Evaluation of rice transplanting machine to suit spraying for cotton crop

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ABSTRACT

The experiments were conducted at laboratory and research farm of Rice Mechanization Center, Meet El-Deeba, Kafe El-Sheikh Governorate during summer season 2005. The sprayer was tested at four different spray heights, four different spray pressures, three different orifice diameter and four different nozzle spaces.

The orifice diameter of 1.0 mm gave the lowest values of the coefficient of variation compared with the other diameters for all the spray heights and pressures. The minimum values of coefficient of variation were 38.64, 29.36, 22.08 and 13.20 % at spray heights of 400,500,600, and 700 mm, respectively, with spray pressure of 500 kPa and orifice diameter of 1.0 mm.

The maximum values of coefficient of uniformity were 75.78, 78.60 and 77.22 % at orifice diameters of 0.50,1.0, and 1.5 mm, respectively, with spray height of 700 mm and spray pressure of 500 kPa.

It is clear that the maximum values of coefficient of symmetry were obtained with the orifice diameter of 1.0 mm for all the spray heights and pressures. The highest values of coefficient of symmetry were 91.66, 93.16, 94.50and 95.50 % at spray heights of 400,500,600, and 700 mm, respectively, with spray pressure of 500 kPa and orifice diameter of 1.0 mm.

The maximum values of distribution characteristics were 82.0, 87.0, 93.0 and 95.0 % at spray heights of 400,500,600 and 700 mm, respectively, with pressure of 500 kPa and orifice diameter 1.0 mm.

The maximum values of coefficient of variation were 16.20, 11.76, 10.22 and 13.65 % at nozzle spaces of 300,400,500, and 600 mm, respectively, with spray height of 700 mm and pressure of 500 kPa.

The maximum values of coefficient of uniformity were 78.75, 83.15, 84.75 and 81.15 % with nozzle spaces of 300,400,500,and 600 mm, respectively, at spray height of 700 mm and spray pressure of 500 kPa. The maximum values of distribution characteristics were 91.66,

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94.60, 96.70 and 93.20 % at nozzle spaces of 300,400,500,and 600 mm, respectively, under the same conditions.

The results indicated that the total fixed costs were 12.29 LE/h and the total variable costs were 8.18, and 9.26 LE/h with forward speed of about 1.5, and 2.2 km/h, respectively. While the total costs for spraying operation was 20.45, and 21.56 LE/h (13.4 and 14.1 LE/fed) with the same above forward speeds.

INTRODUCTION

Spraying process and atomization of the liquids are considered the important means in agricultural utilization such as pest control, fertilization, and distribution of field substance. The farmers and growers turn to the application of pesticides to fight pests and weeds since they either feed on agricultural crops or act as vectors of disease and cause major losses of yield and quality.

In general, nozzles can be successfully used to atomizer most common types of liquids. However, nozzles have certain limitations when used to atomize certain materials such as high viscosity liquids, some emulsions and mixtures. Rotary atomizers can atomize these liquids.

Improving the spray distribution and deposition efficiency of spraying machines has been the goal of the present research. The results of the previous investigation showed that the uniformity of distribution (application) is affected by a host of factors such as spray pressure, height, droplet size, spray angle, the forward speed of the sprayer and characteristics of the spraying liquid. Therefore, the main objectives of the present study were:

Developed and evaluate of sprayer prototype using the power unit of the prime mover of Yanmar ARP-8 Rice Transplanter to meet the demands of small and medium farmers in Egypt to control weeds, insects and diseases for different crops.

Badawy (1997) studied the effect of nozzle pressure (103, 138, 207, and 276 kpa) and nozzle spacing 510 and 670 mm on distribution pattern and deposit efficiency with different types of nozzle. He added that, all nozzles tested had coefficients of variation lower than 15%. He found that the spray deposition increased by pressure increasing.

Abd El-Aty (1998) noticed that the orifice diameters of 0.57, 1.0 and 1.5 mm gave the following values of spray angle degree (rad): 121 (2.112), 134 (2.339) and 136 degree (2.374 rad), respectively, with spray height of 200 mm and spray pressure of 2000 kpa. The other spray heights and pressures have the same above – mentioned trend. It is obvious that the spray angle increased by 12.4% when the orifice diameter increasing from 0.57 to 1.5 mm at same variables.

Pergher *et al.* (1999) studied the effect of forward speed on deposition in an asparagus crop. They used two levels of forward speed, low (0.83 m/s) and high (1.69 m/s). They found that deposition was not affected by the forward speed relative to travel direction. The most uniform deposition was obtained with forward speed of 1.69 m/s.

El-Gendy (2000) developed a knapsack air carrier sprayer. The results illustrated that the modifying reduce the quantity of solution discharge per unit area from 120 L/fed to 63 L/fed with reduction ratio 48%. The results inconsequence reduces the environment pollution.

El-Metwally, (2001) manufacture a local self-propelled sprayer with cured and local ability for spraying insects and disease pest control. It suits for spraying crop and orchard fields. Field efficiency and the field productivity for the self-propelled sprayer at spray swath 4.8 m and speed 2.5 km/h were 70 %, 2 fed/h, respectively.

Webb, *et al.* (2002) indicated that increasing spraying speed is known to influence deposit distribution. They carried out a series of field and laboratory experiments to investigate the scale of this effect and some of the underlying mechanisms. Using a 24 m trailed sprayer, deposits on horizontal and vertical targets at ground level on a cut grass sward have been characterized for flat-fan and air –induction nozzles at forward speeds between 7 and 17 km/h with cross-winds between 1 and 6 m/s.

Gad, (2005) design and construct an automatic control boom sprayer device of spraying height above the plant surface. He found that the sprayer forward speed of 2.2km/h recorded the height percentages of mortality for all the spray angles, nozzle height and operating pressures. However, the percentage of mortality decreased by 6.03 % as a result to of increasing the forward speed from 2.20 to 5.89 km/h at spray angle of 65 deg (1.135 rad), nozzle height of 45 cm and operating pressure of 200 kpa.

El-Meseery and Abd-Fattah (2005) compared and evaluate two sprayers for controlling weed in wheat crop. The results indicated that the knapsack spryer

is better than Mist blower sprayer for weed control in wheat crop. The Knapsack sprayer gave an average deposit of 220droplet/cm^2 , 145 micron V.M.D., 82% uniformity, 85% weed control efficiency, 2.4 ton/fed. Wheat yield and 6 LE cost save comparing with the Mist blower. While the Mist blower gave average droplet of 150 deposit/cm^2 150 micron V.M.D., 40% uniformity, 77% weed control efficiency and 1.4 ton/fed wheat yield.

MATERIALS and METHODS

The main purpose of this study is to develop and evaluate of sprayer prototype using the power unit of the prime mover of Yanmar ARP-8 Rice Transplanter to meet the demands of small and medium farmers in Egypt to control weeds, insects and diseases for different crops. On the other hand, the use of a Rice Transplanter as a source of power. The oil pump for raising the seedling trays of transplanter up and down was used a source of power to operate spraying unit. However, the seedling trays of transplanter was separated and the transplanter equipped with pressure regulator which connected to hydraulic motor to convert the oil pressure into rotational movement to be suited for operating herbicide spraying pump was considered in the design of the proposed sprayer to realizing the goal of intensification use of farm machinery.

Materials:-

The materials and equipment used in this study may be indicated as follows: - **Modified sprayer unit:**

The spraying unit consists of frame, transmission power drive and shield as shown in Fig 1and 2 these components are explained as follows:

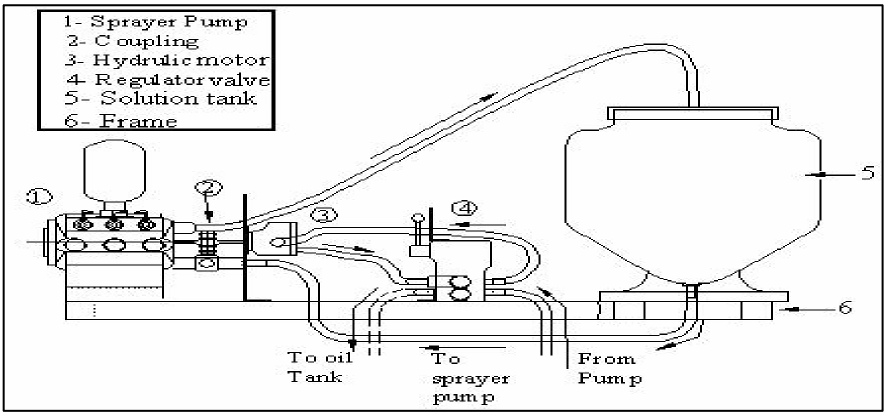


Fig. 1: The modified sprayer unit.

a)Frame sprayer u

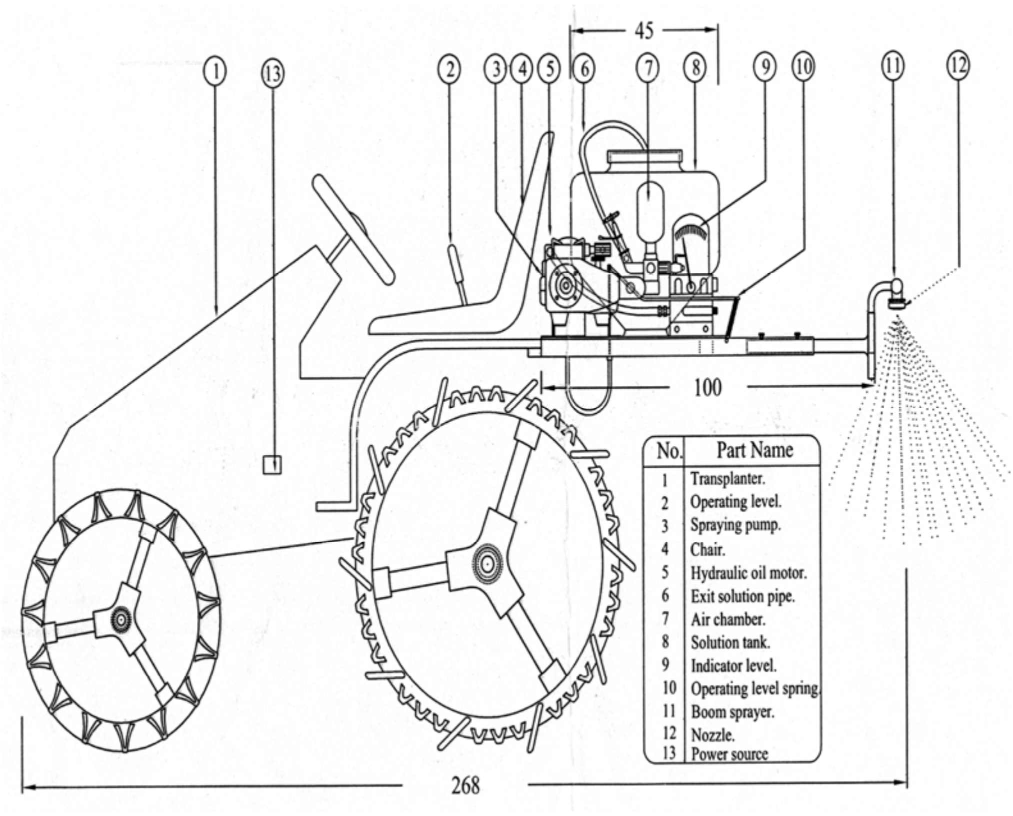
Argetnguler frame is made from steel angles section of 5 × 5 cm, thickness 0.3 cm and dimensions of 94, 50 cm, it is used as a frame for carrying the sprayer parts .

b) Transmission power drive:

The transplanter oil pump is used as a source of power to operate the spraying pump.

c) Sprayer liquid tank:

A corrosion-resis-tank of fiberglass was used to contain the spraying liquied,it has a large opening to allow easy filling plus a drain to construct cleaning. The tank capacity is about 100 liters. During dveloping and manfuctring the spraying unit it consider the simplisty and cheapness. It is simple in use, easy to assambling and easy to adjust. The discharge and nozzle spacing. Fabracting to machine and preliminary test wass carried out.



No.	Part Name
1	Transplanter.
2	Operating level.
3	Spraying pump.
4	Chair.
5	Hydraulic oil motor.
6	Exit solution pipe.
7	Air chamber.
8	Solution tank.
9	Indicator level.
10	Operating level spring
11	Boom sprayer.
12	Nozzle.
13	Power source

Fig. 3-1: The developed sprayer

d) Gear pumps

A gear pump is attached with the transplanter used to pumping the hydrulic oil to operate the gear motor.

e) Regulator (control) valve

A regulator valve is attached in the hydraulic circuit located between the hydraulic pump and hydraulic motor to regulated the oil pressure .

f) Gear motors

A gear motors fitted to the sprayer pump used as the power source. Oil under pressure flow inter the motor though the inlet, the oil then acts agents the fear wheels causing then to rotate thus turning the motor drive shaft. When the oil has spent its energy inturning the motor its discharged through the motor outlet and so back to tank.

g) Sprayer pump:

A three pistons pump is used to generate the pressure to the spring. It consists of 3 pistons, 3 cylinders, cylinder packing, delivery valves, connecting rode, crank, main shaft.

Methods and Measurements:

This research has been carried out in the laboratory of R.M.C., Meet El-Dyba, Kafr El-Sheikh, Governorate during season of 2005 to study the effect of nozzle height, nozzle pressure, orifice diameter, spacing nozzle and sprayer forward speed on the spray distribution pattern of the sprayer.

Tests were conducted at the following nozzle height of 400,500,600, and 700 mm, nozzle pressure of 200,300,400, and 500 kPa, orifice diameters of 0.50, 1.0, and 1.5 mm, spacing between nozzle on boom sprayer of 300, 400, 500, and 600 mm and two sprayer forward speeds of 1.5 and 2.2 km / h. All experiments were run by using water under room temperature and under approximately constant relative air humidity. The laboratory calibration tests includes determination of discharge rate, distribution pattern and spray deposition.

Measurement of distribution pattern:

The measurement of distribution patterns were carried out by using the spray table. Before starting the tests, the sprayer was adjusted at the required operation conditions. The sprayed water was collected in graduated tube for a period of 60 second. Each test was replicated three times. According to **(Ozkan et al.,1992)** the coefficient of variation indicates the uniformity of spray distribution. It is calculated between the center of nozzles across the boom. The standard deviation and coefficient of variation are expressed as follows:

$$\text{Standard deviation } (\sigma) = \sqrt{\frac{\sum\left(x_1 - x^{-}\right)^2}{n-1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where:

σ = Standard deviation

x_1 = Amount of spray deposited in cylinder(1) in spray swath.

x^{-} = Mean of spray of distribution across the spray swath.

n = Number of collector locations used.

$$C.V = \frac{\sigma}{x^{-}} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where:

C.V.= Coefficient of variation.

Spray deposit efficiency:

The spray efficiency was calculated as follow **(Badawy,1997);**

SDP(ή) = SPD / Q ………………………………...3

Where:

SPD = Amount of spray retained by plant (L / min).

Q = The amount applied per plant (L / min).

Q was calculated by using the following equation:

Q = 252 x q / b x v x n………………………..…..4

Where:

Q = Pump output, L / min,(Number of nozzle x nozzle through put, L/min,)

b = Swath width ,m.

v = forward speed, km/h, and

n = Number of plant.

Spray deposit uniformity (U):

Spray deposit uniformity was investigated by using the following equation **(Dragos, 1975).**

U = 100 – C.V, % ……………………......…..……5

Coefficient of symmetry:

The coefficient of symmetry **(C)** of spraying pattern were calculated according to the **(Sayed Ahmed, 1989):**

C = 1 – (ZR – ZL) / ZT, ……………..……………….6

Where :

ZR,ZL = Volume of spray collected from the right and left sides of the nozzle center line, L and

ZT = Total volume of spray collected from the bottles.

Calculating droplets numbers using microscope:

The conventional microscope was used to calculate droplet numbers on the water sensitive card for every treatment. S and St series of wide field droplet numbers that were taken from area of the field microscope were calculated for one cm^2.

Calculating the droplet surface mean diameter:

Droplet surface mean diameter **(DSMD)** is the mean of longitudinal and horizontal diameters of droplet. Micrometry slit was used to measure the longitudinal and lateral diameters of the spray droplets. Then the droplet surface mean diameter was calculated using the following equation:

$$\mathbf{DSMS = DX + DY / 2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where:

DX = The longest distance in the longitudinal direction (um)

DY = The longest distance in the lateral direction (um).

Field experiments:

Field capacity and efficiency:

The average operation speed, turning time, down time (solution preparation and filling of the sprayer) and spray width were determined during the experiment. The productivity (fed/h) and field efficiency was then calculated as follow:

$$\mathbf{Pt = S \times W, fed/h} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

Where:

Pt = Theoretical productivity,

S = Forward speed, and

W = Spray swath width.

The actual productivity (Pa) resulted from

$$\mathbf{Pa = A / T, fed/h} \ldots\ldots\ldots\ldots\ldots\ldots\ldots 9$$

Where:

A = Spray area, and

T = Actual time.

and field efficiency (E) resulted from

$$\mathbf{E = Pt / Pa \times 100, \%} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 10$$

Wheel sprayer slip percentage (S):

Wheel slip is one of the most important sources of soil and traction efficiency during machinery operation. Wheel slip changes as a function of tire conditions and wheel load soil.

$$\mathbf{S, \% = L - L1 / L \times 100} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 11$$

Where:

L = Distance spent without load, m, and
L1 = Distance spent with load, m.

Percentage of damaged plants (D.P.):

It was calculated after carrying out the field experiment for the sprayer. Under the field conditions, its concluded that the main waste plants occurred in the start and end of the spray trip.

Measurement of mortality percentage:-

The population of worms calculated and evaluated after spraying operation for forty cotton plants in each treatment. The number of dead and alive worms in each treatment were counted after 72 hour from the spraying operation. The mortality percentage was assessed and estimated for each treatment .

Power consumption, kW,(EP):

measuring the decrease in fuel level in the fuel tank using a graduated flask. The following formula was used to estimate the engine power.

$$\mathrm{EP} = \frac{\mathrm{Fc} \times \rho_{\mathrm{r}} \times \mathrm{L.C.V} \times 4270 \times \eta_{th} \times \eta_{m}}{3600}, \mathrm{kW} \text{ ------------------- } 12$$

Where:

Fc = Fuel consumption, L/h;
L.C.V = Lower calorific value of fuel (11030 kJ/kg for gasoline fuel);
p_f = Density of the fuel (0.73 kg/l for gasoline fuel);
4270 = Thermal-mechanical equivalent, kg.m/kcal;
$\acute{\eta}_{th}$ = Thermal efficiency of engine (35% for gasoline engine), and
$\acute{\eta}_{m}$ = Mechanical efficiency of engine (80% for gasoline engine).

Cost analysis:

The methodology of estimating spraying costs (LE/h) or (LE/fed) was as follow **(Hunt,1983).**

Total cost (LE/h) = Fixed cost (LE/h) + Variable cost (LE/h……..13

Total cost (LE/fed) = Total cost (LE/h) / Field capacity (fed/h……14

RESULTS and DISCUSSIONS

Effect of spray height, spray pressure and orifice diameter on the following indicators:

Coefficient of symmetry:

The best uniform of distribution pattern was obtained at the maximum values of the coefficient of symmetry.

Fig.3 demonstrates the effect of spray height, spray pressure and orifice diameter on the coefficient of symmetry of the distribution pattern. It can be noticed that the obtained values of coefficient of symmetry were found to be 91.66, 93.16, 94.50 and 95.50 % at spray heights of 400,500,600 and 700 mm, respectively, with spray pressure of 500 kPa and orifice diameter of 1.0 mm. The other spray pressures and orifice diameters have the same above mentioned trend.

It is clear that the spray pressures of 200,300,400 and 500 kPa gave the following values of coefficient of symmetry 83.63, 85.50, 87.71 and 90.00 %, respectively, at spray height of 400 mm and orifice diameter of 1.5 mm. The other spray heights and orifice diameters have the same above mentioned trend.

The orifice diameter of 0.50, 1.0 and 1.5 mm gave coefficient of symmetry values of 93.00, 95.50 and 93.62 %, respectively, at spray height of 700 mm and spray pressure of 500 kPa. The other spray heights and pressures have the same above mentioned trend.

Coefficient of uniformity:

The best uniform of the distribution pattern was obtained at the maximum values of coefficient of uniformity. Fig.4 indicated the effect of spray height, spray pressure and orifice diameter on the coefficient of uniformity of the distribution pattern. The spray heights of 400,500,600, and 700 mm gave coefficient of uniformity of 41.72, 50.11, 60.23 and 69.52 %, respectively; with spray pressure of 200 kPa and orifice diameter of 1.5 mm. The other spray pressures and orifice diameters have the same above mentioned trend.

The obtained values of coefficient of uniformity were found to be 68.11, 70.10, 73.30 and 75.78 % at spray pressures of 200,300,400 and 500 kPa, respectively, with spray height of 700 mm and orifice diameter of 0.50 mm. The other spray heights and orifice diameters have the same above mentioned trend.

It is noted that the orifice diameters of 0.50, 1.0 and 1.5 mm gave coefficient of uniformity of 61.61, 68.82 and 65.11 %, respectively, with spray height of 600 mm and spray pressure of 400 kPa. The other spray heights and spray pressures have the same above mentioned trend. However, the orifice diameter of 1.0 mm gave the maximum values of coefficient of uniformity compared with the other orifice diameters 0.57 and 1.5 mm for all the spray heights and pressures.

Spray droplets number using microscope:

Table 1 demonstrates the effect of spray pressure and orifice diameter on spray droplets at two different forward speed. The results indicated that increasing spray pressure increased spray droplet for both orifice diameter and forward speed. However, increasing orifice diameter decreased the spray droplet for two forward speeds with all spray pressure. It is noticed that the maximum values of droplet number were obtained with the orifice diameter 0.50 mm for all the spray pressure and forward speed. The data showed that the number of droplets on the upper surface of leaves was better than droplet numbers at lower surface.

Data presented in Table 2 show that the effect of forward speed and nozzle spacing on deposit (number of droplet /cm^2). The data showed that increasing the forward speed decreased number of droplet/cm^2 with different nozzle spacing. The data showed that the numbers of droplets on the upper surface of leaves was better than droplet numbers at lower surface. The nozzle spacing 300 mm and forward speed of 1.5 km/h gave the best droplet numbers (390 and 250 droplet/cm^2) at the upper and lower surface of leaves.

Droplets surface mean diameter (DSMD):

Droplet surface mean diameter is the longitudinal and lateral diameter of droplets. Micrometry slit was used to measure the lateral and longitudinal diameter of the spray droplets. Then the droplets mean diameter was calculated.

Droplet mean diameter is affected by spray pressure and orifice diameter at two forward speeds. Table 3 observed that the orifice diameter 0.50 mm gave lower droplet mean diameter than the other orifice diameter at various levels of spray pressure. This may be due to the flow rate of orifice diameter 0.50 mm less than the flow rate of the other orifice diameter.

The results in this Table 3 clarified that the lowest values of droplet mean diameter was (90 µm) by using spray pressure 200 kPa, orifice diameter 0.50 mm and forward speed 2.2 km/h. The highest values of droplet mean diameter were (250 µm) at spray pressure 200 kPa, orifice diameter 1.5 nn and forward speed 1.5 km/h.

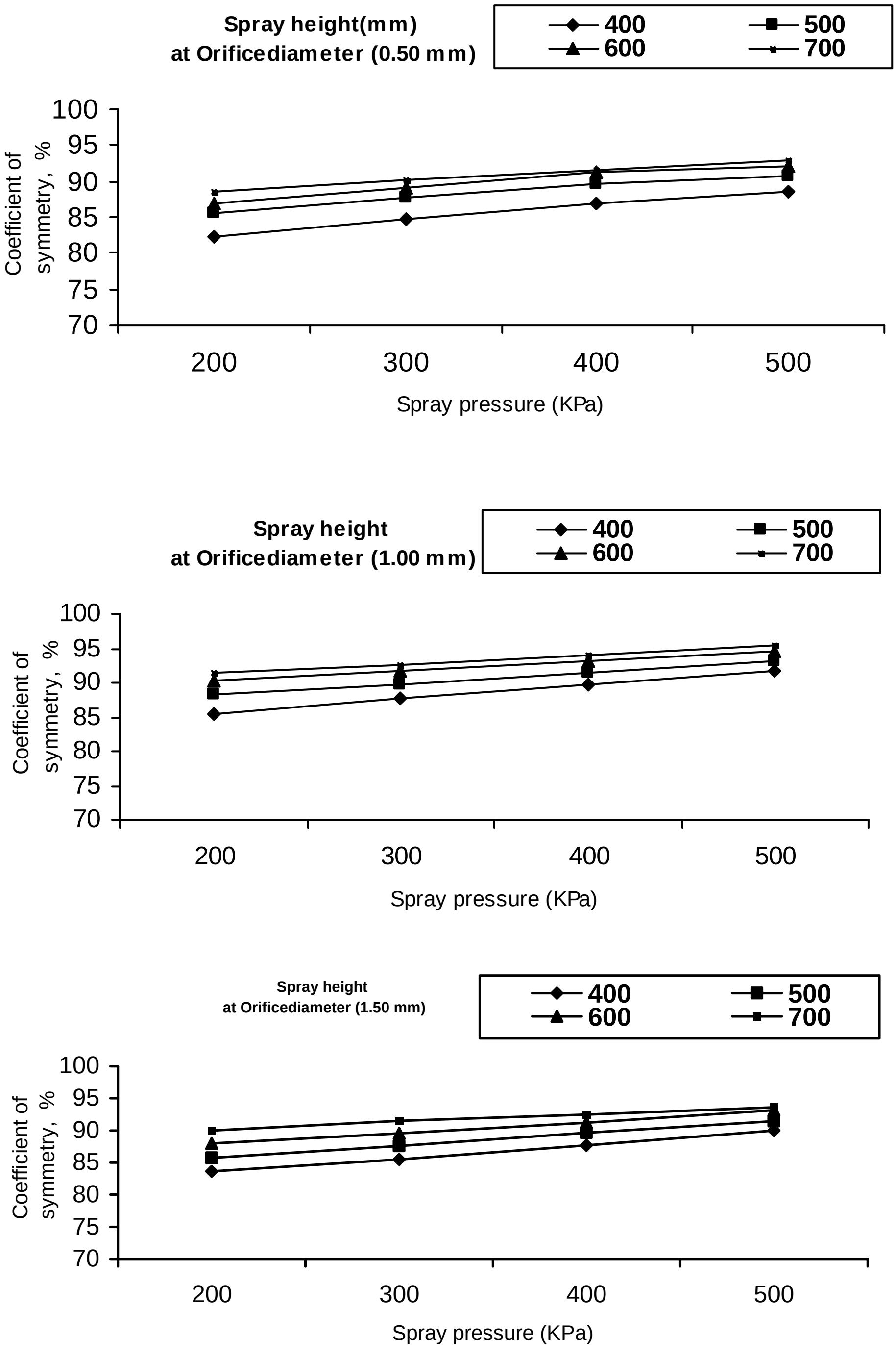


Fig. (3):-Effect of spray pressure, orifice diameter and spray height on the percentage of coefficient of symmetry at 500mm nozzle space.

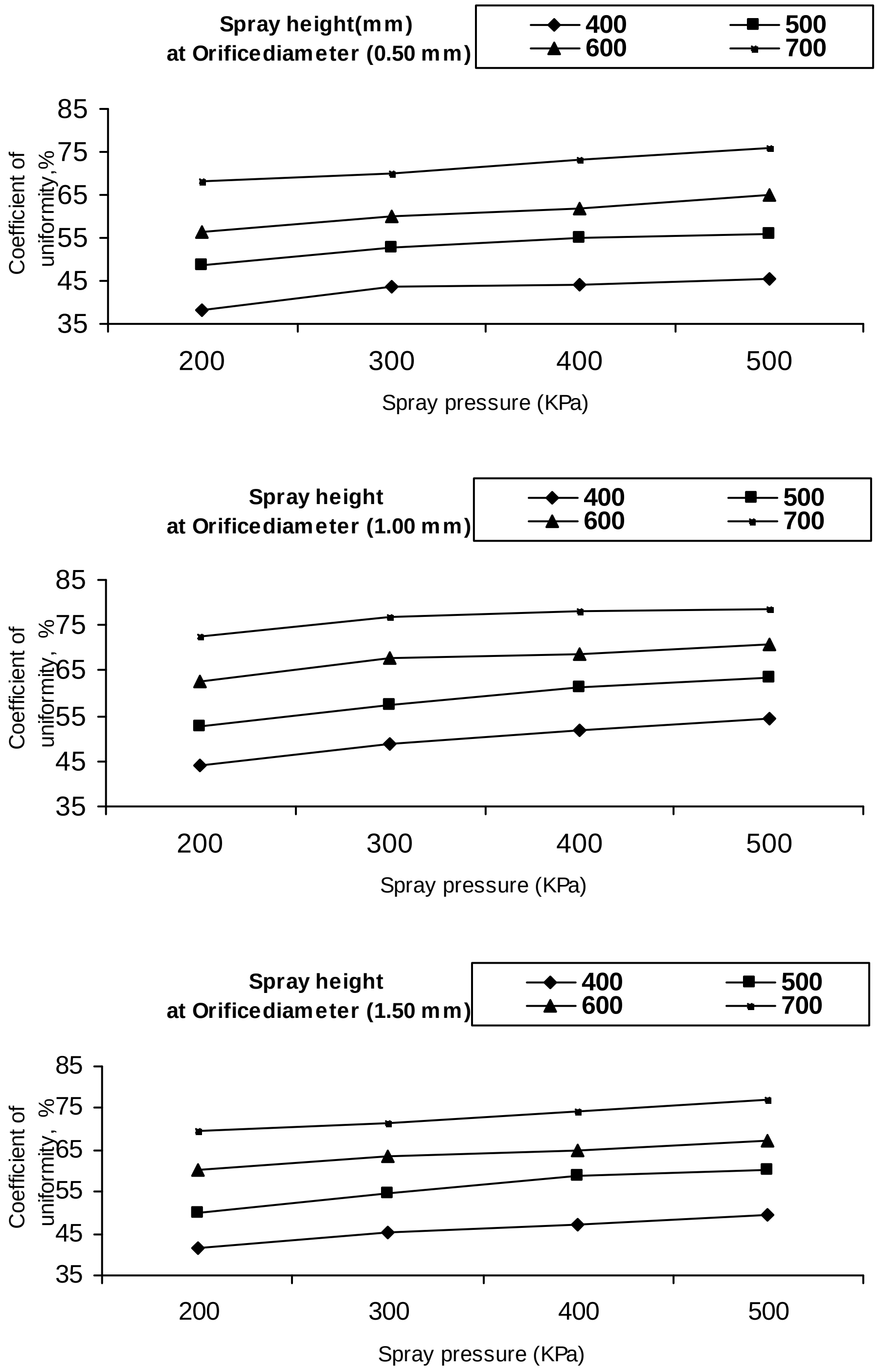


Fig. (4):-Effect of spray pressure, orifice diameter and spray height on the percentage of coefficient of uniformity at 500mm nozzle space.

Table 1: Effect of spray pressure and orifice diameter on spray droplets (droplets / cm^2) on upper and lower leaves surfaces at two forward speed.

Orifice diameter, (mm)	Spray pressure, (kPa)	Average spray droplets number /cm^2			
		1.5 km/h		2.2 km/h	
		Upper	Lower	Upper	Lower
0.50	200	430	205	400	190
	300	480	260	420	210
	400	530	310	435	240
	500	562	345	480	280
1.00	200	310	190	280	172
	300	340	205	305	189
	400	380	250	330	225
	500	405	290	370	260
1.50	200	270	150	230	110
	300	290	175	260	130
	400	330	195	292	157
	500	370	230	325	187

Table 2: Effect of nozzle spacing on spray droplets number (droplets/cm^2) on upper and lower leaves surface at two forward speeds.

Nozzle spacing, (mm)	Average spray droplets number / cm2			
	1.5 km/h		2.2 km/h	
	Upper	Lower	Upper	Lower
300	390	250	315	200
400	340	200	295	180
500	317	160	240	150
600	265	140	220	110

Percentage of damaged plants:-

To calculate the percentage of damaged plant after using the transplanter mounted sprayer. By increasing the machine forward speed from 1.5 to 2.2 km/h tends to increase the percentage of damaged plant from 0.87 % to 0.92%.

Table 3: Effect of orifice diameter and spray pressure on droplet mean diameter at two forward speeds.

Orifice diameter, (mm)	Spray pressure, (kPa)	Average of droplets surface mean diameter (µm)	
		Forward speed, km/h	
		1.5	2.2
0.50	22	190	172
	300	173	150
	400	150	115
	500	121	90
1.0	200	225	195
	300	200	155
	400	160	120
	500	130	95
1.5	200	250	210
	300	210	170
	400	180	130
	500	140	100

Mortality percentage:-

The fabricated prototype sprayer after development was tested in the field during the cotton spraying through determining the percentage of mortality.

The impact of sprayer forward speed, orifice diameter, nozzle height and operating pressure on the percentage of mortality were conducted during testing the field performance of the developed transplanter sprayer as shown in Figs. (5 and 6). However, the maximum percentages of mortality remark to increase the uniformity of the spray pattern.

It can be seen that increasing the forward speed tends to decrease the obtained percentages of mortality for all the other variables. The sprayer forward speed of 1.5 km/h recorded the highest percentage of mortality (98.6 %) for all the orifice diameter, nozzle height and operating pressures. The percentage of mortality decreased from 88.48 % to 81.40 % as a result of increasing the forward speed from 1.50 to 2.20 km/h at orifice diameter 0.50 mm, nozzle height of 400 mm and operating pressure of 200 kpa. This trend was due to the decrease of the uniformity of spray pattern with the high forward speeds.

The results indicated that the orifice diameter and operating pressure on the mortality efficiency under different levels of forward speed and nozzle height were shown in Figs. (5 and 6). It must be

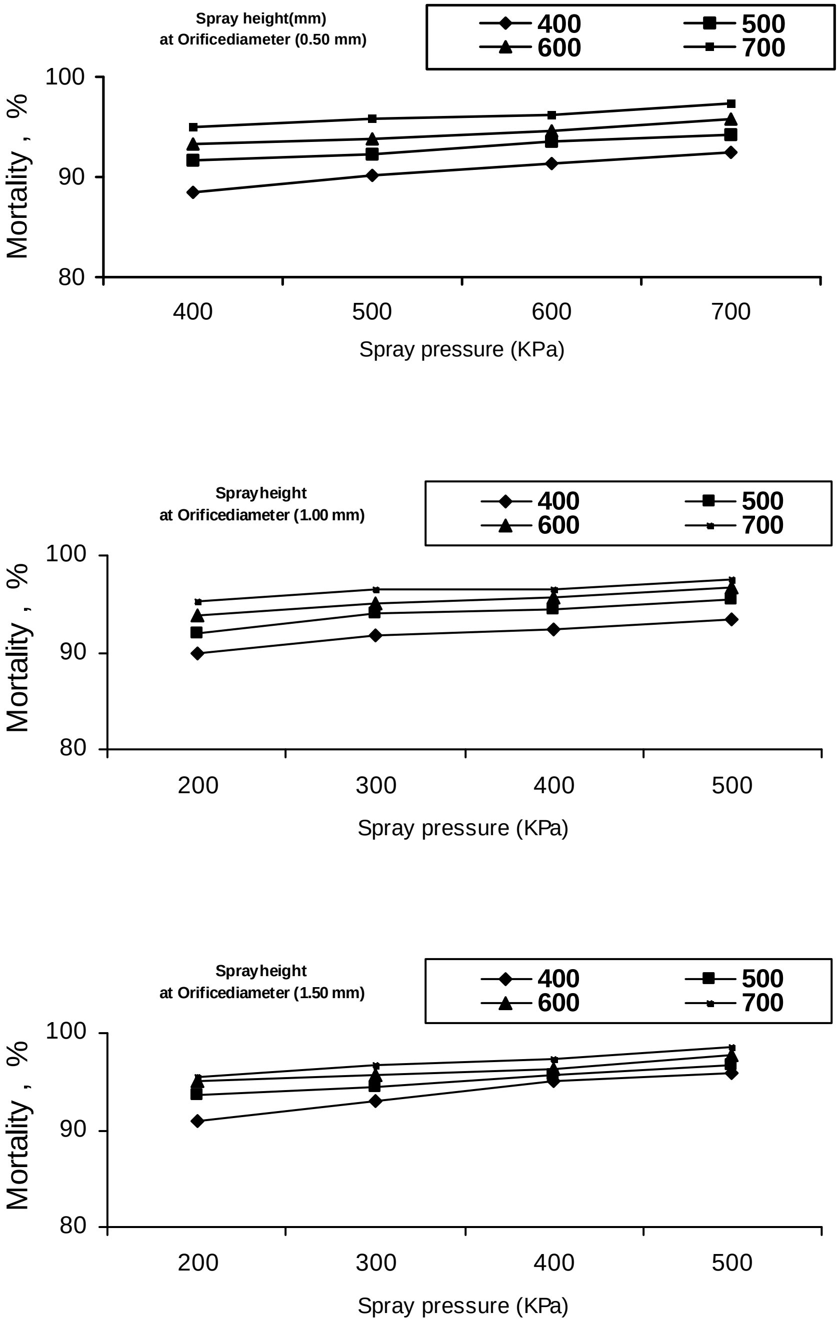
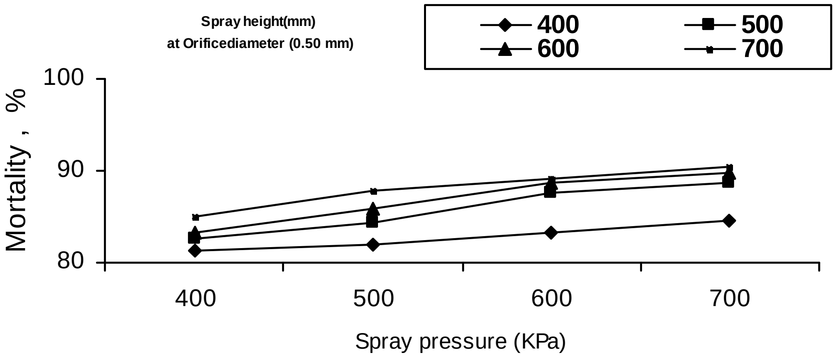
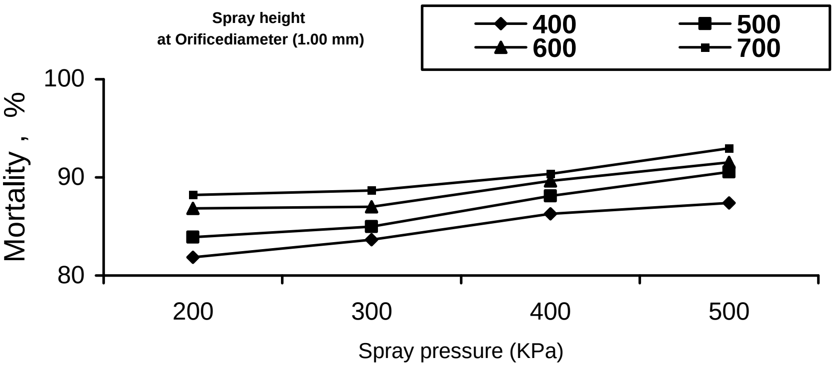


Fig. (5):- Effect of spray pressure, orifice diameter and spray height on the percentage of mortality at spray forward speed 1.5 Km/h.





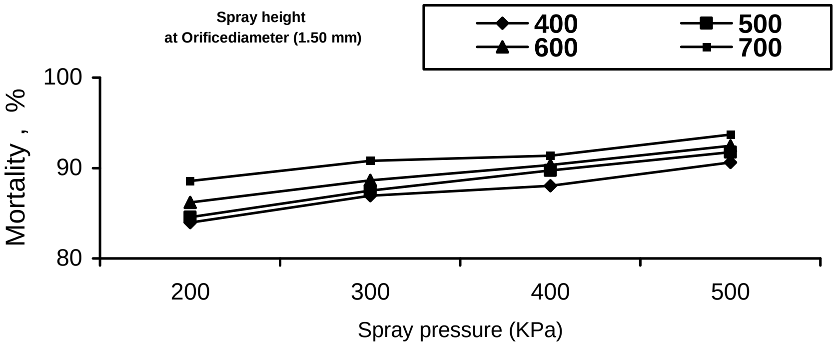


Fig. (6):- Effect of spray pressure, orifice diameter and spray height on the percentage of mortality at spray forward speed 2.2 Km/h.

mentioned that both orifice diameter and operating pressure have a considerable effect on the mortality percentage according the Figs. (5 and 6). For all the sprayer forward speeds and nozzle height, the increase of both the orifice diameter and operating pressure tended to increase the percentage of mortality for the sprayer. The mortality percentage increased from 92.45 % to 95.80 % when the orifice diameter was increased from 0.50 to 1.50 mm at forward speed of 1.50 km/h, operating pressure of 200 kpa and nozzle height of 700 mm. On the other hand, it increased from 92.45 % to 97.35 % when the operating pressure increased from 200 to 500 kpa at the same pervious variables with the orifice diameter of 0.50 mm.

However, the orifice diameter of 1.50 mm and operating pressure of 500 kpa achieved the maximum values of mortality percentage for all the forward speeds and nozzle heights.

The percentage of mortality increased from 88.48, 90.15, 91.33 and 92.45 % at nozzle heights of 400, 500, 600 and 700 mm, respectively, with forward speed of 1.50 km/h, orifice diameter of 0.50 mm and operating pressure 200 kpa

Field efficiency:

To calculate the field efficiency of the transplanter mounted sprayer the following steps were followed:

Forward speed = 2.2 km/h
Spraying swath = 4.5 m
Experimental plot area = (4.5 x 100) = 450 m^2
Application rate = 2.2 x 4.5 x1000 / 4200 = 2.36 fed/h
Actual time = $t_1 + t_2 + t_3$
t_1 = is the spraying time = 2.6 min t_2 = is the turning time = 0.60 min
t_3 = is the filling time = 0.80 min
Actual time = 2.6 + 0.6 + 0.8 = 4.0 min
Theoretical time = 2.6 min Field efficiency = 2.6 / 4.0 X 100 = 65 %

Then the field productivity = 2.2 X 4.5 X 1000 X 0.65 / 4200 = 1.53 fed/h Then the field productivity = 1.53 X 6 = 9.18 fed/day.

Slip ratio, (%):

By increasing spray speed from 1.5 to 2.2 km/h tends to increased the sprayer slip from 5.6 to 7.5 %. This agrees well with **(Kamel and El-khateeb, 2002).**

Energy requirements:

Effect of forward speed on power consumed. The results showed that the power consumed reached 4.75 and 7.50 kW at forward speeds of

1.5 and 2.2 km/h. This agrees well with the results of **(Kamel and El-khateeb, 2002).**

Cost analysis:

The results indicated that the total fixed costs were 12.29 LE/h and the total variable costs were 8.18, and 9.26 LE/h with forward speed of about 1.5, and 2.2 km/h, respectively. While the total costs for spraying operation was 20.45, and 21.56 LE/h(13.4 and 14.1 LE/fed) with the same above forward speeds.

Finally, the minimum values of variation of coefficient(13.20 %) and the maximum values of symmetry coefficient (95.50%) and coefficient of uniformity(78.60%) were obtained with orifice diameter of 1mm, spray pressure of 500 kPa and spray height of 700 mm.

Also, the sprayer machine with forward speed of 1.50 km/h, orifice diameter of 1.50 mm, nozzle height of 700 mm and operating pressure of 500 kPa achieved the maximum percentages of mortality percentage (98.6 %) , minimum plant damage (0.87%), energy requirements (4.75 kW) and total cost for spraying operation (13.4 LE/fed).

CONCLUSION

The study conducted to the following:

The maximum values of coefficient of uniformity were 75.78, 78.60 and 77.22 % at orifice diameters of 0.50,1.0, and 1.5 mm, respectively, with spray height of 700 mm and spray pressure of 500 kPa.

It is clear that the maximum values of coefficient of symmetry were obtained with the orifice diameter of 1.0 mm for all the spray heights and pressures. The highest values of coefficient of symmetry were 91.66, 93.16, 94.50and 95.50 % at spray heights of 400,500,600, and 700 mm, respectively, with spray pressure of 500 kPa and orifice diameter of 1.0 mm.

The maximum values of coefficient of uniformity were 78.75, 83.15, 84.75 and 81.15 % with nozzle spaces of 300,400,500,and 600 mm, respectively, at spray height of 700 mm and spray pressure of 500 kPa. The maximum values of distribution characteristics were 91.66, 94.60, 96.70 and 93.20 % at nozzle spaces of 300,400,500,and 600 mm, respectively, under the same conditions.

The sprayer forward speed of 1.50 km/h recorded the height percentage of mortality 98.6 % for all the orifice diameter, nozzle height and operating pressures. However, the percentage of mortality decreased from 97.35 to 90.40 % as a result to increasing the forward speed from 1.50 to 2.20 km/h at orifice diameter of 0.50 mm, nozzle height of 700 mm and operating pressure of 500 kpa.

The percentage of mortality increased from 91.90 to 95.48 % as a results of using the nozzle height of 400 to 700 mm at the forward speed of 1.50 km/h, orifice diameter of 1.0 mm and operating pressure of 300 kpa.

The results indicated that the total fixed costs were 12.29 LE/h and the total variable costs were 8.18, and 9.26 LE/h with forward speed of about 1.5, and 2.2 km/h, respectively. While the total costs for spraying operation was 20.45, and 21.56 LE/h (13.4 and 14.1 LE/fed) with the same above forward speeds.

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الملخص العربي

تقييم أله شتل الأرز لتناسب رش محصول القطن

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يتناول هذا البحث تطوير شتالة الأرز لتستخدم في رش المحاصيل الحقلية بهدف تحويلها لآلة متعددة الاستخدام بدلا من استخدامها في شتل الأرز فقط وبالتالي تزداد أهمية هذه الشتالات باستخدامها على مدار العام تصبح أكثر اقتصادي بالإضافة إلى تقليل تكاليف عملية الرش 0

تم تصنيع آلة رش صغيرة من خامات محليه محمولة على الشتالة لرش المبيدات في الحيازات الصغيرة.

الاختبارات تمت في المعمل والمزرعة البحثية لمركز ميكنة الأرز بميت الديبة – محافظة كفر الشيخ أثناء موسم صيف 2006م على محصول القطن صنف جيزة 68. الرشاشة اختبرت عند أربعة إرتفاعات للرش مختلفة وأربعة ضغوط للرش وثلاث أقطار للبشابير وأربعة مسافات بين البشابير على حامل البشابير.

وقد أسفرت النتائج عما يلى :-

تأثير ارتفاع الرش وقطر البشبورى وضغط المحلول على المؤشرات الآتية:-

نسبة معامل الانتظام :-

أعلى قيم لنسبة معامل الانتظام كانت 75,78 ، 78,60 ، 77,22 % عند قطر بشبورى 0,5 ، 1 ، 1,5 مم على الترتيب عند ارتفاع 700 مم وضغط رش 500 كيلو باسكال.

معامل التماثل :-

أعلى قيمة لمعامل التماثل نحصل عليها عند قطر بشبورى 1 مم عند كل الارتفاعات والضغوط. أعلى قيم لمعامل التماثل كانت 91,66 ، 93,16 ، 50, 94 ، 95,50% عند الارتفاعات 400 ، 500 ، 600 ، 700 مم على الترتيب مع قطر بشبورى 1 مم وضغط رش 500 كيلو باسكال.

تأثير المسافة بين البشابير على المؤشرات الآتية :-

نسبتي معامل الانتظام وخصائص التوزيع :-

أعلى قيم لنسبة معامل الانتظام كانت 78,75 ، 83,15 ، 84,75 ، 81,15 % عند المسافة بين البشابير 300 ، 400 ، 500 ، 600 مم عند ارتفاع 700 مم وضغط رش 500 كيلو باسكال.

أعلى قيمة لنسبة خصائص التوزيع كانت 91,66 ، 94,60 ، 96,70 ، 93,20% عند المسافة بين البشابير 300 ، 400 ، 500 ، 600 مم على الترتيب تحت نفس الظروف.

نسبة الوفيات :-

1. السرعة 1,5 كم / ساعة سجلت أعلى نسبة للوفيات 98,6 % عند كل أقطار البشابير وارتفاع البشابير وضغوط التشغيل. على اى حال نسبة الوفيات نقصت من 35 ,97 إلى 90,4

1- أستاذ الهندسة الزراعية – كلية الزراعة – جامعة الازهر
2- رئيس بحوث – معهد بحوث الهندسة الزراعية
3- باحث مساعد - معهد بحوث الهندسة الزراعية

% لما زادت السرعة الأمامية من 1,5 - 2,2 كم / ساعة عند قطر بشبورى 0,5 مم وارتفاع البشابير 700 مم وضغط الرش 500 كيلو باسكال.

2. نسبة الوفيات زادت من 91,9 إلى 95,48 % عند زيادة ارتفاع الرش من 400 إلى 700 مم عند سرعة أمامية 1,5 كم / ساعة وقطر بشبورى 1 مم وضغط رش 300 كيلو باسكال.

اقتصاديات التشغيل :-

تم حساب تكليف التشغيل لآلة الرش المطورة الثابتة منها والمتغيرة فكانت التكاليف الثابتة 29و12 جنية/ساعة والتكليف المتغيرة كانت 18و8 – 26و9 جنية/ساعة مع السرعة الأمامية 5و1 – 2و2 كم/ساعة0

أما تكاليف التشغيل الكلية فكانت 45و20 – 56و21 جنية/ساعة (4و13 – 1و14 جنية / فدان) مع نفس السرعات السابق ذكرها.

أنسب ظروف تشغيل للآلة المطورة :-

أعلى قيمة لمعامل التماثل (95.5٪) ومعامل الانتظامية (78.60٪) حصلت عند قطر بشبورى 1مم وضغط الرش 500 كيلو باسكال وارتفاع الرش 700 مم.

وجد أن الآلة المطورة أثناء عملية رش محصول القطن مع السرعة الأمامية 1.5 كم/ساعة وقطر بشورى 1.5 مم وارتفاع رش 700 مم وضغط الرش 500 كيلو باسكال حققت أعلى نسبة وفيات (يرقات ميتة) 98.6٪ وأقل تلف لنباتات القطن 0.87٪ وطاقة مستهلكه 4.75 كيلو وات وتكاليف تشغيل لعملية الرش 13.4 جنية/فدان.

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