MANUALLY OPERATED PLANTER FOR PLANTING DIFFERENT SEEDS IN SMALL AREAS

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ABSTRACT

Laboratory and field experiments were carried out to develop and evaluate a manually operated planter suits to plant some different seeds. The constructed planter consists of four main parts namely: seed hopper, feed device, furrow opener and covering device. The constructed planter was evaluated under three different types of seeds (sugar beet, zucchini and ground nut), five different cell diameters of 1.0, 1.5, 2.0, 3.0 and 4.0 cm and three numbers of cells on the disk of 2, 3 and 4. The obtained data reveal the following: The laboratory tests included the determination of average weights of seed discharged from hoppers, percentage damage of seeds and uniformity of hill spacing in the row. The field tests comprised the determination of uniformity of hill spacing in the row, effective field capacity and efficiency, average depth of placement of seeds in the row, energy and planting cost. From obtained laboratory and field tests, it could be concluded the followings: The maximum seed weights discharged from the hoppers of 64.53 and 168.27 and 720.27 g were achieved at cell diameters of 2.0, 3.0 and 4.0 cm and No. of cells on the disk of 4 for sugar beet, zucchini and ground nut, respectively. The minimum damage percentage of 2.57, 0.13 and 4.89 % were obtained at No. of cells on the metering disk of 2 and cell diameter of 2.0, 3.0 and 4.0 cm for sugar beet, zucchini and ground nut, respectively. The maximum field capacity of 0.547 fed/h was obtained at higher forward speed of 2.3 km/h, while the maximum field efficiency of 73.65 % was obtained at lower forward speed of 0.8 km/h. The minimum energy consumed and planting cost of 0.278 kW.h/fed and 15.61 L.E/fed were obtained at high forward speed of 2.3 km/h.

INTRODUCTION

There are some seeds such as sugar beets, zucchinis and groundnuts considered very sensitive to planting using mechanical planters which may give high percentage of seed damage affecting on plants emergency and then total crop yield.

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The seed-metering system is an important component in row-crop planters in terms of uniform seed distribution. In Delta Egypt, because of fragmented areas most farmers obliged to plant these crops manually consuming large time, effort, labors and cost; and also obtaining poor total yield resulting from un-uniformity distribution of seeds during planting operation. So, there is therefore a need to develop a simple planting unit that will be used in planting such different seeds to save time, labors, and total cost of planting and also give the suitable seed uniformity. **Keppner et al. (1982)** stated that the percent of cell fill for a given planter is influenced by such factors as: the maximum of seed size in relation to cell size, seed shape, cell shape, exposure times of a cell to seed in the hopper and the peripheral speed of the cell. They also mentioned that the diameter or length of the cell should be about 10 % greater than the maximum seed dimension and the cell depth should be about equal to average seed diameter or thickness. They added that most of seed damage was caused by the cut of device and the percentage of seed damage increases as the cell speed is increased. **Taib (1997)** found that the mechanical planting of sugar beet saved 33 % of seeds compared with the manual planting, and also decreased the cost of the energy consumed by 58%. The mean yield values were 29.22 and 34.38 Mg/fed with manual and mechanical planting, respectively. **Moussa (1999)** fond that the percentage of seeds dropped per meter along the furrow decreased about 20 % for the different crops by increasing operating speed. Also, the lateral and longitudinal deviation of seeds along the row increased by increasing operating speed and decreasing seed size. **Tayl et al. (1999)** designed a two rows planter for no coated beet seeds. Cell shapes were tested such as cylindrical, trapezoidal, conical and half sphere. They recommended using agitator speed not less than 20 rpm with forward speed lower than 4 km/h. **Awady et al. (2002)** designed a single-row hand push seeder for planting cotton seeds (Giza-86), maize, sunflower and peas. The feeding mechanism of the seeder was consisted of (a) feeding mechanism box has a 4-bar structure (b) agitator device (shaking base) made from a spring steel sheet which provided flexibility to the base shaking. They found that the best feeding rate for cotton seeds (Giza86) was set by a gate height of 2 cm at which missing hills ratio was 1.68 % and the mode 5 seeds/hill with shaker base. For maize, sunflower and peas, with a feeding rate of 1-3 seeds/hill, the appropriate conditions were: feeding speed of 80-100 rpm, feeding gate height of 0.5-1.5 cm with visible damage in such conditions was within 1 %. **Imbabi and Omran (2002)** developed a feeding device for planting sesame seeds. This device consists of (a) seed pushing mechanism - number of steady distributed brushes in the bottom of the seed hopper- (b) a roller conceived seed screen which is fixed over the seed pushing mechanism of a number of holes. They found that the amount of seeds and total sowing costs per feddan decreased by 58.3 and 60 %; by 49.87 and 53.66 % in furrow and flat plantations, respectively. The field capacity increased by 203 % and 182.6 % in furrow and flat plantations. **Ibrahim et al. (2008)** developed the feeding device of seed drill for planting the soaked and hasted seed rice in rows. The results showed that decreasing the weed plants in square meter and increasing the germination percentage by 97 % at machine forward speed of 0.64 m/s. **Marey et al. (2008)** reported that the highest values of root and sugar yield were 31.027 and 5.573 Mg/fed at 50 cm row space with modified opener and machine forward speed of 3.5 km/h. **Afify (2009)** developed the seed drill device to be suitable for Black seed planting. He found that the optimum distance between hills was 30 cm to achieve higher seed yield of 815 kg/fed, lower energy consumed of 7.24 kW.h/ton, production cost of 26.44 L.E/ton and higher germination ratio of 95.37 % with higher field efficiency of 89.41% at machine forward speed of 3.13 km/h. **Ismail et al. (2010)** constructed a vertical brush seed metering device for planting the common varieties of sugar beet seeds (multi or mono germ). They found that the seed feed index was 86.73%, 79.77% and 74.56% for Hd3, Hd2 and Hd1 hair density of feeding device at 1.0 km/h planting speed, while at 4.0 km/h the seed feed index was 71.04%, 61.07% and 46.21%, respectively. The optimum operation of brush metering device is found at seeding speed of 2.0 m/s, 0.3 m/s peripheral speed of feeding device and 100 hair/hole densities. Sugar beet planting has been limited to manual planting, which is very tedious and laborious. Therefore, there is a need to develop a simple tool that will be used in planting sugar beet seeds. The conveying seeds in horizontal wheel device face many factors that affect the performance of conveying sugar beet seeds. **Navid et al. (2011)** used a seed metering device of vertical-roller type with 118 mm diameter. The planter was installed on the 11m long, 40 cm wide grease belt test rig.

Also, a semi-professional digital camera (Nikon D70) was installed at 1 m ahead of the planter and above the belt. Orange colored tomato seeds (sun f1) were used during experiments with blue background for easy detection of seeds. The factorial experiments with three replications were conducted on the basis of completely randomized design with two levels of number of seed cells (15 and 21) machined on vertical-roller and four levels of seed metering device speed (40, 53, 60 and 66 rpm). Within each image, the middle band was selected, separated from the rest of it and processed immediately. Seed images appeared as small orange spots on black background. Comparison of the number of spaces that fell in normal domain in different seed-metering speeds showed that image processing method had higher value than grease-belt method. Since the initial falling velocity of seed and angle of its exit from metering device was unknown, thus the precision of space index was different in two methods.

So, this work aimed to develop, construct and evaluate a simple manually operated planter with vertical feed device to plant such sensitive seeds in small areas to decrease planting cost and increase total yield.

MATERIALS AND METHOD

2.1. MATERIALS:

2.1.1. The constructed planter:

The manually operated planter shown in (Fig.1) was constructed at the work shop of Agricultural Engineering Department, faculty of agriculture, Zagazig University. This planter consists of feed hoppers, metering disks and housing having discharge spouts, ground wheels, furrow opening, covering devices, handles and the frame which support all previous planter parts. (Fig.1).

1. Seed hopper: The planter has two seed hoppers made of mild steel, each one has a rectangular cross section. The maximum capacity of each hopper was 12.96 liters. This capacity is based on the volume of seeds required to plant about one feddan of land continuously from the small seeds. The dimension of the upper part of seed hopper is 200 mm × 200 mm × 300 mm. The lower part with trapezoidal shape ended with the housing.

No.	Part name	No.off	No.	Part name	No.off
1	Metering disk	2	6	Bearing	4
2	Seed hopper	2	7	Ground wheel	2
3	Furrow opener	2	8	Frame	1
4	covering device	2	9	Handle	1
5	Drive shaft	1	10	Soil surface	1

All Dimensions in, mm

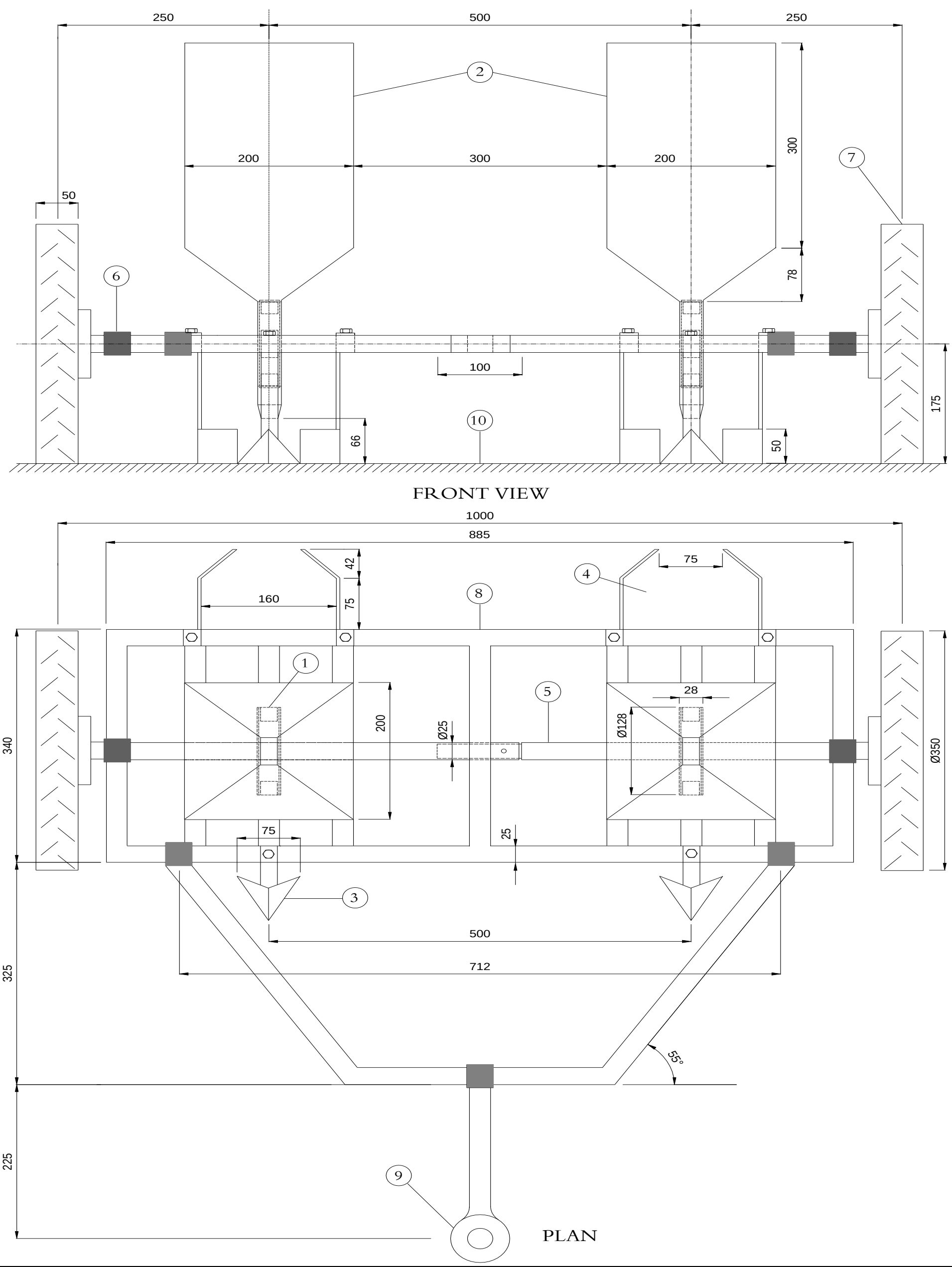

Fig.(1): A front view and plan of the manually operated planter.

2. Feed device: The feed device consists of two metering disks or flutes in a vertical poison. The metering disks made of hard wood because of its durability, high strength, and resistance to shrinkage. Each metering disk has 128 mm in diameter and 20 mm in thickness. On each disk there are two, three or four semi cylindrical cells bored and equidistant from each other along the periphery. The dimensions of the cell on each disk are varied in diameters and deep as shown in Fig.(2). These dimensions are such that the different sizes of seeds can be accommodated if they are oriented on the major axis.

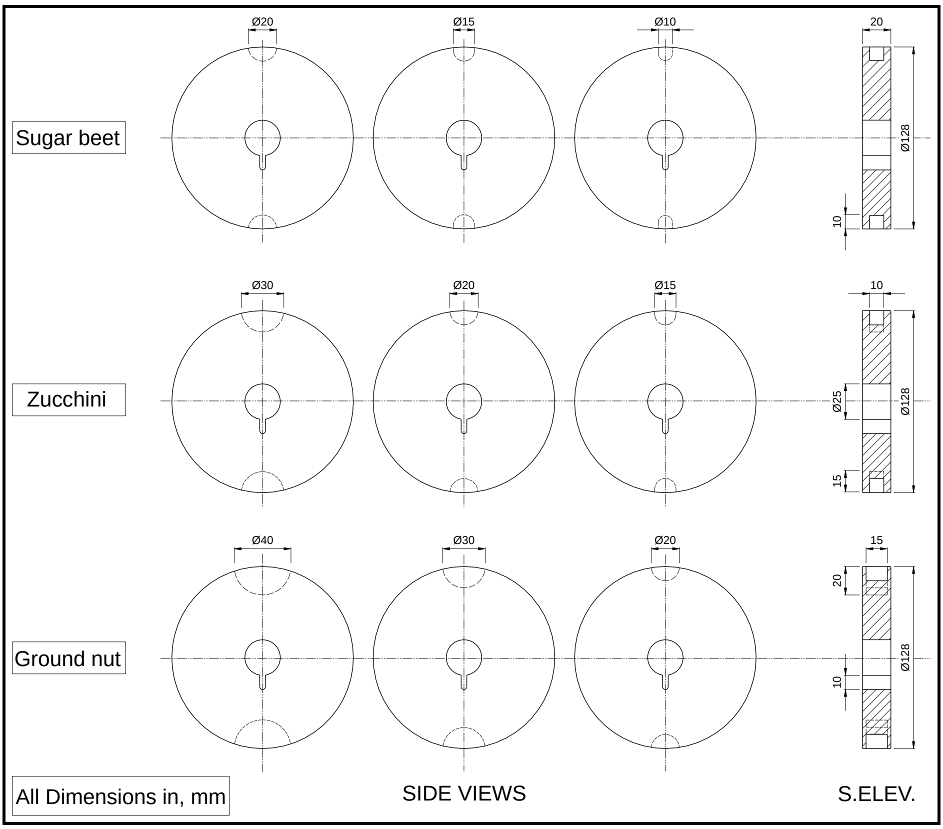

Fig.(2): Schematic views of a vertical metering disks and cells.

To change the metering disks with another cell diameter as the seed variety changed, the planter has two feed shafts, each one has 450 mm in length and 25 mm in diameter. After changing the metering disks, the two feed shafts shall fixed together through a bolt and nut, making one feed shaft with total length of 900 mm, then the metering disks could rotate together.

3. Metering disk housing: The material used for the construction of the two metering disks housings is a mild steel hollow pipe, 130 mm internal diameter and 22 mm long. Two slots (40×20 mm) were made at the upper and lower parts on each of the metering housing. The seeds from the hopper pass through the upper slot into the cell on the metering disk from where they were discharged through the lower slot into the discharge spout and then into the row.

4. Furrow opening device: The furrow opener is a 50 mm mild angle iron with a length of 150 mm. The angle iron is slightly beveled at the upper edge in a 20° to facilitate an easy cut through the soil. To facilitate the attachment of the furrow opening device to the support frame, a mild steel plate with width of 50 mm and 200 mm long was drilled to accommodate an 8 mm diameter bolt with the nut welded on the support frame.

5. Covering device: The covering device is made of two rectangular mild steel plate having dimension of (135 mm×40 mm). Each plate for attachment to the support frame was welded back to the furrow opener directly. The covering device is inclined at an angle of 45^{o} against each other to the direction of travel for optimum covering of the soil after planting.

6. Drive wheels: The two drive wheels were made from mild steel and transmit the rotating motion to the seed metering mechanism. The diameter of each wheel is 256 mm and its width is 20 mm supported with 16 cross bars (40×20 mm) to minimize slippage during operation. The circumference of the ground wheel was designed to obtain the required seed spacing within the row to enable the metering disk discharge the seeds along 20, 26.6 and 40 cm in one revolution of the ground wheels.

7. Handle: The handle consists of two mild steel pipes having internal diameter of 25 mm, each of length is 600 mm. At the two ends of previous pipes, two bushings each of 30 mm internal diameter and 40 mm long were welded in a horizontal position in the main frame at 35^{o} with the moving direction. A cross pipe with 25 mm internal diameter and 400 mm long was welded with the two ends of previous pipes. Another pipe having the same section and 225 mm in length was welded in the middle of the cross pipe ended with a bushing has internal diameter of 40 mm. The plan and side view of the manufactured planter shown in photo (1).

Photo (1): The plan and side view of the manufactured planter

2.1.2. Seed varieties:

The seed varieties used through the tests were sugar beet (multi germ), zucchini and groundnut seeds having different characteristics, shown in table (1).

Table (1): Geometric and mechanical properties of seeds varieties.

Geometric and mechanical properties	Seed variety			Unit
	Sugar beet	Zucchini	Groundnut	
Av. Length	5.35	16.23	20.60	(mm)
Av. Width	4.95	9.94	9.64	(mm)
Av. Thickness	4.64	2.49	8.36	(mm)
Av. Volume	64.31	210.22	868.82	(mm^3)
Av. Weight of 1000 seeds	26.10	142.28	882.40	(g)
Av. Geometric diameter	4.97	7.38	11.84	(mm)
Av. Arithmetic diameter	4.98	9.55	12.87	(mm)
Av. Flat surface area	20.79	126.64	155.89	(mm^2)
Av. Transverse surface area	19.47	71.64	165.55	(mm^2)
Av. Sphericity	92.93	45.46	57.48	(%)

2.2. METHOD:

The major tests carried out on the new constructed planter were done in the laboratory and on the field after that. The laboratory and field tests were carried out at Agricultural Engineering Department, Faculty of Agriculture, Zagazig University and a private farm in Fakkous, Sharkia province to evaluate the performance of the manufactured planter during the successful agricultural season of (2009/2010).

2.2.1. Laboratory tests:

1. Planter calibration: The constructed planter was calibrated in the laboratory to determine the rate of discharge, uniformity of seed spacing in rows and seed damage. Each hopper of the constructed planter was loaded with 250, 500 and 2000 g of sugar beet, zucchini and groundnut seeds, respectively. The planter was held above a special stand to free the drive wheel was rotated. A paint mark was made on the drive wheel to serve as reference point to count the number of revolutions when turned; and a polythene bag was placed under each of the discharge spouts to collect the seeds discharged. The drive wheel was rotated 30 times at low speed as would be obtained on the field. A stop watch was used to measure the time taken to complete the revolutions. The seeds in each bag were weighed on an electrical balance and the procedure was repeated five times to calculate the mean of each treatment.

2. Seed damage test: The test for percentage seeds damaged was done with the planter held in a similar position to that described above. The drive wheels were rotated 30 times, and the time taken to complete the revolutions was recorded with the aid of the stop watch. The seeds discharged from each spout were observed for any visible damage, and then the damaged seeds were weighted to represent the seed damage percentage.

3. Uniformity of seed spacing: To determine the uniformity of seed spacing 250, 500 and 2000 g of sugar beet, zucchini and groundnut seeds, respectively were loaded into the planter hoppers individually. A 20 meters run was marked out on the ground and the planter run within the length at four different walking speeds of 0.8, 1.2, 1.7 and 2.3 km/h, recording by calculating the time of each travel. A measuring tape was used to determine the distance between successive hills dropped.

2.2.2. Field tests:

The experimented area was 2700 m^2 (about 0.64 feddan) in sandy loamy soil, divided into three main plots having dimensions of (50×18 m) planted with sugar beet, zucchini and groundnut seeds. The plot areas were ploughed with chisel plow double face and harrowed to obtain a fairly flat ground. The constructed planter was operated at four different walking speeds of 0.8, 1.2, 1.7 and 2.3 km/h and replicated three times to determine the actual field capacity and efficiency, average depth of placement of seeds in the row, uniformity of seed spacing in the field, energy consumed and total planting cost.

1. Field capacity: was the actual average time consumed during planting operation (lost time + effective time). It can be determined from the following equation, (Keppner et al. 1982):

$$F.C_{act} = \frac{60}{Tu + Tl}\ , \quad (fed/h) ....(1)$$

Where: $F.C_{act}$ = Actual field capacity of the planter.

T_u = Utilization time per feddan in minutes.

T_l = Summation of lost time per feddan in minutes.

2. Field efficiency: is calculated by using the values of the theoretical field capacity and effective field capacity rates as, (Keppner et al. 1982):

$$\eta_f = \frac{F.C_{act}}{F.C_{th}} \times 100 \quad (\%),\ ....(2)$$

Where: η_f = Field efficiency, %.

3. Planting depth: The average depth of seed placement in the row was determined by running the planter over an area of 150 m^2 without the furrow covering devices and with medium setting of the furrow openers. Along each furrow, ten hills were randomly sampled and investigated for depth of placement using a steel tape to measure the planting depth.

4. *Energy of manual work:* Manual labor could be determined as mechanical power equal to (0.075 to 0.10 hp) at continuous work (Lijedahl et al. 1951).

$$Worker\ power = 0.1 \times 0.735 = 0.0735\, kW,\ ....(3)$$

So, the energy can be calculated as following:

$$Consumed\ energy = \frac{Worker\ power, (kW)}{Field\ capacity, (fed/h)},\ kW.h/fed ....(4)$$

5. *Planting cost:* The total cost of planting operation was estimated using the following equation (Awady 1982):

$$Operating\ cost = \frac{Machine\ cost\ (L.E/h)}{Actual\ field\ capacity\ (fed/h)},\ (L.E/fed) ......(5)$$

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

$$C = \frac{P}{h}\left(\frac{1}{a} + \frac{i}{2} + t + r\right) + \left(0.9W.S.F\right) + \frac{m}{144} \qquad (6)$$

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, y.
i = Interest rate/year.
F = Fuel price, L.E/*l*.
t = Taxes, over heads ratio.
r = Repairs and maintenance ratio.
m = 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.

RESULTS AND DISCUSSION

3.1. Planter calibration:

Table (2) shows the obtained data from the calibration of the planter. It could be seen from the table that the average weights discharged from the two hoppers are 64.53, 142.67 and 452.19g at cell diameter of 2.0 cm and No. of cells (4) for sugar beet, zucchini and groundnut, respectively.

Table (2): Calibration the planter. (Seed weights discharged from hoppers).

No. of cells	Seed variety								
	Sugar beet			Zucchini			Groundnut		
	Cell diameter, (cm)								
	1.0	1.5	2.0	1.5	2.0	3.0	2.0	3.0	4.0
	Average seed weights discharged, (g)								
2	19.87	25.23	33.46	28.74	35.64	48.74	113.65	171.94	216.05
3	23.15	30.49	41.84	50.94	69.43	85.65	210.14	401.63	437.18
4	32.93	44.36	64.53	107.63	142.67	168.27	452.19	578.48	720.27

It was observed that the rate of discharge was affected by the cell diameter and the No of cells on the disk. Increasing both cell diameter and No. of cells on the disk increased seed discharged from the two hoppers at constant rotating speed of 30 rev./min. It was observed that the planter was able to effectively meter out (2-3) seeds per hill at 1.0 and 1.5 cm for sugar beet and zucchini, respectively. While it was meter out (1-2) seeds per hill at cell diameter of 2.0 cm for ground nut. This is good enough and the design is such that the number of seed metered out could be regulated by increasing cell diameter or No. of cells on the disk.

3.2. Seed damage test:

Fig. (3) shows the percentage of seed damaged during planter calibration under different seed types and cell diameters. The higher percentage of seed damaged was observed in groundnut seeds of 31.69 % followed by the sugar beet seeds of 7.06 %, and the lower was in zucchini seeds of 2.98 %.

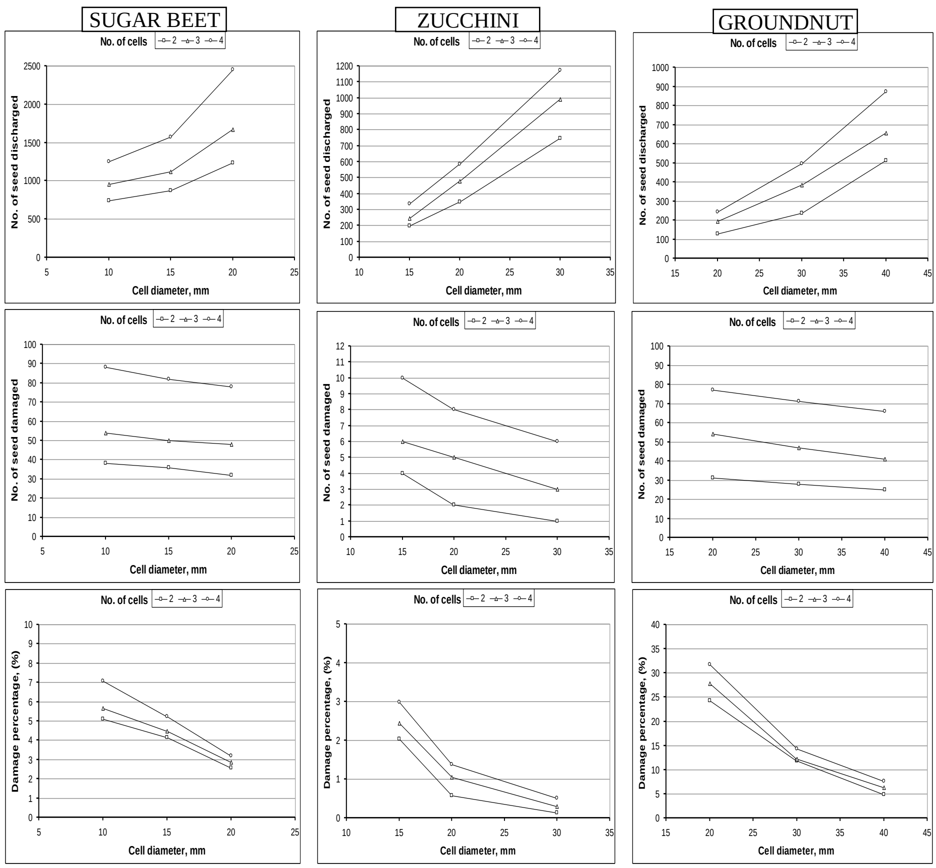

Fig.(3): Effect of cell diameter and its number on seed discharged, seed damaged and damage percentage.

These results may be attributed to the kind of seeds. The ground nuts having a thin and sensitive cortex. While the multi germ sugar beet variety could be damaged and broken due to the minimal clearance between the metering device and its housing which producing shearing force resulting from rotating speed of metering disk in the metering house. Thus, to minimize the percentage of seed damage, the metering disk should be rotated at lower speed and increasing the cell diameter. On the other side, increasing the No.

of cells on the metering disk from 2 to 4 cells increasing the seed damage percentage from 2.57 to 3.18, 0.58 to 1,37 and 24.22 to 31.69 % for sugar beet, zucchini and ground nut, respectively. This result was attributed to increasing the number of shearing forces by increasing the No. of cells on the metering disk.

3.3. Uniformity of seed spacing:

Table (3) shows the measurements taken for intra-row spacing in the laboratory and on the field after three weeks of planting. In the laboratory test, the mean intra-row spacing of seeds for the furrows was 21.67, 45.65 and 23.25 cm for sugar beet, zucchini and ground nut at cell diameter of 1.0, 1.5 and 2.0 cm and No. of cells on the disk of 4, 2 and 4, respectively. This shows a fairly uniform spacing of seeds within the rows when the planter was run laboratory on plain ground. The spacing obtained from the field test was higher than that obtained in the laboratory test.

Table (3): Uniformity of hill spacing in the row (laboratory and field).

Seed variety	Cell diameter, (cm)	Forward speed, (km/h)	Av. Spacing (Lab.), (cm)			Av. Spacing (Field), (cm)		
			No. of cells					
			2	3	4	2	3	4
Sugar beet	**1.0**	1.50	42.56	27.73	<u>21.67</u>	44.75	31.27	<u>23.54</u>
Zucchini	**1.5**	1.50	<u>45.65</u>	30.41	24.33	<u>48.25</u>	34.54	27.28
Groundnut	**2.0**	1.50	46.32	29.37	<u>23.25</u>	50.64	32.39	<u>26.51</u>

The mean intra-row spacing of seeds for the furrows was 23.54, 48.25 and 26.51 cm under the same previous conditions and lower planter forward speed of 0.8 km/h. It could be seen that the laboratory test gave a better spacing result than what was obtained on the field. This could be due to the clogging of the seed and the germination rate of seeds planted, since the seeds did not attain 100% germination. The other reason is the operator's level of experience and also taking into consideration the slippage of machine. The machine at a uniformly low speed would achieve better spacing than higher speeds.

3.4. Planter performance:

a- Field capacity and efficiency:

As shown in Table (4), the effective field capacity of the machine increased from 0.211 to 0.540 fed/h as machine forward speed increased from 0.8 to 2.3 km/h. While the field efficiency was decreased from 73.78 to 65.77 %.

This values correspond to those of the literature cited and even have acceptable values as those of the manually-operated seeding attachment of 0.282 ha/h for an animal drawn cultivator developed by Kumar et. al (1986), especially at higher forward speeds. The satisfactory result may be due to its maneuverability, which saves time in turning or moving the planter from one point to another.

Table (4): Planter field capacity and efficiency.

Planter forward speed, (km/h)	Theoretical field capacity, (fed /h)	Actual field capacity, (fed /h)	Field efficiency, (%)
0.8	0.286	0.211	73.78
1.2	0.429	0.301	70.16
1.7	0.607	0.415	68.37
2.3	0.821	0.540	65.77

b- Planting depth:

Table (5) shows the depth measurements taken in the determination of the average depths of furrows opened for different seeds. The mean depth of furrows opened at the medium setting of both openers are 20 mm. However, the suitable planting depth is achievable with the adjustment of the opening devices according to the type of seed variety. The recommended planting depth for sugar beet, zucchini and groundnut were (10-20), (30-40) and (40-50) cm. The furrow openers were adjusted to achieve these depths. The average depth of both furrow openers were 19.57, 40.21 and 49.67 cm which were suitable for planting sugar beet, zucchini and groundnut, respectively.

Table (5): Average depth of placement of seeds in the row, (mm).

No. of actions	Sugar beet		Zucchini		Groundnut	
	Furrow-1	Furrow-2	Furrow-1	Furrow-2	Furrow-1	Furrow-2
1	19.75	18.23	39.65	41.77	46.21	50.34
2	20.64	20.63	38.29	38.56	53.33	51.27
3	18.84	18.24	40.65	39.34	46.18	49.52
4	19.63	17.28	41.26	42.18	50.43	52.94
5	22.72	19.74	39.55	40.83	47.86	48.61
Average	20.32	18.82	39.88	40.54	48.80	50.54
	19.57		**40.21**		**49.67**	

3.5. Energy consumed and planting cost:

Concerning the effect of machine forward speed on energy consumed (kW.h/fed) and planting cost (L.E/fed), results in Table (6) indicated that at forward speeds of 0.8, 1.2, 1.7 and 2.3 km/h the energy consumed and planting cost were 0.719, 0.500, 0.362 and 0.278 kW.h/fed and 40.43, 28.10, 20.36 and 15.61 L.E/fed, respectively. It is noticed that increasing machine forward speed leads to decrease both energy consumed and planting cost; this results were attributed to the increase in machine field capacity.

Table (6): Energy consumed and planting cost .

Planter forward speed, (km/h)	Energy consumed, (kW.h/fed)	Planting cost, (L.E/fed)
0.8	0.348	26.64
1.2	0.244	18.67
1.7	0.177	13.54
2.3	0.136	10.41

SUMMARY

A manually-operated two row planter was developed and manufactured from locally available materials to suit the need of the peasant farmers in delta Egypt. This machine could be drawn by a human, animal or small tractor. The manually-operated planter consists of four main parts of two hoppers, metering device, furrow openers and covering device. This planter was developed to be suitable for planting three different types of seeds, sugar beet, zucchini and groundnut. From obtained laboratory and field tests, it could be concluded the followings:

- The maximum seed weights discharged from the hoppers of 64.53 and 168.27 and 720.27 g were achieved at cell diameter of 2.0, 3.0 and 4.0 cm and No. of cells on the disk of 4 for sugar beet, zucchini and groundnut, respectively.
- The minimum damage percentage of 2.57, 0.13 and 4.89 % were obtained at No. of cells on the metering disk of 2 and cell diameter of 2.0, 3.0 and 4.0 cm for sugar beet, zucchini and groundnut, respectively.
- The minimum energy consumed and planting cost of 0.136 kW.h/fed and 10.41 L.E/fed were obtained at high forward speed of 2.3 km/h.
- Planting both sugar beet and groundnut seeds on 50 cm spacing between rows and 20 cm spacing between hills using cell No. of 4 cell on the metering disk,

while the zucchini seeds planting on 50 cm spacing between rows and 40 cm spacing between hills using cell No. of 2 cell on the metering disk.

- Planting sugar beet, zucchini and groundnut seeds using cell diameters of 1.0, 1.5 and 2.0 cm to but (2-30, (2-3) and (1-2) seeds in each hill, respectively.

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الملخص العربي

تصنيع وتقييم آلة للزراعة في جور تعمل يدوياً لتناسب المساحات الصغيرة

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يوجد العديد من البذور الحساسة جداً عند الزراعة الآلية باستخدام آلات الزراعة في جور مثل البنجر، الكوسة والفول السوداني، حيث يتسبب ذلك في إتلاف نسبة عالية من البذور مما يؤثر على نسبة الإنبات وبالتالي على كمية المحصول النهائي. ويعتبر جهاز التلقيم في آلة الزراعة في جور من أهم المكونات التي من خلاله يمكن التحكم في معدل التلقيم وكذلك نسبة التلف الميكانيكي للبذور.

في دلتا مصر، بسبب الحيازات المفتتة يلجأ الكثير من المزارعين إلى زراعة مثل هذه المحاصيل يدوياً مما ينتج عنه توزيع غير منتظم للبذور، نسبة إنبات منخفضة لاختلال عمق الزراعة وكذلك استهلاك كمية كبيرة من التقاوي فضلاً عن المجهود العالي والتكلفة الكبيرة للزراعة اليدوية. لذلك كانت هناك حاجة إلى تطوير آلة زراعة في جور بسيطة التركيب ومصنعة من خامات محلية يمكن من خلالها زراعة مثل هذه المحاصيل بمجهود بسيط مع التغلب على عيوب ومشاكل الزراعة اليدوية في المساحات الصغيرة. حيث يمكن أن تجر هذه الآلة بواسطة العامل أو الحيوان أو جرار صغير وذلك لبساطة تركيبها وخفة وزنها.

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تم تطوير وتصنيع الآلة المطورة في ورشة قسم الهندسة الزراعية ـ كلية الزراعة ـ جامعة الزقازيق. تتركب هذه الآلة من أربع أجزاء رئيسية هي: قادوس البذور، جهاز التلقيم وهو من النوع ذو القرص الرأسي، الفجاجات وجهاز تغطية البذور. وقد تم إجراء بعض الاختبارات المعملية والحقلية على الآلة المطورة في ورشة قسم الهندسة الزراعية وفي مزرعة خاصة بفاقوس – شرقية ، وذلك لمعايرة هذه الآلة، قياس كلاً من نسبة التلف الميكانيكي للبذور والتوزيع المنتظم لمسافات الزراعة، السعة والكفاءة الحقلية، عمق الزراعة وكذلك الطاقة المستهلكة والتكاليف الكلية لعملية الزراعة من خلال المتغيرات التالية: ثلاثة أنواع من بذور المحاصيل المختلفة (البنجر متعدد الأجنة، الكوسة والفول السوداني) – ثلاثة أقطار لخلايا البذور (١,٠ ، ١,٥ و ٢,٠ سم للبنجر) ، (١,٥ ، ٢,٠ و ٣,٠ سم للكوسة) و (٢,٠ ، ٣,٠ و ٤,٠ سم للفول السوداني) للتحكم في عدد البذور في الجورة – أعداد مختلفة من الخلايا على محيط قرص البذور الرأسي (٢ ، ٣ و ٤) للتحكم في المسافات بين الجور.

وقد خلصت النتائج إلى الآتي:

- أعلى كمية بذور خارجة من قادوسي البذور كانت ٦٤,٥٣ ، ١٦٨,٢٧ و٧٢٠,٢٧ جم عند استخدام قطر خلايا البذور ٢ ، ٣ و ٤ سم وكذلك عدد خلايا على محيط القرص ٤ خلايا لكل من البنجر، الكوسة والفول السوداني، على الترتيب.
- أقل نسبة تلف ميكانيكي للبذور كانت ٢,٥٧ ، ٠,١٣ و ٤,٨٩ ٪ عند استخدام قطر خلايا البذور ٢ ، ٣ و ٤ سم وكذلك عدد خلايا على محيط القرص ٢ خلية لكل من البنجر، الكوسة والفول السوداني، على الترتيب.
- أعلى سعة حقلية كانت ٠,٥٤٠ فدان/س كانت عند سرعة أمامية عالية ٢,٣ كم/س، بينما كنت أعلى كفاءة حقلية ٧٣,٧٨ ٪ عند سرعة أمامية منخفضة ٠,٨ كم/س.
- أقل طاقة مستهلكة وأقل تكاليف للزراعة الآلية باستخدام الآلة المطورة كانت ٠,١٣٦ كيلووات.س/فدان و ١١,٤١ جنيه/فدان عند سرعة أمامية عالية ٢,٣ كم/س.
- يتم زراعة كلاً من البنجر والفول السوداني على مسافات ٥٠ سم بين الصفوف و٢٠ سم بين الجور باستخدام عدد خلايا على قرص البذور ٤ خلية، بينما تتم زراعة الكوسة على مسافات ٥٠ سم بين الصفوف و٤٠ سم بين الجور باستخدام عدد خلايا على قرص البذور ٢ خلية.
- يتم زراعة البنجر باستخدام قطر خلايا ١,٠ سم للحصول على (٢-٣ حبة في الجورة) ، تتم زراعة الكوسة باستخدام قطر خلايا ١,٥ سم للحصول على (٢-٣ حبة في الجورة) و يتم زراعة الفول السوداني باستخدام قطر خلايا ٢,٠ سم للحصول على (١-٢ حبة في الجورة).