Misr J. Ag. Eng., 24(4): 752-774 FARM MACHINERY AND POWER

MANUFACTURING AND EVALUATION OF A SELF-PROPELLED MACHINE FOR BROADCASTING SEEDS AND GRANULAR FERTILIZERS

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ABSTRACT

The object of this study was to develop and evaluate a small self propelled machine for spreading seeds and granular fertilizers. It consists of two hoppers, twin disc contra-rotating and transmission system to transmit the rotating motion from the machine engine to the rotating discs. This machine was evaluated to find out the optimum operating parameters for spreading both seeds and granular fertilizers. The developed machine was evaluated versus two different materials of pady seeds and granular fertilizer (super phosphate), four disc speeds of 350 (4.76), 450 (6.12), 550 (7.48) and 650 (8.84), rpm (m/s); four machine forward speeds of 4, 5, 6 and 7 km/h and four gate openings area of 6, 12, 18 and 24 cm^2. The results revealed that the lower coefficient of variation (C.V.) of 16.28 and 19.16 % and the higher coefficient of uniformity (C.U.) of 83.72 and 80.84 % were achieved at disc linear speed of 6.12 and 7.48 m/s and gate opening of 12 and 18 cm^2 for spreading pady and fertilizer, respectively. The fuel and energy consumed at the suitable forward speeds of 5 and 7 km/h and gate opening area of 12 and 18 cm^2 were 3.59 l/h and 0.98 kW.h/fed and 2.28 l/h and 0.55 kW.h/fed for spreading pady and fertilizer, respectively. The machinery spreading cost ranged from 3.26 L.E/fed at lower forward speed of 4 km/h to 2.27 L.E./h at the higher forward speed of 7 km/h.

INTRODUCTION

It must be save some important elements such as: Nitrogen, Phosphor and Potassium for soil to improve its physical and mechanical properties or to increase its fertility by application of fertilizers.

Most crops, especially in poor lands, need fertilizing application to save main elements for increasing yields and their qualities. Application of fertilizers and seeds to the soil with the broadcasting machines could increase the expected both yield and crop quality and save time, energy,

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and cost requirements.

In Egypt, because of fragmented areas, most farmers use the conventional method to spread fertilizers and seeds in their fields, which give bad distribution uniformity. Nowadays, to distribute the fertilizers and seeds with typical amount in uniformity patterns it must be used mechanical methods to: Determine the amount of fertilizers for distribution, spread fertilizers exactly in the time and unit area and distribute fertilizers and seeds as fast as possible. The broadcasting machines operating with centrifugal force could be the right way to spread fertilizers and seeds in uniformity patterns with high field capacity and efficiency and low power and cost requirements. **Follet *et al.* (1981)** classified the distribution pattern into six different types. The flattop, oval and pyramid patterns are most desirable because they lend themselves to uniform overlapping of swaths. The most common undesirable patterns are M, W and off side patterns. **Parish (1986)** reported that the most agriculture fertilizer spreaders of the rotary type have a method of adjusting the spreaders allow adjusting the drop point of fertilizer on the impeller as a means of adjusting the pattern to correct for product or operating variables affecting the distribution pattern include particle size, particle density, particle shape, coefficient of friction of the particle on the impeller, critical relative humidity, impeller speed and ground speed. **Bosoi *et al.* (1988)** reported that the mineral fertilizer spreader with centrifugal type metering unit is intended for continuous application of mineral fertilizers on the soil surface and also for broadcasting of green manure crop seeds. The disc diameter is 455 mm and the frequency of rotation is 680 rpm. Each disc has four radially arranged vanes of fluted form. Sowing rate varies between 40 and 2000 kg/ha for fertilizers and 8 and 500 kg/ha for green manure crops. The operation width of the unit is 6-12 m, hopper volume 0.5 m^3, working speed 6-12 km/h and productivity up to 12 ha/h. **Sayedahmed (1989)** reported that the spinner with diameter of 500 mm was suitable for feed rates ranged from 8 to 12 kg/min, which gave better uniformity of distribution than 400 mm. He added that the C-shaped blades and C-curved blades tended to make the spreading performance look better. The difference between these two types of blades and L shape seemed to be due to the different amounts of materials bouncing in or out the spinner. **Ahmed *et al.* (1990)** evaluated the distribution pattern of the spreader and found that a change in feed rate from 2 to 8 kg/min. had minor effects on pattern distribution. Increasing feed rate to 12 kg/min. worsened the spreading performance. They added that the best results from the field experiments for granular and coarse fertilizers were obtained at forward speed of 4.83 km/h at application rate of 200 kg/fed. **Morad (1990)** reported that the distribution pattern width and uniformity of fertilizer distribution are clearly affected by the spreader speed. Increasing the spreader speed leads to increase the distribution width and improves the uniformity of distribution, but on the other hand a low discharge rate of fertilizer is observed. The spreader disc speed of (540 rpm) is considered the optimum to produce the best performance. He added that the spreader blade pitch affects significantly on the distribution width and the uniformity of distribution. The results indicated that the forward pitched blade +15 degree increased the distribution width and improved the uniformity of distribution in comparison to the backward pitched blade. **Claude (1992)** carried out much experimental works with the aim of determining what evenness of distribution is acceptable. The results leave some doubts about min standards in borderline causes, but some broad conclusion, which may be down are: Lack of uniformity at moderate fertilizer application levels should not exceed ± 10:15 % in good conditions of level land and little wind. **Metwali (1995)** found that the spinner speed of about 540 rpm gave the highest values of effective field capacity, lowest cost of production unit and gave the best distribution pattern hence, gives more swath width. **Mechail (1999)** mentioned that the better distribution pattern was given at -10 degree blade angle using U-blade shape with coarse and granular fertilizers. Also, the better distribution pattern was given at zero blade angle degree using C curved blade shape with powder fertilizer. **Tissot *et al.* (1999)** mentioned that the homogeneous application of fertilizers depends on the physical properties of the particles, such as particle size distribution, bulk density, particle shape and breaking strength. **T.T.C. and N.A.R.P. (2000)** reported that fertilizers broadcasting machine depends on centrifugal force to spread fertilizers with working width from 6 to 12 m at rotating speed from 500 to 600 rpm. This machine is popular used due to its small size and big hopper which carry about 200-300 kg of fertilizers. **Kamel *et al.* (2002)** indicated that there are significant differences in the amount skewing, coefficient of variation and minimum and maximum points in the overlapped pattern of resulting from choice of methods. Using blades with curved C- shaped, the coefficient of variation was varied from about 51.05 to 38.04 % for spinner speed of 540 rpm and -10 blade angle degrees without wind protection. Using spiral curved shaped blades; the coefficient of variation was varied from 42.70 to 32.93 % at the same conditions. **Morad *et al.* (2002)** developed a simulation model of the spinning disc performance of the broadcaster fertilizers. They found that the experimental results as well as the simulation model results reveal that the predicting operational parameters (feed radius of 75 mm, spinner radius of 250 mm and spinner rotating speed of 480 rpm) improve the uniformity of fertilizer distribution. **Kishta and Eliwa (2005)** developed and evaluated a portable seed and fertilizers spreader. They found that the highest uniformity coefficient of distribution of 95.80 % is noticed at beater speed of 500 rpm when using the electrical device in the wheat field. Increasing total required time 1.2 h/fed by manual device (Fertilizer) caused to continuous decreasing in effective field capacity. The highest field efficiency of 61.60 % and the lowest operational cost of 1.57 L.E/fed are achieved at a beater speed of 500 rpm using electrical spreader in the wheat field. **Morad *et al.* (2005)** reported that the optimum distribution pattern and high degree of fertilizer uniformity can be achieved under the following conditions: Linear speed of about 10.5 m/s, (500 rpm), blade angle of +15 deg forward, (0.26 rad), dip angle of 0 deg (0 rad), gate opening of 16.63 cm^2 and machine forward speed of about 6 km/h.

In this investigation, a small self propelled machine was developed and manufactured for broadcasting both granular fertilizers and pady seeds on the soil. The manufactured machine was evaluated in terms of distribution uniformity, energy and cost requirements as a function of change in disc speed, machine forward speed and gate opening.

MATERIALS AND METHOD

Field experiments were carried out at private farm in Damietta governorate during the summer season of 2007 to construct and evaluate a self-propelled broadcasting machine with twin contra-rotating discs.

A- THE USED SEEDS AND FERTILIZERS:

The manufactured broadcasting machine was evaluated using the pady seeds and super-phosphate fertilizer. The physical properties of the pady seeds and fertilizes are shown in table (1).

Table (1): Physical properties of pady seeds and fertilizer.

Material form	Bulk density, (g/cm^3)	Moisture content, (%)	Angle of repose, (deg)	Coefficient of friction with metal	Diameter range, (mm)
Seeds (Pady)	1.53	10	44	0.87	2-4
Fertilizer (Granular)	1.16	6.74	35	0.68	0.5-2

B- CONSTRUCTED BROADCASTING MACHINE:

A self propelled broadcasting machine was manufactured and evaluated to overcome the problems noticed clearly at using the traditional method which give bad distribution and consumed more time, effort and cost. Also, the use of tractor with ordinary attached broadcasting machine could be compact the soil layers due to its heavy weight.

To overcome these problems, a small self propelled broadcasting machine was manufactured and evaluated to give the best uniformity of particles distribution, the high field capacity and efficiency, save total cost requirements and also to reduce soil compaction to the minimum values. The top view and the side view of the developed spreading machine are shown in Figs (1 and 2). The constructed machine consists of the following main parts: machine, spreading device and transmission system.

The spreading device of the constructed machine consists of the followings:

1- Disc spreader:

The broadcasting machine have two metal spreader discs, each disc have diameter of 260 mm and thickness of 2 mm. The disc spreader has four blades U-curved in shape. The blade and dip angles were adjusted at +15 deg and 0 deg according to (Sayedahmed 1989, Morad 1990, Kamel *et al*. 2002 and Morad *et al*. 2005).

No.	Part Name	No.off	No.	Part Name	No.off
1	Hopper	2	6	Power shaft	1
2	Disc	2	7	Front wheel	2
3	Gear (1)	2	8	Rear wheel	2
4	Gear (2)	2	9	Drive wheel	1
5	Chain	1	10	Clutch	1

All dimensions in, mm

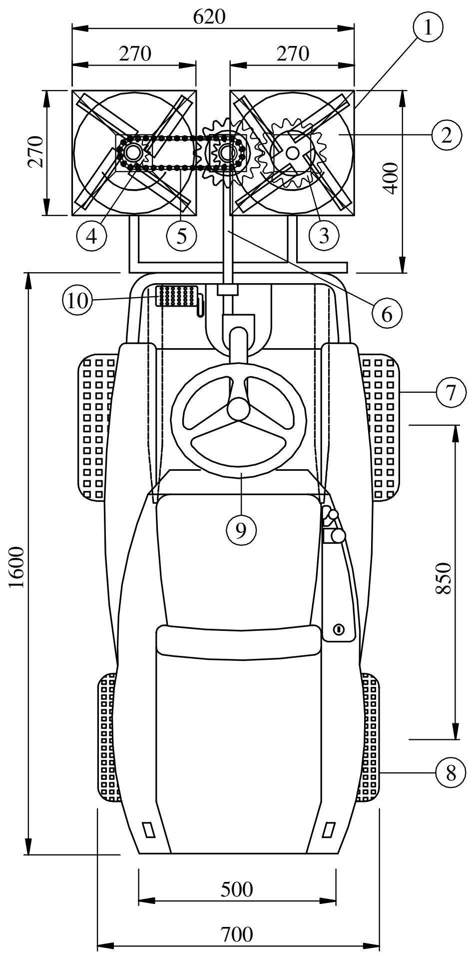
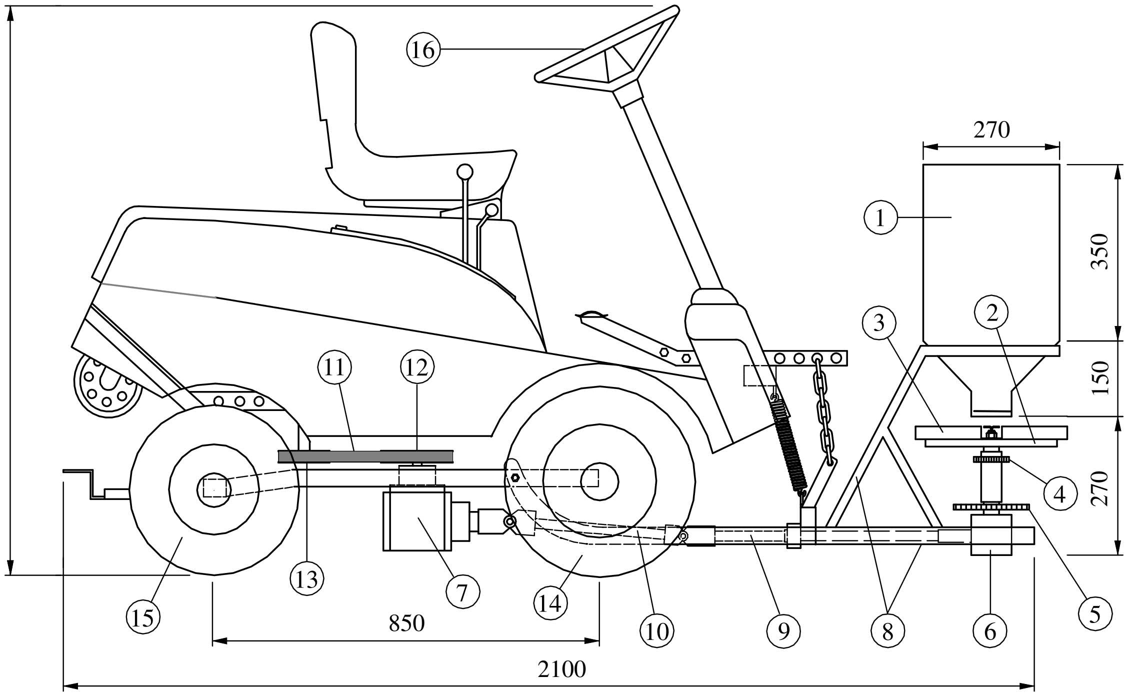


Fig.(1): The top view of the self propelled broadcasting machine.



No.	Part Name	No.off
1	Hopper	2
2	Disc	2
3	Disc fan	4
4	Gear (1)	2
5	Gear (2)	2
6	Gear box (1)	1
7	Gear box (2)	1
8	Frame	1
9	Power shaft	1
10	Flexible joint	1
11	V-Belt	1
12	Drive pulley	1
13	Engine pulley	1
14	Front wheel	2
15	Rear wheel	2
16	Drive wheel	1

All dimensions in, mm

Fig.(2): The side view of the self propelled broadcasting machine.

The previous items were the suitable conditions to produce conical pattern which give good uniformity distribution and also wide spreading width. Each disc rotates against the other one through a gear box and two big gears having diameter of 150 mm and two small gears having diameter of 70 mm with connecting chain. Fig.(3).

2- Particles hopper:

The broadcasting machine have two metal hoppers each one has dimensions of (270×270×350 mm) and has feed opening of (30×50 mm) which could be minimize using special gate, shown in Fig.(3).

3- Transmission system:

The power is transmitted from the machine engine to the rotating discs as shown in Fig. (4).

- A 3000 rpm at engine pulley which has diameter of 112 mm can be transmitted to gear box pulley having diameter of 150 mm using V-belt between the two pulleys to be equal 2100 rpm, with reduction ratio of 1.43: 1.
- The 2100 rpm at gear box pulley is reduced to 700 rpm in the gear box with reduction ratio of 3: 1.
- The rotating speed transported from the gear box to the power shaft through a universal joint having length of 500 mm.
- The power shaft transport its motion to the spreading discs through a small gear box with reduction ratio of 1: 1.

The overall specifications of the constructed broadcasting machine were given in table (2).

Table (2): Overall specifications of constructed broadcasting machine:

• ***Engine:***	
Model	1141-E
Type	Briggs & Stratton
Made	USA
Power	12.5 hp (9.38 kW)
Rated speed	3200 rpm
Fuel	Gasoline

No.	Part Name	No.off	No.	Part Name	No.off
1	Hopper	2	6	Gear (2)	2
2	Disc	2	7	Gear box	1
3	Fan	4	8	Frame	1
4	Chain	1	9	Power shaft	1
5	Gear (1)	2	10	Guide plate	2

All Dimensions in, mm

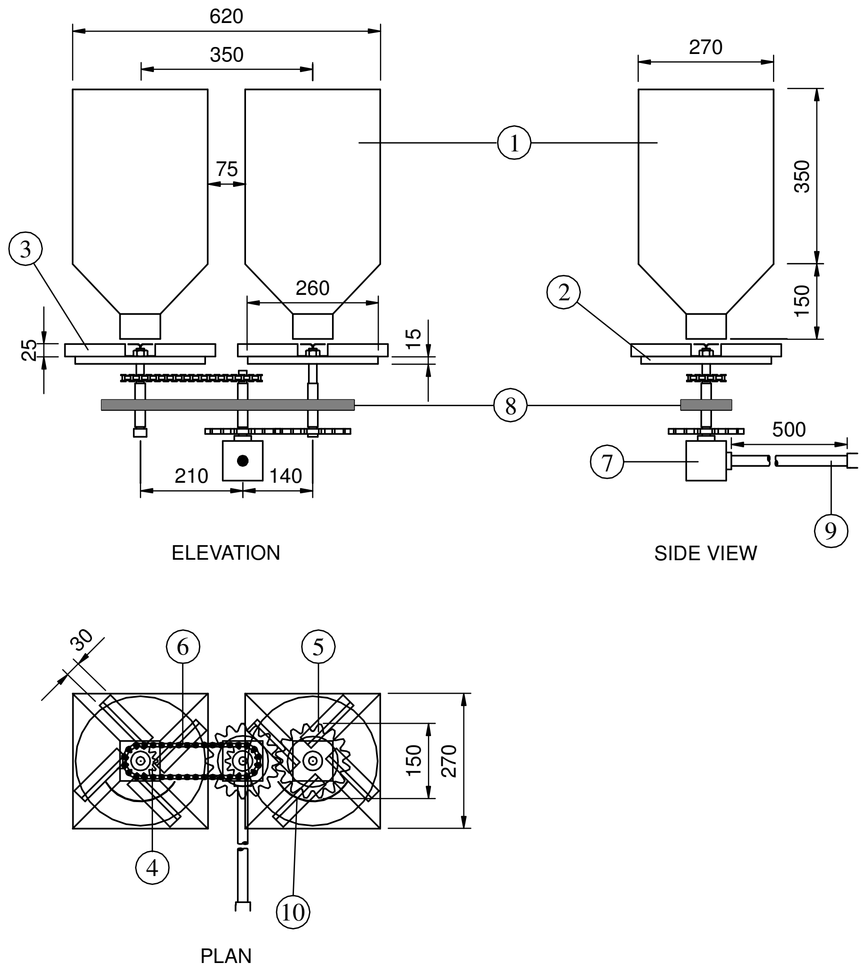


Fig.(3): The elevation, plan and side view of the spreading device of the self propelled broadcasting machine.

No.	Part Name	No.off	No.	Part Name	No.off
	Disc	2	8	Universal joint	1
2	Fan	4	9	Gear box (2)	1
3	Gear (1)	2	10	Gear box pulley	1
4	Gear (2)	2	11	Engine pulley	1
5	Gear box (1)	1	12	V-Belt	1
6	Power shaft	1	13	Engine shaft	1
7	Bearing	1	14	Machine engine	1

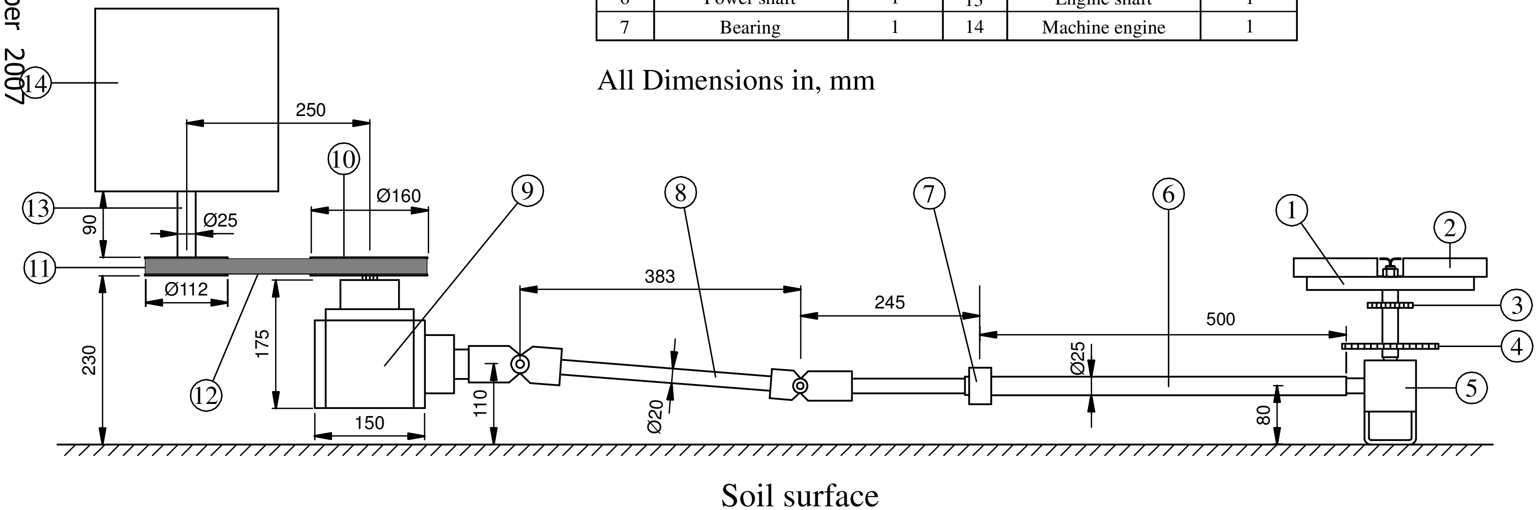


Fig.(4): Power transmission from the machine engine to the rotating discs.

• ***Machine:***	
Model	Stiga Villa
Made	Sweden
Gear box (Fast-Slow)	(5 forward & 1 reverse) speeds
Working width	600 cm
Overall length	260 cm
Overall width	120 cm
Overall height	120 cm
Overall weight	280 kg
• ***spreading device:***	
Particles hopper	2
Disc spreader (twin disc)	2
Gear box	1

C- MEASUREMENTS:

1- Uniformity of distribution:

The uniformity distribution pattern indicates the degree of uniformity of particles distribution in terms of coefficient of variation and symmetry. The evaluation of the distribution pattern and machine performance was carried out using collection trays having dimensions of (320×220×100) mm according to **ASAE S341.3 (2004)**, measuring tape, small bags, gradient flask, stop watch and electrical balance. During all field experiments, the average wind speed was about 2.1 km/h and the air temperature varied from 28 to 32 C^o. After each treatment, the materials from each tray was put in a small bag and weighted to calculate the C.V and C.U.

a- Coefficient of variation (C. V., %):

The coefficients of variation under 10 % are considered excellent, with values under 20 % generally considered acceptable for most field applications as reported by **Coates (1992)**:

The mean value (x_a), standard deviation (δ) and coefficient of variation (C.V.) is determined as follows:

$$\delta = \sqrt{\frac{\sum (x_i - x_a)^2}{n-1}} \quad \ldots\ldots\ldots\ldots(1)$$

Where: x_i = The individual reading.

x_a = Mean reading = $\frac{\sum x_i}{n}$

n = Number of readings.

$$C.V. = \left(\frac{\delta}{x_a}\right) \times 100 \quad \ldots\ldots\ldots\ldots\ldots(2)$$

b- Coefficient of uniformity (C. U.):

The coefficient of uniformity of distribution pattern is calculated by the following equation, (**Dragos, 1975**):

$$C.U = 1 - \left[\frac{\sum (x_i - x_a)^2}{n-1} / x_a\right] \ldots\ldots\ldots(3)$$

Where: x_i = Weight of particles in each box, g.

x_a = Average weight of particles in all boxes, g.

n = Total number of collection boxes.

<u>2- Application rate:</u>

The application rate was calculated by the flowing equation:

$$Q = \frac{q}{C_{act}} \quad \ldots\ldots\ldots\ldots(4)$$

Where: Q = Application rate of particles, kg/fed.

q = Feeding rate of particles, kg/h.

C_{act} = Effective field capacity, fed/h.

<u>3- Energy requirements:</u>

To estimate the engine power during broadcasting process, the decrease in gasoline fuel level in fuel tank accurately measuring immediately after each treatment. The following formula was used to estimate the engine power (**Hunt, 1983**):

$$EP = \left[F.C\,(1/3600)\,PE \times L.C.V \times 427 \times \eta_{thb} \times \eta_m \times 1/75 \times 1/1.36\right],\ kW \ ..(5)$$

Where:

$F.C$ = Fuel consumption, (l/h).

PE = Density of fuel, (kg/l), (for gasoline = 0.72).

$L.C.V$ = Calorific value of fuel (11.000 k.cal/kg).

η_{thb} = Thermal efficiency of the engine (for Otto engine, 25%,).

427 = Thermo-mechanical equivalent (kg.m/k.cal).

η_m = Mechanical efficiency of the engine (for Otto engine, 85%).

The energy can be calculated as following:

$$Energy\ Requirements = \frac{Engine\ power, (kW)}{Actual\ field\ capacity, (fed/h)},\ kW.h/fed \quad ..(6)$$

4- Spreading cost:

The operating cost of spreading operation was estimated using the following equation (**Awady *et al.* 1982**):-

$$Operating\ cost/fed = \frac{Machine\ cost\ (L.E/h)}{Actual\ field\ capacity\ (fed/h)},\ (L.E/fed) \quad .....(7)$$

Where:

Machine cost was determined by using the following equation (**Awady, 1978**):

$$C = \frac{P}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r\right) + (0.9W.S.F) + \frac{m}{144} \quad ....(8)$$

Where:

C = Hourly cost, L.E/h.
P = Price of machine, L.E.
h = Yearly working hours, h/year.
a = Life expectancy of the machine, h.
i = Interest rate/year.
F = Fuel price, L.E/l.
t = Taxes, over heads ratio.
r = Repairs and maintenance ratio.
m = The monthly average wage, L.E
0.9 = Factor accounting for lubrications.
W = Engine power, hp.
S = Specific fuel consumption, l/hp.h.
144 = Reasonable estimation of monthly working hours.

The manufactured machine was evaluated taking into consideration the following parameters:

- Spreader speed: 4.76 (350), 6.12 (450), 7.48 (550) and 8.84 (650), m/s (rpm).
- Machine forward speed: 4, 5, 6 and 7 km/h.
- Gate opening area : 6, 12, 18 and 24 cm^2.

RESULTS AND DISCUSSION

Results show that the distribution pattern and effective swath width are greatly affected by many parameters such as spreader type, spreader speed, gate opening and spread materials.

1- Effect of spreader speed on distribution pattern:

The recommended application rates are 60 and 100 kg/fed for pady and fertilizer, respectively. These data were used to gain the charts mentioned in Figs (5 and 6).

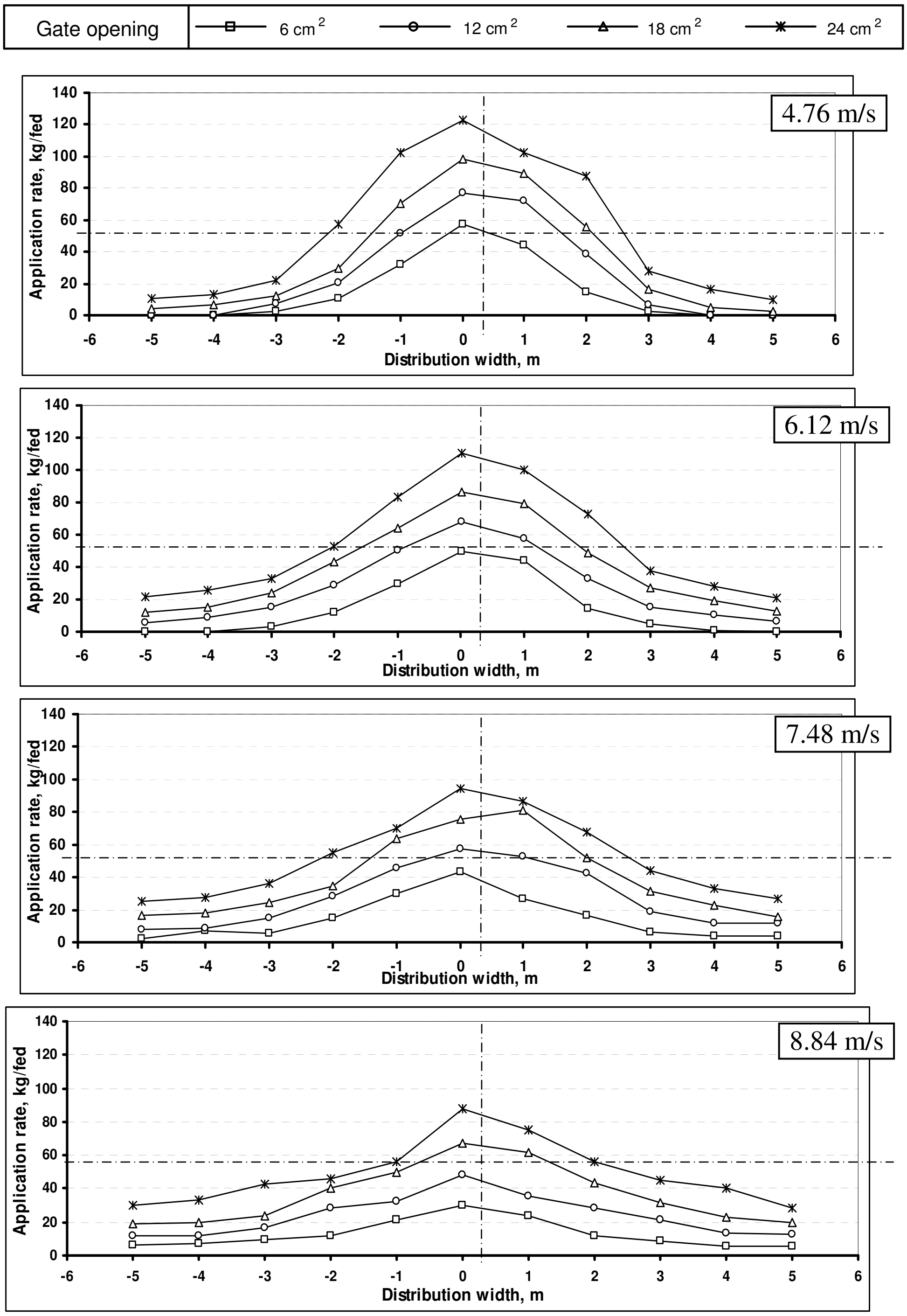


Fig.(5): Effect of spreader speed on pady distribution pattern at different gate openings area.

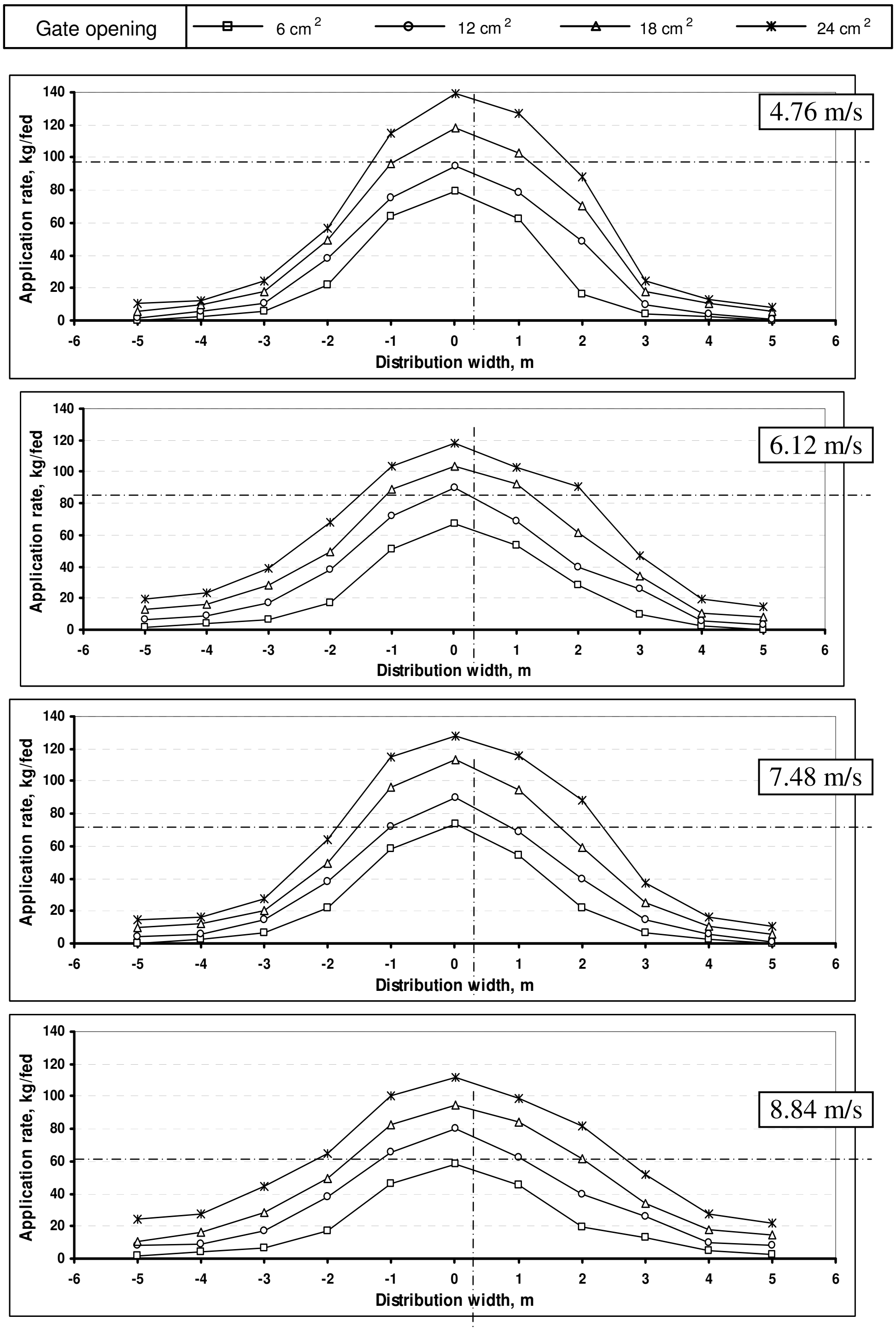


Fig.(6): Effect of spreader speed on fertilizer distribution pattern at different gate openings area.

From Figs (5 and 6) it is clear that the most amount of particles are distributed in small width at lower spreader speed of 6.12 (450) m/s (rpm) compared with the high speed of 8.84 (650) m/s (rpm) which increases the distribution width from 6 to 10 m around the centerline of the spreading machine especially in small gate opening area of 6 cm^2. This result may be attributed to the increase in centrifugal force occurred at high rotating speed. So, the effective swath width could be increased by increase disc rotating speed. This result agrees with (Bosoi *et al.* 1988). Figs (6 and 7) also show that, the spreading particles are distributed uniformity around the centerline at spreader speed of 6.12 and 7.48 m/s for both pady and fertilizer, respectively. The best uniform distribution pattern is coincided the lowest values of C.V. as shown in Figs (7 and 8).

The spreader disc speed of 6.12 (450) and 7.48 (550) m/s (rpm) gave the lowest value of C.V. of 21.35, 16.28, 26.54 and 35.65 %; 26.76, 32.24, 19.16 and 39.65 % under different gate openings area of 6, 12, 18 and 24 cm^2 for pady and fertilizer, respectively. The decrease or increase spreader in speed less or more than the optimum values mentioned above leads to increase C.V. consequently resulted in bad distribution pattern. The highest values of C.U. are 78.65, 83.72, 73.46 % and 64.35; 73.24, 67.76, 80.84 and 60.35 % obtained at the same previous conditions. Results show that, the suitable spreader speed for pady and fertilizer are 6.12 (450) and 7.48 (550) m/s (rpm). These results agree with (El-Khateeb *et al.* 2002 and Morad *et al.* 2005).

2- Effect of gate opening area on distribution pattern:

The gate opening area is highly affected the spreader distribution effective width. Generally, increased of gate opening area from 6 to 24 cm^2 increased the effective swath width from 6 to 10 m around the centerline of the spreading machine. Figs (7 and 8) show that the gate opening area of 12 cm^2 is the suitable feed opening for spreading pady which gave the lowest and highest values of C.V. and C.U. of 29.32, 16.28, 24.19 and 33.72; 70.68, 83.72, 75.81 and 66.28 at different disc speeds of 4.76, 6.12, 7.48 and 8.84 m/s, respectively. According to fertilizer spreading, the gate opening of 18 cm^2 is the suitable feed opening for spreading Fertilizer which gave the lowest and highest values of C.V. and C.U. of 34.46, 28.39, 19.16 and 29.67; 65.54, 71.61, 80.84 and 70.33 at different disc speeds of 4.76, 6.12, 7.48 and 8.84 m/s, respectively.

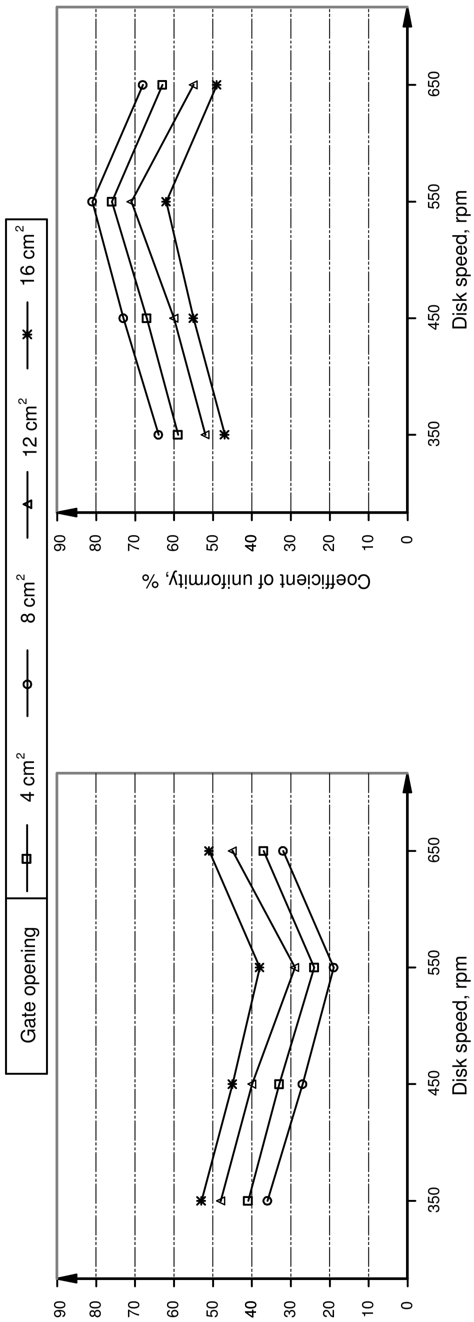


Fig.(7): Effect of disc speed on twin-spreader performance at different gate openings with fertilizer spreading.

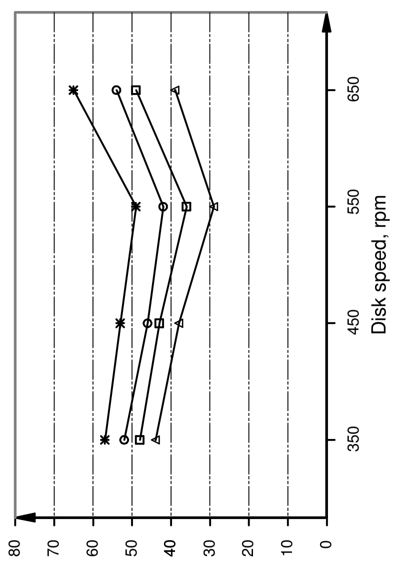


Fig.(8): Effect of disc speed on twin-spreader performance at different gate openings with pady spreading.

3- Effect of machine forward speed on application rate:

Field experiments were carried out under the optimum operating parameters obtained from the laboratory tests. The operating parameters are spreader speed of 6.12 (450) and 7.48 (550) m/s (rpm) and gate opening of 12 and 18 cm^2, for spreading pady and fertilizer, respectively. Generally, increasing the gate opening area leads to increase the application rate (kg/h), but the increase in machine forward speed leads to decrease the application rate (kg/fed) due to the increase in machine field capacity.

Table (3) show that increasing forward speed from 4 to 7 km/h decreased the application rate from 72.08 to 50.31 and from 165.37 to 115.41 kg/fed at gate opening of 12 and 18 cm^2 for pady and fertilizer, respectively. The suitable application rate for pady and fertilizer of 62.01 and 115.35 kg/fed were obtained at forward speed of 5 and 7 km/h with gate opening of 12 and 18 cm^2, respectively.

Table (3): Effect of machine forward speed on application rate, (kg/fed).

Gate opening, (cm^2)	Machine forward speed, km/h							
	4		5		6		7	
	Pady	S.Ph.	Pady	S.Ph.	Pady	S.Ph.	Pady	S.Ph.
6	27.21	29.51	23.40	25.38	20.95	22.72	18.99	20.59
12	72.08	75.62	62.01	65.05	55.51	58.23	50.31	52.77
18	154.77	165.37	133.13	142.25	119.18	127.35	108.01	115.41
24	319.43	344.88	274.77	296.66	245.99	265.58	222.93	240.69

4- Effect of machine forward speed on fuel and energy requirements:

Fuel and energy consumed are highly affected by machine forward speed. Fig.(9) show that increasing machine forward speed from 4 to 7 km/h decreased the fuel and energy consumed from 3.98 to 2.28 lit/h and from 1.38 to 0.55 kW.h/fed, respectively. The decrease of fuel and energy consumed as the machine forward speed increased was attributed to change machine gear box to the high speed and also the increase in machine field capacity. The fuel and energy consumed at the suitable machine forward speed of 5 and 7 km/h were 3.29 and 2.28 lit/h and 0.98 and 0.55 kW.h/fed, for pady and fertilizer, respectively. These values of fuel and energy consumed consider too low compared with the other spreading equipments attached with tractors which consumed more fuel and energy.

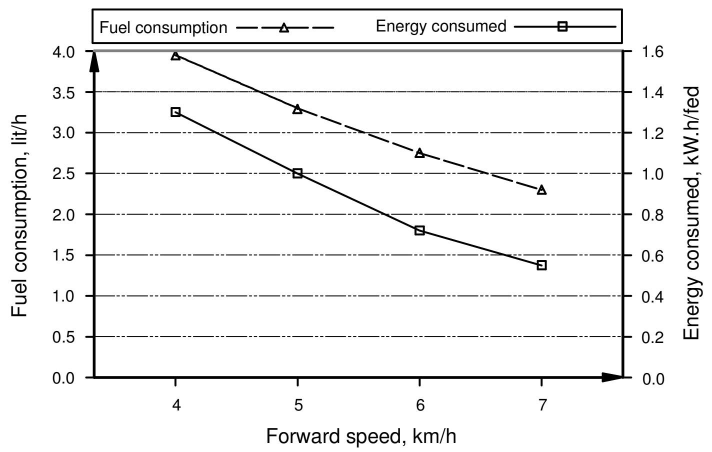


Fig.(9): Fuel consumption and energy requirements of disc spreader at different machine forward speeds.

5- Effect of machine forward speed and gate opening on spreading cost:

Concerning the effect of machine forward speed on spreading cost (L.E/fed), results in Fig (10) indicated that at forward speeds of 4, 5, 6 and 7 km/h the spreading costs were 3.26, 2.80, 2.51 and 2.27 L.E/fed. It is noticed that increasing machine forward speed leads to decrease spreading cost; this was attributed to the increase in machine field capacity. At suitable forward speed of 5 and 7 km/h, the spreading costs were 2.80 and 2.27 L.E/fed. They were considered to be acceptable compared with other spreading equipments or manual spreading.

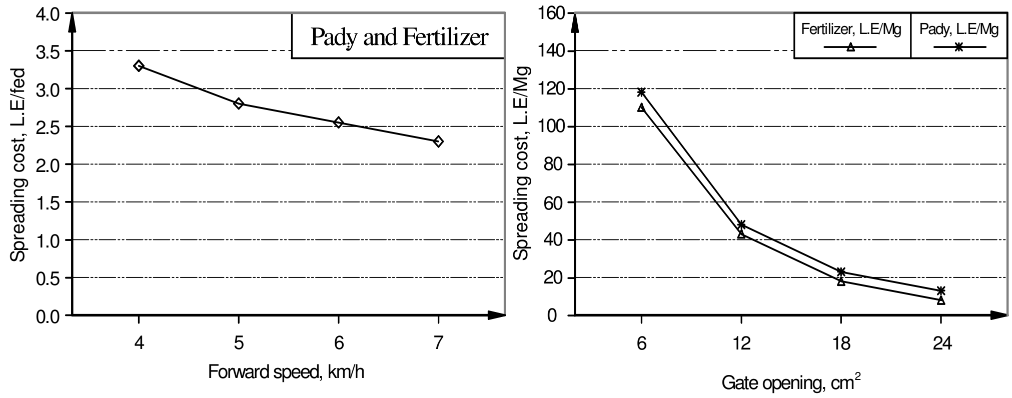


Fig.(10): Effect of forward speed and gate opening on spreading cost for both pady and granular fertilizer.

On the other side, the effect of gate opening on spreading cost is highly clear from Fig (11). Increasing gate opening from 6 to 24 cm^2 decreased the spreading cost from 119.81 to 10.22 L.E/Mg and from 110.48 to 9.45 L.E/Mg for pady and fertilizer, respectively. These results were attributed to more time consumed to spread amount of particles from small gate opening compared with big one which consumed little time.

CONCLUSION

A manufactured self propelled machine was evaluated using two different materials namely: pady seeds and granular fertilizer (super phosphate), versus four disc speeds of 4.76 (350), 6.12 (450), 7.48 (550) and 8.84 (650), m/s (rpm); four machine forward speeds of 4, 5, 6 and 7 km/h and four gate openings of 6, 12, 18 and 24 cm^2. From obtained results, the following conclusions can be taken:

- The lowest coefficient of variation of 16.28 and 19.16 % and the highest coefficient of uniformity of 83.72 and 80.84 % were achieved at disc speed of 6.12 (450) and 7.48 (550) m/s (rpm) and gate opening area of 12 and 18 cm^2 for spreading pady and fertilizer, respectively.
- The fuel and energy consumed at the suitable forward speeds of 5 and 7 km/h and gate opening of 12 and 18 cm^2 were 3.59 *l*/h and 0.98 kW.h/fed and 2.28 *l*/h and 0.55 kW.h/fed for spreading pady and fertilizer, respectively.
- The spreading machinery cost was ranged from 2.27 L.E/fed at high forward speed of 7 km/h to 3.26 L.E./h at low forward speed of 4 km/h.

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الملخـص العربـي

تصنيع وتقييـم آلـة ذاتيـة الحركـة لتوزيـع البـذور والأسمـدة الكيماويـة

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تعتبـر آلات ومعـدات النثـر بـالطرد المركـزي مـن الآلات الواعـدة فـي توزيـع كـلاً مـن البـذور والأسمدة الكيماويـة، ويمكن أن تكون الطريقـة المناسبة لزيـادة المحصـول وارتفـاع جودتـه، كمـا أنها توفر الوقت، الجهد، الطاقة والتكاليف الكلية لعملية النثر. وفـي مصـر بسبب تفتت الحيـازات وخاصة في محافظات الدلتا فإن عمليات الزراعة والتسميد نثراً تتم يدوياً مما يعطي توزيعاً غير منتظم للحبوب والسماد علـى السـواء. كمـا أن اسـتعمال معـدات النثـر الملحقـة بـالجرار تزيـد مـن تضاغط التربة بسبب وزنها الثقيل مما يؤثر على الإنتاجية في وحدة المساحة.

لهذا تم تصنيع وتقييم آلة صغيرة ذاتية الحركة لتقوم بتوزيع كلاً من البذور والسماد المحبب مما يعطي توزيعاً منتظماً للحبيبات. وتتركب هذه الآلة من الأجزاء الآتية:

1- صنـدوق الحبيبـات:

تحتوي هذه الآلـة على صندوقين من المعدن أبعـاد كل منها هي (35 × 27 ×27) سم.

2- القـرص الـدوار:

تحتوي الآلة على زوج من الأقراص المعدنية قطر كل منها 26 سم وسمكها 2 مم، ويوجد علـى كل قرص عدد 4 ريش على شكل حرف U بزاويـة +15 درجـة وزاويـة ميل للأقراص تسـاوي صفر درجة، ويدور القرصان عكس بعضهما من خلال جهاز نقل الحركة.

3- **جهاز نقل الحركـة:**

هذا الجهاز مكون من مجموعة من التروس مختلفة الأقطار والجنازير وكذلك صندوق تروس ذو نسبة تخفيض (1:1) لنقل الحركة من موتور الآلة إلى الأقراص من الوضـع الأفقي إلـى الوضـع الرأسي وإعطائها الحركة الدورانيـة لتـدور في اتجاهيـن متضـادين للخارج.

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تم دراسة عدد من المتغيرات لتقييم هذه الآلة بعد التصنيع والتركيب والتي تشمل استخدام نوعين مختلفين من المواد هي حبوب الأرز والسماد المحبب (السوبر فوسفات)، سرعات مختلفة للقرص الدوار هي 4.76 ، 6.12 ، 7.48 و8.84 م/ث (350 ، 450 ، 550 و650 لفة/د)، فتحات تلقيم أسفل صندوق الحبيبات هي 6 ، 12 ، 18 و24 سم^2 وسرعات أمامية للآلة هي 4 ، 5 ، 6 و7 كم/س. وقد تم تقييم أداء هذه الآلة من خلال القياسات التالية:

- منحنى التوزيع الطبيعي للحبيبات حول المحور الطولي للآلة.
- معامل الاختلاف ومعامل الانتظامية.
- الطاقة اللازمة لعملية النثر.
- التكاليف الكلية لعملية النثر.

وقد أظهرت النتائج المتحصل عليها ما يلي:

- أقل معامل اختلاف هو 16.28 و19.16% وأعلى معامل انتظامية في مسطح التوزيع هو 83.72 و80.84% تم الحصول عليها عند سرعة دورانية للقرص الدوار 450 و550 لفة/د وفتحة تلقيم 12 و18 سم^2، لكل من بذور الأرز وسماد السوبر فوسفات على الترتيب.
- الوقود والطاقة المستهلكة كانت 3.59 لتر/س و0.98 كيلووات.س/ف و 2.28 لتر/س و0.55 كيلووات.س/عند السرعات المناسبة 5 و7 كم/س والتي تعطي أقل معامل اختلاف وأعلى معامل انتظامية للتوزيع عند فتحات تلقيم مساحتها 12 و 18 سم^2، لكل من بذور الأرز وسماد السوبر فوسفات على الترتيب.
- تراوحت التكاليف الكلية لعملية نثر بذور الأرز وسماد السوبر فوسفات آلياً ما بين 2.27 و 3.26 جنيه/ف عند السرعة الأمامية 7 و 4 كم/س، على الترتيب.

- بالتالي فإن أنسب العوامل لتشغيل هذه الآلة لنثر كلاً من بذور الأرز وسماد السوبر فوسفات المحبب على الترتيب هي: سرعة القرص الدوار 6.12 (450) و 7.48 (550) م/ث (لفة/د)، فتحات التلقيم أسفل صندوق الحبيبات 12 و 18 سم^2 والسرعة الأمامية للآلة أثناء عملية النثر 5 و7 كم/س.