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Development a Single Row Potato Planter for Small Holdings

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ABSTRACT

The objective of this research was to develop a single-row of automatic potato planter by modification the metering mechanism spoon size to well-matched with size and shape of slide tuber that previous cutting to overcome the high prices of import potato tuber in January period. This planter was locally fabricated to be operated by mini tractor to suit the small holdings. The modified planter performance was evaluated under three different spoon diameters of 25, 35 and 45 mm, three forward speeds of 1.6, 2.4 and 3.2 km/h and two different shapes of potato (oblong and spherical) namely, Sponta and Diamond varieties. The field results revealed that, as spoon size diameters (D) increased from 25 to 45 mm, the percent of void tubers decreased from 4.04 to 2.58% and the percent of double tubers increased from 2.83 to 8.31 %. While as the forward speed (S) increased from 1.6 to 3.2 km/h, the percent of void tubers increased from 2.57 to 3.87 % and the percent of double tubers decreased from 7.18 to 4.95 %. The proper distribution uniformity values of 91.81% for the potato planter was obtained at 25 mm spoon diameter and 3.2 km/h forward speed which gave 3.4 and 4.79 % for the percent of void and double tubers respectively. The distribution uniformity of oblong potato tubers (Sponta) was better than that of spherical potato tubers (Diamond). At the proper operating parameters, the consumed specific energy was 22.28 kWh/fed, the estimated total costs was 180.18 EGP/fed.

Keywords: A single-row; potato planter; distribution uniformity; void tubers; double tubers.

INTRODUCTION

Potato is an essential food crop for humans and animals due to its desirable starch, protein and vitamins contents. The potato is used as a versatile vegetable and in food manufacturing. The potato is planting in many countries under the world and it various climates (Taheri and Shamabadi 2013). It crop is considered one of the main vegetable crops in Egypt. The process of potato planting is important to be studied. For example, at summer season which putting tubers in January, tuber need be cutting into pieces, each pieces including two or three buds in order to multiply pieces consequently reduce the cost per unit area. Therefore, it was necessary to recognize a modification appropriate for size of cut tubers, by identifying the spoons size for automatic potato planter. Consequently, to increase the yearly operating time of mini-tractors with low cost it is imperative to develop a single-row automatic potato planter for small holdings (Griepentrog, 1998). The planting of potatoes is carried out by hand or use semi-automatic planters and or use fully automatic planters. Planting done by hand is time-consuming and requires a great deal of labor. Semi-automatic potato planters have a suitable performance and low labor and less time-consuming compared to plant by hand. Labor and time-consuming in fully automatic potato planters are the lowest level. Results achieved in potato planting machine depend on complex relationships between the technical machine performance and the ability to work fast with a minimum demand for labor (Steele *et al*, 2010). The fully automatic potato planters is transfer the potato from the hopper to the conveyor belt with cups sized to release one potato seeds in furrows at desired certain spacing and depth (Ebrahem *et al.*, 2011).

Accuracy of in-row tubers spacing is the main parameter of the feeding metering device. Because of improvement of tubers spacing uniformity leads to high yield and to facilitate harvesting and post-harvest operations (Pavek and Thornton, 2003). The uniformity of tubers spacing and the regularity of depth leads to increase germination and productivity by reducing competition between plants and some of them for the availability of light, water and nutrients available (Iritani *et al*, 2002 and Buitenwerf *et al*, 2006). Tubers spacing uniformity is very important role for evaluating a potato planter performance (Seyedbagheri, 2006). The spacing uniformity in-row decreased as ground speed increases (Altuntas, 2005). And also Khairy (1997) found that when the ground speed was higher than 3.6 km h^{-1}, tubers spacing uniformity became worse. Moreover, Al-Gaadi and Marey (2011) showed that there was an effect of ground speed and different tubers sizes and shapes on tubers spacing uniformity. The results revealed that the lowest and the highest mean values of CV% were 28.73 and 54.53% for ground speed of 1.80 and 3 kmh^{-1}, respectively.

To reduce the costs of growing potatoes, farmers planted potato tubers cut into 2 to 4 parts as seeds for planting. In Korea, since the method used to manually cut potato tubers by workers, it is difficult to determine the size and shape of the seed cups. Therefore, the fully automatic potato planting machine had to be developed (Cho, 2017). In addition hand cutting minimizes the number of blind pieces, but is slow and labor intensive. Size potatoes before cutting, tubers under 45g should not be planted. Tubers weighing between 45g but less than 90g should be planted whole. Tubers with 90 – 150g should be cut into two pieces and tubers with mass of 150 - 210g should be cut into three

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pieces (Johnson, 2004). According to the measured physical and mechanical properties by (El-Ghobashy *et al*., 2014) to design, manufacture and evaluate a locally made potato seed cutting prototype. The prototype performance was evaluated at the variables of two potato varieties shapes of oblong and spherical (Sponta and Diamond), three mass categories Cm1 (90 - 150g), cm^2 (150 - 210g) & cm^2 (210 - 300g) and three plunger speeds (0.08, 0.12 and 0.16 m/s). Results revealed that the potato tuber dimensions were mainly properties to design the pocket sizes which must be equal or greater than the maximum dimensions of the three tuber mass categories for the two studied varieties. The maximum sizes (length and width) for cm^2 105.2, 63.1 mm and 79.2, 67.1 mm were obtained, 121.2, 69.4 mm and 89.1, 77.2 mm for cm^2, however, for cm^2 were 155.0, 69.1 mm and 107.7, 87.2 mm for the Sponta and Diamond respectively. Also Ismail (2006) showed that the size of the most suitable tuber segment should be in the range of 30-50 g when the distance between the tuber and the other in the same line is around 25 cm. The results also showed that only 10% of the variation in the mass of the tubers is due to the size of the tubers when the spacing was 30 cm and added that a life span potato plant takes about 120 days. Islam *et al*, (2012) studied effect of tuber size and planting space on tuber yield and yield contributing characters of potato (*Solanum tuberosum*) in the northern region of Bangladesh. It wasfound that days to emergence increased with closer spacing and small size seed tuber. The number of tubers per plant increased with increasing Intra- row spacing and tuber size. They recommended 28 - 35 mm size seed tubers in 60 × 25 cm spacing was the best method for farmers for getting higher income. Choi *et al*., (2017a); Choi *et al*., (2017b) developed a fully automatic potato planter by adding a device that can cut potato tubers to reduce the cost of potato seeds. It is important to consider the process of properly transporting potato seed of various sizes and shapes at the appropriate time. A full automatic potato planter with the seed metering mechanism with the vertical disc was tested by (Boydas, 2017) under different cups size (C1<C2<C3), different tubers sizes (25 to 45 and 45 to 65 mm), different shapes (oblong and spherical), and angular speeds (0.9, 2.04 and 3.18 rad s^{-1}) in laboratory. The laboratory tests showed that, all studied parameters have significant effect on the seed metering mechanism. The best seed spacing uniformity was obtained for C2. Both small and large cups disturbed the seed spacing uniformity. As cup size increased, percent value of doubles increased, while percent value of skips decreased. The seed spacing uniformity of oblong potato seeds was better than that of spherical potato seeds. Skips value of oblong potato seeds was lower than that of spherical potato seeds. Nevertheless, the percent value of doubles obtained from oblong potato seeds was slightly higher than that of spherical potato seeds. Small potato seeds of 25- 45 mm led to an increase in the value of CV%. The reason for this was the doubles. Increasing the angular speed decreased the seed spacing uniformity. As the angular speed increased, percent value of doubles decreased and percent value of skips increased.

The present study aims to develop a single row automatic potato planter for small holdings by modifying spoons size of automatic feeding device to suit the position of cut tubers size. Evaluate some parameters affecting the developed planter to plant the cut tubers more efficiently with low cost.

MATERIALS AND METHODS

Various spoons size diameter of automatic feeding device for a single-row automatic potato planter was modified to suit the cut tuber sizes throughout planting. The developed single-row automatic potato planter was locally fabricated at Tanta Motors Company, Emagro Branch, Gharbia Governorate. While the field evaluation experiments were carried out in the farm of Etay Elbaroud, Agricultural Research Station, Behera Governorate, during the Agriculture Season (2020).

Machine description

Fig.1 shows the modified planter, which consists of main frame, tubers metering mechanism, tubers hopper, tuber tube, ground wheels, furrow openers and covering shares and the tuber spacing adjustment gear. The general specifications of the single-row automatic potato planter is overall dimension (122×113×147.5 cm), mass (130 kg), space between plants 20-30cm, space between furrow tops 65-80cm, connecting of 3 point linkage of category one. The tubers metering device of the single-row automatic potato planter is a spoon type vertical drive which, consists of 14 spoons and chain with equivalent spoon distance. Tuber packing is greatly affected by the relationship between the cell size and thickness of the tuber. So, the chain-feed of the potato planter was developed to plant tuber pieces by modified spoons size. These spoons diameters were modified from 60 mm to three various diameters of 25, 35 and 45 mm to suit the cut tubers, according to the measured physical properties by (El-Ghobashy *et al*., 2014). The spoons with chain is passed from the hopper bottom to top and driven by ground wheels. The tubers hopper (50 kg capacity) was designed to easily feed the cut tubers and conveys it from the hopper-through the metering device to the furrow opener by tuber tube. The motion of the tubers takes place due to gravitational force. The transmission system was constructed to control the number of spoons per revolution using different chain-sprocket transmission to prevent slipping and also to transmit the motion from the planter wheel (D = 540 mm) to the feeding device. Furrow opener (shoe shape type) is fixed in the front beam to adjusted and control the depth of the furrow. The closing system consists of two covering shares units located at the back end.

Operational considerations of the modified planter

During operation, the planter moves forward by tractor, then the chain and spoon assembly start moving anchored from the bottom to the top through the cut tubers hopper. As the chain moves up, each spoon carries one piece of cut tubers and the chain moves further up and the spoon gets inverted inside a tuber tube which drops the tuber piece to the ground at desired spacing and depth. At the same time, the furrow opener opens up a furrow in which the cut tubers are planted. As the planter moves further, the ridge attachment then covers the cut tubers and makes a ridge.

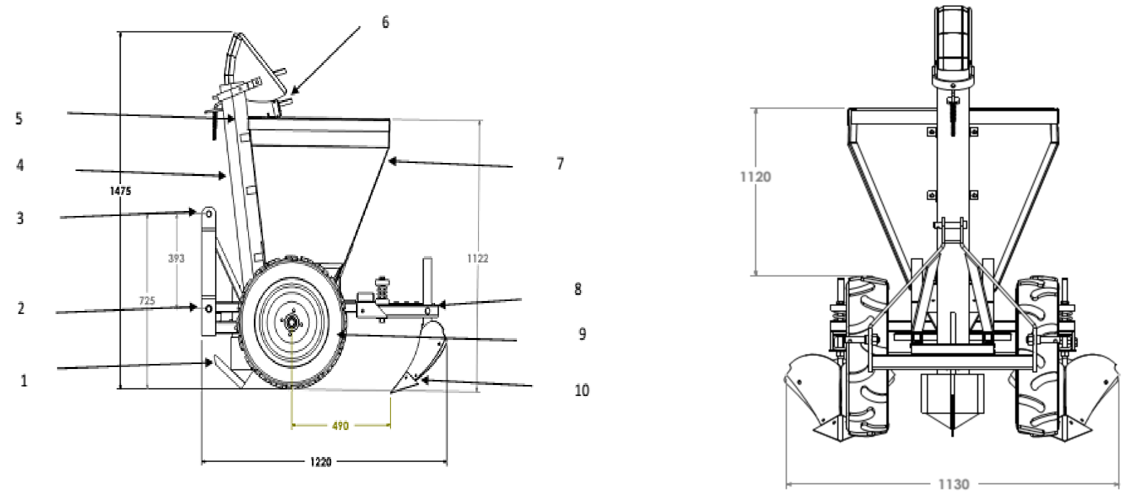
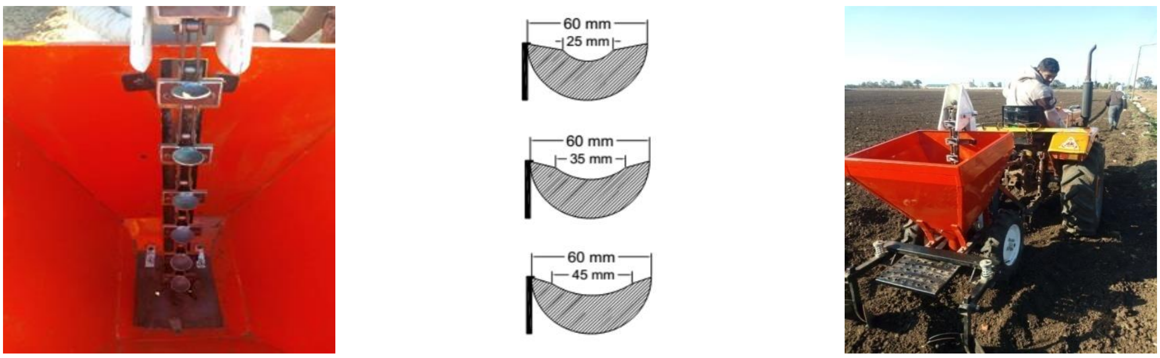


Fig. 1. Schematic diagram of main components for a single-row automatic potato planter

1- Furrow opener.
2- Bottom link.
3- Top link.
4- Tuber tube.
5- Tuber metering device.
6- Spoons.
7- Tuber hopper.
8- Frame.
9- Ground wheel.
10- Covering shares.
Dim in (mm).



Spoon size before modification **Spoons diameter after modification** **Planter during operation**

Fig. 2. Metering device for the single-row potato planter

Tuber spacing adjustment

Tuber to tuber spacing in the field is regulated by the rate of rotation of the tuber-metering pulley. The metering pulley rotation i.e. the tuber spacing of potato is maintained by the planter drive wheel diameter and the size of sprockets attached to the planter drive wheel and the axle of the tuber-metering pulley.

Field condition

The field condition is important for sowing operation and therefore, has considerable effect on tuber germination and tuber yield. The field conditions were soil type (sandy loam), soil moisture content in percent (15.83%), bulk density (1.347 gm /cm^3), depth of seedbed (25 cm). the intra row distance between tuber to tuber (25 cm) and planting depth (10cm).

Field experiments of the modified potato planter

The aim of experimental work is to test the performance of the modified single-row automatic potato planter. The experimental work was conducted to evaluate the effect of three different parameters on the modified machine performance. The experimental area was 35 m length × 3.5 wide m for each plot, each parameter was replicated three times. The experiments were arranged in factorial design with three replicates using COSTAT 6400 software. The analysis of variance was done to investigate the significance of studied parameters. These parameters were as the follows:

a) Three different forward speeds (S), (1.6, 2.4 and 3.2 km/h).
b) Three different spoons diameter (D), (25, 35 and 45 mm).
c) Two different shapes of potato tubers (V), (oblong and spherical) namely, Sponta and Diamond varieties.

The travel speed, S (km/h), d is premeasured distance, m and t is recorded time (sec) by performing the following tests in the laboratory as well as in the field as the following.

$$S = \frac{3.6 \times d}{t} \qquad (1)$$

The field experiments were carried out by rotating the planter ground wheel for 20 revolutions to evaluate the planter performance such as the tuber void ratio, the tuber double ratio, distribution uniformity of tuber in a row, germination ratio, field efficiency, consumed specific energy and cost of developed planter as follows.

Void tuber ratio, (T_v, %): It could be considered as the first indicator of the planter performance. It was estimated for each treatment by counting the number of spoons that have no tubers and counting the number of the used spoons in each treatment. Then the percentage of voids can be calculated as follows (Morsy, 2005):

$$T_v,\% = \frac{Bn}{M} \times 100 \quad (2)$$

Where:

Bn: The number of spoons that have no cut tubers.

M: The number of the used spoons.

The double tuber ratio, (T_d, %): It could be considered as the second indicator for planter performance. It was estimated for each treatment by counting the number of spoons that have more than one piece tuber and counting the number of the used spoons in each treatment. Then the percentage of piece tuber doubles ratio can be calculated as follows (Morsy, 2005):

$$T_d,\% = \frac{A_n}{M} \times 100 \quad (3)$$

Where:

A_n: The number of spoons that have more than one cut tuber.

M: The number of the used spoons.

The distribution uniformity of tuber piece in a row (U_H, %): It could be considered as the third indicator for planter performance. It was estimated by calculating the cut tuber void ratio and the cut tuber double ratio. Then the percentage of the uniformity of the cutting tuber in a row can be calculated as follows (Morsy, 2005):

$$U_H,\% = 100 - (T_v,\% + T_d,\%) \quad (4)$$

Tuber germination test in field: After one week of planting potato, germinated tubers were measured in a span of 10 m by counting the number of tubers that germinated and attributed to the total number of all falling tubers for each treatment. The cutting tubers were manually planted to compare germination ratio between manually and mechanically planting (Raulaji, 2004).

Theoretical field capacity (TFC, fed/h), effective field capacity and field efficiency were calculated by common methods (Ismail, 2011) and (Kepner *et al*., 1982).

Power requirements, (EP, kW)

The following formula was used to estimate the engine power according to (Hunt, 1983).

$$EP(kW) = Fc \times \frac{1}{60 \times 60} \times Pf \times L.C.V \times 427 \times \eta m \times \eta th \times \frac{1}{75} \times \frac{1}{1.36} \quad (5)$$

Where:

Fc: Fuel consumption L/h. Pf: Density of fuel, kg/L (for solar = 0.85).

L.C.V: lower calorific value of fuel for solar (11000 kcal / kg).

η_{th}: Thermal efficiency of the engine (about 35 % for diesel engines).

427: Thermo-mechanical equivalent, kg m / kcal.

η_m: Mechanical efficiency of the engine (about 80 % for diesel engines).

So, the consumed specific energy (CSE) can be calculated as the following equation:

$$\text{Consumed specific energy}, (kW.h/fed) = \frac{\text{Required power}(kW)}{\text{Effective field capacity}(fed/h)} \quad (6)$$

Planting operation cost:

The total operational cost which includes the potato planter cost and tractor cost in EGP/h and EGP/fed. were calculated from test results. The assumption for machine life and tractor, hours of operation (per day and per year), rate of interest and the cost of machine, etc. as per standard procedure was calculated. The cost for each of planter and tractor is divided into two components such as fixed cost and variable costs. Annual fixed cost including depreciation, interest on investment, tax, insurance and shelter whereas the variable cost includes repair and maintenance, labor, fuel and oil costs. Annual use of tractor and planter was considered as 1000 and 300 h/ year respectively. The planter and tractor price (Kubota L1-18hp) was 20000 and 50000 EGP respectively.

Planting cost was estimated using the following equation:

$$\text{Planting cost}, (EGP/fed) = \frac{\text{Total cost(planter + Tractor)}, EGP/h}{\text{Effective field capacity}, fed/h} \quad (7)$$

RESULTS AND DISCUSSION

Table 1 shows the statistical results (ANOVA), which revealed that the spoons diameter (D), forward speeds (S) and varieties (V) and the interactions of D×S, D×V and D×S×V had a significant effect on percent value of void, double tubers and distribution uniformity at (P<0.01), except for the interaction of S×V and D×S×V which showed a significant effect on percent value of double at (P<0.05).

Table 1. Analysis of Variance of spoons diameter, forward speed and tubers variety on percent value of void, double and distribution uniformity

Source of variance	DF	Void tuber %		Double tuber, %		Distribution uniformity,%	
		MS	P	MS	P	MS	P
Spoons (D)	2	9.804	0.000 [a]	151.066	0.000 [a]	84.779	0.000 [a]
Speed (S)	2	7.671	0.000 [a]	22.609	0.000 [a]	4.109	0.000 [a]
Variety (V)	1	47.884	0.000 [a]	11.436	0.000 [a]	12.521	0.000 [a]
Replication	2	0.317	0.000 [a]	0.127	0.448	0.045	0.796
D × S	4	0.388	0.000 [a]	1.133	0.000 [a]	1.096	0.001 [a]
D × V	2	0.436	0.000 [a]	1.940	0.000 [a]	4.006	0.000 [a]
S × V	2	0.038	0.309	0.561	0.037 [b]	0.454	0.114
D ×S× V	4	0.316	0.000 [a]	0.524	0.019[b]	0.865	0.006 [a]
Error	34	0.032		0.154		0.196	
Total	53	1.666		7.093		4.034	

[a], [b] significant at 1% and 5% level of probability respectively; DF, degrees of freedom; MS, mean square

The void tuber ratio as affected by various variables:

Fig. 3 shows that the percent of void tuber decreased with increasing spoons diameter (D) from 25 to 45 mm, but it continuously increased with increasing forward speed (S) from 1.6 to 3.2 km/h for Sponta and Diamond varieties respectively. The effect of spoons diameter, forward speed and tuber shapes on value of void, % was statistically significant (P<0.01). The highest value of void, % was determined for spoons diameter as 3.26 and 4.81 % at D1 and for the forward speed as 2.98 and 3.87 % at S3 for Sponta and Diamond varieties respectively. The lowest value of void, % for spoons diameter was 1.50 and 3.67 % at D3 and for forward speed was 1.60 and 2.57 % at S1 for Sponta and Diamond varieties respectively. The increase of forward speed from 1.6 to 3.2 km/h caused more void tuber, %. This may be attributed to the tuber pick up time is not sufficient and consequently did not suitable for the spoons feeding rate. The obtained results are in accordance with that obtained by (Morsy, 2005) and (Boydas, 2017).

The double tubers ratio as affected by various variables

Fig. 4 is revealed that the percent of double tuber increased with increasing spoons diameter from 25 to 45 mm, but it has decreased with increasing the forward speed from 1.6 to 3.2 km/h for Sponta and Diamond varieties respectively. Statistical analysis showed that the effect of various variables on doubles, % was statistically significant (P<0.01) as well. The highest and lowest values of doubles, % for spoons diameter were 8.59 and 8.02 % at D3 while they were 3.67 and 2.0 % at D1 and for forward speed they were 7.85 and 6.52 % at S1 while, 5.32 and 4.58 % at S3 for Sponta and Diamond varieties respectively. The positive effect of increasing the forward speed from 1.6 to 3.2 km/h caused less double tuber ratio. This may be attributed to the decrease of the available tuber pickup time at the higher machine forward speed of 3.2 km/h causing lower double tuber ratio as mentioned (Morsy, 2005) and (Boydas, 2017).

The tubers distribution uniformity, % as affected by various variables

Fig. 5 shows that, the tuber distribution uniformity, % recorded the highest uniformity values of 93.07 and 93.19 % at spoons diameter D1 and uniformity of 91.7 and 91.18 % at forward speed S3, while the lowest values of 89.91 and 88.31 % were recorded at spoons diameter D3 and a uniformity of 90.55 and 90.25 % at forward speed S1 for Sponta and Diamond varieties respectively. The effect of spoons diameter, forward speed and tuber shapes variety on the values of tuber distribution uniformity, % was statistically significant (P<0.01).

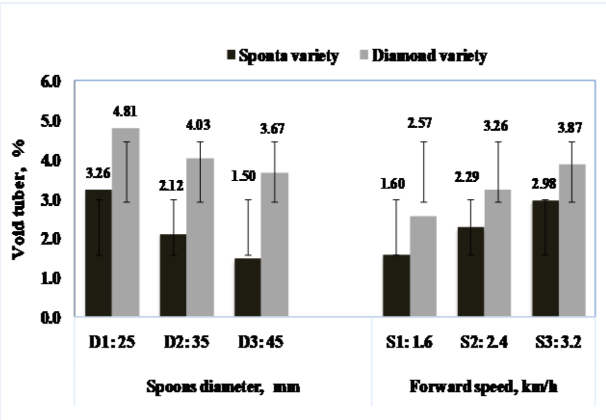


Fig. 3. The void tuber ratio as affected by spoons diameter, forward speeds and varieties.

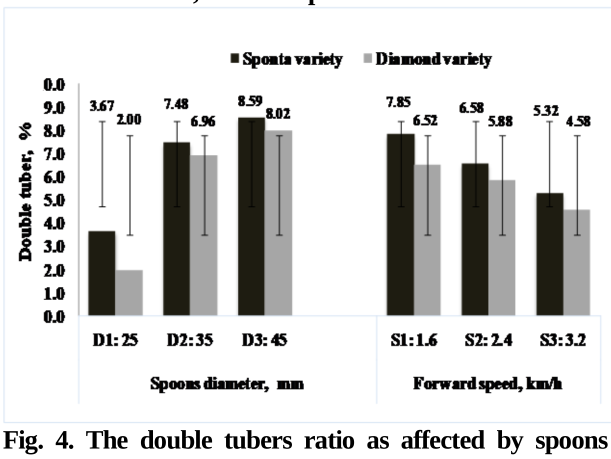


Fig. 4. The double tubers ratio as affected by spoons diameter, forward speeds and varieties.

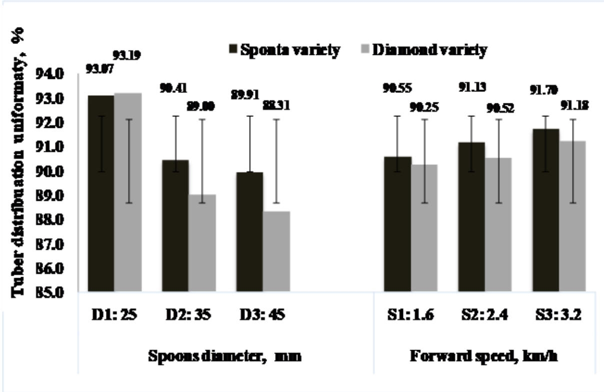


Fig. 5. The tubers distribution uniformity, % as affected by spoons diameter, forward speeds and varieties.

The proper performance of the single-row potato planter:

Table 2 shows the effect of spoons diameter, forward speed and tuber shapes variety on void, % double tubers, % and distribution uniformity, % for least significant difference (LSD) at 5%. LSD is used to compare means of various treatments that have an equal number of replication. The distribution uniformity, % is the most important measurement to choose the proper level of various parameters. It represent the interaction between the void, % and double tubers, %. (equation 4). The highest percent value of distribution efficiency was determined as 93.13% for spoons diameter D1, which recorded 4.04 and 2.83% for void,% and double, % respectively. As the highest percent value of distribution efficiency was 91.18 % for forward speed S3, the void,% and double recorded 3.87 and 4.95 % respectively. Sponta variety is better than Diamond variety which, recorded the highest percent value of distribution efficiency as 91.13%, which gave 2.29 and 6.58 % for void,% and double, % respectively. Accordingly, adjusting the potato planter at 25 mm spoons diameter and 3.2 km forward speed for Sponta and Diamond varieties gave the most proper distribution uniformity.

Table 2. Least significant difference (LSD) at 5% of spoons diameter, forward speed and tuber variety on percent value of void, double and distribution uniformity

Variables		Void, %	Double, %	Distribution uniformity, %
Spoons (D)	D1	4.04 a	2.83 c	93.13 a
	D2	3.08 b	7.22 b	89.70 b
	D3	2.58 c	8.31 a	89.11 c
	LSD 5%	0.12	0.27	0.30
Speed (S)	S1	2.57 c	7.18 a	90.25 b
	S2	3.26 b	6.23 b	90.52 b
	S3	3.87 a	4.95 c	91.18 a
	LSD 5%	0.12	0.27	0.30
Variety (V)	Sponta	2.29 b	6.58 a	91.13 a
	Diamond	4.17 a	5.66 a	90.17 b
	LSD 5%	0.10	0.22	0.24

The different letter means that there are a significant effect between level variables and conversely for same letter at the 5% level using the LSD test

Tubers germination:

Table 3 shows the tuber germination ratio for the planter which varied from 82.61 to 84.75 % for Sponta and 79.13 to 82.05 for Diamond at the three forward speeds comparing with manual planting of 83.33 and 81.67 % for

Sponta and Diamond varieties respectively. The highest tuber germination ratios were 84.75 and 82.05 % at speed of 3.2 km/h for Sponta and Diamond respectively. Consequently, there are no effect of planting speeds on percent germination. Also, there no difference were found in percentage of germination between the planter and manual planting.

Potato planter field capacity and field efficiency

As shown in Table 3. The effective field capacity of the potato planter increased from 0.22 to 0.41 fed/h as the planter forward speed increased from 1.6 to 3.2 km/h, while the field efficiency was decreased from 82.5 to 76.88%.

Consumed specific energy and planting cost:

The results in table 3 indicated that the consumed specific energy decreased from 27.68 to 22.28 kWh/fed as the forward speed increased from 1.6 to 3.2 km/h. The total cost of the planter and tractor were 67.13, 70.50 and 73.88 EGP/h and the planting cost were 305.11, 220.31 and 180.18 EGP/fed for the forward speeds of 1.6, 2.4 and 3.2 km/h respectively. At the proper forward speed of 3.2 km/h, the estimated planting costs was 180.18 EGP/fed. It was noticed that increasing the planter forward speed leads to decrease both consumed specific energy and planting cost. This was attributed to the increase in the planter field capacity as the forward speed increased.

Table 3. Germination ratio, field capacity, field efficiency, power, consumed specific energy and planting cost.

Forward speed, km/h	Germination ratio, %		Efc, fed/h	ηf, %	Power, kW	CSE, kWh/fed.	Total cost, EGP/h	Planting cost, EGP/fed.
	Sponta	Diamond						
1.6	82.61	81.42	0.22	82.50	6.09	27.68	67.13	305.11
2.4	83.76	79.13	0.32	80.00	7.61	23.78	70.50	220.31
3.2	84.75	82.05	0.41	76.88	9.13	22.28	73.88	180.18

Efc: Effective field capacity, ηf,: Field efficiency and CSE: Consumed specific energy

CONCLUSION

A single-row automatic potato planter for small holdings was modify its spoons diameter of the automatic feeding device to plant different size of cutting tuber. The modified planter was tested at different spoons diameter, forward speed and two different shapes of potato tubers (oblong and spherical) namely, Sponta and Diamond varieties. The statistical results (ANOVA), revealed that the all previous variables had significant effect on percent value of void tuber, double tuber and distribution uniformity at ($P<0.01$). As spoons diameter (D) increase from 25 to 45 mm, the percent of void tuber decreased from 3.26 to 1.5% for Sponta and from 4.81 to 3.67% for Diamond and the percent of double tuber increased from 3.67 to 8.59% for Sponta and from 2.0 to 8.02 % for Diamond. On contrary as the forward speed (S) increase from 1.6 to 3.2 km/h, the percent of void tuber increased from 1.60 to 2.98 % for Sponta and from 2.57 to 3.87 % for Diamond and the percent of double tubers increased from 7.85 to 5.32 % for Sponta and from 6.52 to 4.58 % for Diamond. The proper distribution uniformity value of 91.81% for the potato planter was obtained at 25 mm spoons diameter and 3.2 km forward speed which gave 3.4 and 4.79% for the percent of void and double tubers respectively. The distribution uniformity of oblong potato tubers (Sponta) was better than that of spherical potato tubers (Diamond). There was no effect of speed on tuber germination tests. The field efficiency was decreased from 82.5 to 76.88% and the consumed specific energy decreased from 27.68 to 22.28 kWh/fed as the planter forward speed increased from 1.6 to 3.2 km/h. At the proper forward speed of 3.2 km/h, the estimated planting costs was 180.18 EGP/fed.

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تطوير بلانتر بطاطس ذات خط واحد ليناسب الحيازات الصغيرة

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تقاوي البطاطس والتي غالباً ما يتم استيرادها تكون ذات أحجام صغيرة وهى مرتفعة الثمن مقارنة بالأسعار المنخفضة للتقاوي المستوردة ذات الأحجام الكبيرة وللعمل على خفض تلك التكاليف بقدر المستطاع يمكن زراعة البطاطس في مصر بتقاوي مجزاة بحيث يتم تجزئتها إلى أجزاء على حسب وزنها على أن يحتوى كل جزء من هذه البذور المجزاة على عدد 2 برعم أو أكثر مع مراعاة بعض الاحتياطات الفنية عند إجراء التقطيع لضمان المحافظة علي الإنبات بشكل جيد. وآلات الزراعة المستخدمة (البلانتر) تقوم بزراعة الدرنة الكاملة عن طريق ملاعق ملحقة بجهاز التلقيم للبلانتر حيث تلتقط الدرنات وتقوم بزراعتها على العمق والمسافة المحددين. لذا يهدف هذا البحث إلى تعديل مقاس قطر ملاعق البلانتر المستخدمة في التقاط بذور الدرنات الكاملة لتلائم التقاط بذور الدرنات المجزاة وذلك بناءا على الخواص الطبيعية المقاسة ذات الصلة بوزن الدرنات المجزاة وهى مقسمة من (90-150جم) , (150-210جم)، (210-300جم) وذلك لتقطيع الدرنة إما إلى جزئيين أو ثلاثة أو أربعة أجزاء .تم استخدام بلانتر صغير ذات خط واحد يصلح للحيازات الصغيرة ويتم تشغيله بجرار صغير ذو قدرة 18 حصان. تم تقييم أداء البلانتر المعدل وذلك باستخدام ثلاثة مقاسات لقطر ملاعق التقاط الدرنات هي 25، 35 ، 45 مم مع ثلاثة سرعات أمامية للآلة هي 1,6 ، 2,4 و 3,2 كم /ساعة وذلك باستخدام صنفين من البطاطس إحداهما بيضاوي (أسبونتا) والأخر مستدير (دياموند). وكانت أهم النتائج الحقلية المتحصل عليها أنه يمكن استخدام البلانتر المعدل تحت الدراسة عند مقاس ملاعق 25 مم و سرعة امامية 3,2 كم/ساعة لتعطى أفضل انتظامية لتوزيع الدرنات بمقدار91,81 % وكذلك نسبة تخطى الدرنات بمقدار 3,4 % وكذلك نسبة الدرنات المزدوجة بمقدار 7,49 % .عند انسب العوامل التشغيلية السابقة سجلت الطاقة النوعية المستهلكة 22,28% كيلووات ساعة / فدان وكانت التكاليف الاقتصادية بمقدار 73,88 جنية / للساعة بمقدار (180,11 جنية /للفدان).