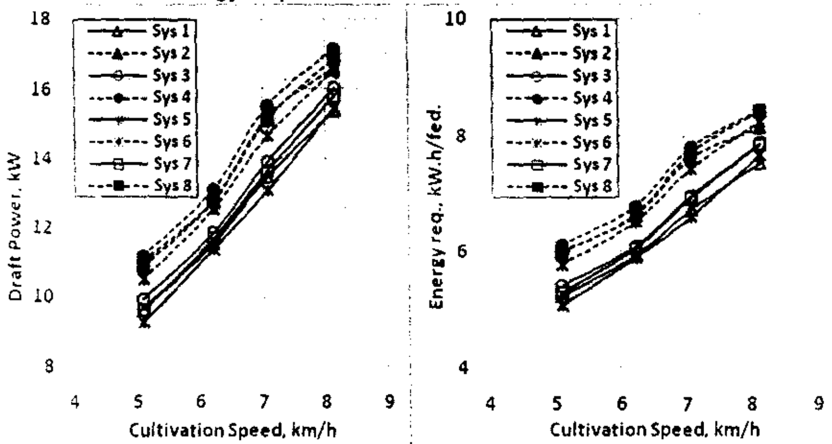


Fig. (7): **Effect of forward speed on the total power consumption and energy requirements for different cultivation systems.**

It could be observed that increasing forward speed the values of the total draft power and total energy requirement of each inter-row cultivation system was increased. However the increment rate due to increasing forward speed in the total power was higher than that obtained in the total energy requirement. Increasing forward speed from 5.11, to 6.23, 7.09 and 8.16 km/h increased the total draft power for cultivation system 4 by 17.2 %, 18,5 % and 10.4 %, respectively while the increment rate percentages in the total energy requirement were 11.1%, 14,9% and 8.5%, respectively. These results may be due to the effects of forward speed on the slippage and field capacity consequently, on the total energy. Also, from results illustrated in Fig (7) one can say the best inter-row cultivation system is that gave the lowest values of the total power and total energy requirement .

REFERANCES

Alexandrou A. and G.Coffing (2001) Mechanical weed control, tine weeder, row cultivator, rotary hoe, sweep cultivator, inter-row, intra-row, Published by the American Society of Agricultural and Biological Engineers, Paper number 011034,ASAE Annual Meeting

Anon (2003). Access all areas. Horticulture Week (June 26), 39-40.

Bowman G. (1997). Steel in the Field: A Farmer's Guide to Weed Management

Derres, G.; G. Dimitrievics; J. Huszar and L.Purak, (1990). High clearance sprayer for field crops Hungarian-Agricultural-Engineering. Vol.(3):23-2

Duane B; D. Alan and Z. Richard (1999). Mechanical Weed Control with a Harrow or Rotary Hoe North Dakota State University Agriculture and University Extension Morrill Hall,P.O.Box 5562,Fargo, ND 58105-5562

Jones P. A.; A. M. Blair and J. Orson (1996). Mechanical damage to kill weeds. Proceedings Second International Weed Control Congress, Copenhagen, Denmark, 949-954.

Kepner, R.A., R. Bainer and E.L.Barger (1986). Principles of farm machinery. 3rd ed. avi pub Co. west part, Connecticut. USA. P. 464 –468.

Klooster J. J. (1982). The role of soil tillage in weed control. Proceedings of the 9thConference of the Soil Tillage Research Organization. Institution of Agricultural Engineering, Wageningen, 256-261.

Kurstjens D. A. G. (2002). Study of the uprooting and soil covering processes and plant recovery from mechanical damage. PhD Thesis, Wageningen University, Wageningen, The Netherlands.

Lara-Lopez, A. (1996). Field evaluation of a high-clearance, two-wheeled tractor designed for local manufacture in Mexico. AMA,-Agricultural-Mechanization-in-Asia,-Africa-and-Latin America.vol.27(1): 59-62 Mark Hanna, Robert Hartzler, Kevin Paarlberg

Mbanje E., S. J. Twomlow and O'Neill (2001). Evaluation of animal-drawn weeders for smallholder maize production in Zimbabwe. Proceedings of the BCPC Conference - Weeds, Brighton, UK, 913-918.

Olawale J. O. and O. Philip (2006). Design of a row crop weeder. Conference on International Agricultural Research for Development, Univ. of Boon.

Pullen D (1999). Field work. Organic Farming, Issue 61 (Spring), 18-19.

Pullen, D. W. M. and P. A. Cowell (1997). An evaluation of the performance of mechanical weeding mechanisms for use in high speed inter-row weeding of arable crops. Journal of Agricultural Engineering Research 67, 27-34.

Rydberg, T. N. (1995). Weed harrowing in growing cereals – Significance of time of treatment, driving speed, harrowing direction and harrowing depth. Dissertation, Swedish University of Agricultural Sciences, Uppsala, 1995.

Terpstra, R. and J. K. Kouwenhoven (1981). Inter-row and intra weed control with a hoe ridger. Journal of Agri. Eng. Rese. 26, 127-134.

Tewari V.k., R.K. Datta and A.S.R. Murthy (1993). Performance of weeding blades of a manually operated push-pull weeder. J. Agric. Eng. Res. vol. 55 page 129-141.

Welsh J. P., N. Tillett, M. Home and J. A. King (2002). Inter-row hoeing and its associated agronomy in organic cereal and pulse crops – A review of knowledge.

Yong, R. N. and B. P. Warkentin , (1975). Soil properties and behavior. Elsevior Sci. Publ. Co. Amsterdam, 451 pp.

تقيم الأداء لنظم العزيق بين الخطوط باستخدام نموذج لجرار ذو خلوص أرضى عالي مطور محليا

محمد أحمد الشيخة[1]، مصطفى محمد أبوحباجة[1]،حسنى الشبراوى عبدالله[1]، محمد عبدالفتاح مصطفى[1] و وائل فتحي على محمد المتولى[2]

١- قسم الهندسة الزراعية – كلية الزراعة – جامعة المنصورة.

٢- مركز ميكنة الارز بميت الديبة– معهد بحوث الهندسة الزراعية

لقد أصبحت العمليات الزراعية التي تعتمد على العمالة اليدوية في حاجة ملحة إلى التطوير وإيجاد البدائل للأيدي العاملة والتي شهدت الفترة الأخيرة زيادة مطردة في أجور العمالة مما دعي المزارعين إلى البحث عن وسائل بديله لأداء العمليات الزراعية بتكلفة أقل. وتعتبر عملية العزيق من العمليات الزراعية ذات الأهمية لتأثيرها الشديد على إنتاجية المحصول فمازالت المنقرة و الفأس والمحراث الذي يجر بواسطة الحيوان من أهم الأدوات التي تستخدم في عمليات العزيق في مصر. أما عن الآلات الميكانيكية التي تستخدم لأداء هذة العملية في مصر فمحدودة الانتشار وكذلك التصنيع المحلى لها.

لذا أجريت هذه الدراسة لتطوير وتصنيع نموذج بحثي لجرار ذو خلوص أرضي عالي محليا يناسب احتياجات المزارع المصري في خدمة المحصول النامي من عزيق ورش وتسميد.......الخ. وتقييم أداءه وهو ملحق به العزاقة بين الخطوط من خلال تقييم ثماني أنظمة (توليفات) للعزيق الميكانيكي بين الخطوط والمكونة من ثلاثة مجموعات من الأسلحة (الحفارة ، المجنحة ، الفجاجة) ولكل مجموعة حجمين مختلفين لعزيق محصول الذرة مزروع في تربة مستوية السطح عند أربع مستويات من السرعة وهى ٥،١١ ، ٦،٢٣ ، ٧،٠٩ و٨،١٦ كم/ساعة وقد تم تطوير وتصنيع هذا الجرار ووحدة العزيق بين الخطوط بورش مركز ميكنة الأرز بميت الديبة – فرع معهد بحوث الهندسة الزراعية بكفر الشيخ خلال عامى ٢٠٠٧' ٢٠٠٨ بينما تمت التجارب والاختبارات بالمركز والمزرعة البحثية الملحقة به.

وقد كانت أهم النتائج التى تم الحصول عليها ما يلي:

١- كانت القيم العظمى لنسب النباتات التالفة من محصول الذرة عند السرعة ٥ كم / ساعة هى ٣،٩١% و٤،٨% للنظام رقم ٧ و ٨ من توليفة أسلحة العزيق على الترتيب بينما كانت القيم العظم لنسب النباتات التالفة من الذرة باستخدام النظام رقم ١و٢ من أسلحة العزيق كان٣،٤٥% و٥،٥٦% على الترتيب.

٢- ارتفعت نسبة الزيادة في كفاءة العزيق من ٢،٤ الى ٣،٩% و٢،٦ الى ٤،٧ % ومن ٣،٢ الى ٤،٣% على الترتيب نتيجة لزيادة سرعة العزيق من٥،١١ الى٦،٢٣كم/س ومن ٦،٢ إلى ٧،٠٩ كم/س ومن٧،٠٩ الى٨،١٦ كم/س على الترتيب.

٣- كانت القيم العظمى للسعة الحقلية باستخدام نظام العزيق ١ هي ١،٨٤و١،٩٤ و٢،٠٠ و٢،٠٥ فدان/ساعة ١،٨١ و ١،٩٢ و١،٩٧ و٢،٠٠ فدان/ساعة لنظام العزيق ٨ عند مستويات السرعة تحت الدراسة على الترتيب.

٤- قد تلاحظ أنة بزيادة سرعة التقدم تزداد قيم قوي الشد الكلية والطاقة المطلوبة للعزيق لكل نظم العزيق تحت التقيم.