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Fabricating and Evaluating Performance of a Planter Prototype for Planting Chinese Garlic Cloves

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El Shal, A. M.[*] and A. Awny

Agricultural Engineering Department, University of Zagazig, Zagazig, Egypt

ABSTRACT

The present study aimed to fabricate a two rows planter prototype with a new feeding device with a chain and spoons for planting Chinese garlic cloves. The performance of the planter prototype was evaluated under four levels of planting forward speeds of 1.2, 1.7, 2.2 and 2.9 km/h and two sizes of Chinese garlic cloves big and small. The results showed that the best forward speed about 1.7 km/h giving the actual field capacity of 0.19 and 0.2 fed./h, the field efficiency of 78 and 82 %, the specific energy requirement of 22.4 and 21.3 kW. h/fed., operating cost of 385 and 366.5 EGP/fed., the missing hills of 8 and 6 %, longitudinal scattering of 13.3 and 11.7 %, transverse scattering of 3.9 and 3.3 %, the double hills of 8 and 13 % by using big and small Chinese garlic cloves, respectively. It turns out that this prototype does not cause significant damage to the garlic cloves because it quietly and smoothly picks garlic from the bottom to up in the cloves hopper, does not exceed the damage rate 0.8 and 0.4 % when the size of cloves was big and small, respectively. The prototype saves about 81 % of cost compared with manual planting and saves the time of planting.

Keywords*:* Chinese garlic; Prototype; Planter; Mechanical; Fabricating.

INTRODUCTION

Garlic (*Allium sativum* L.) is a very precious spice crop having with its spices and medicinal values. It was known to ancient Egyptians and has been used both as a food flavoring and as traditional medicine. Garlic is a strongly aromatic bulb crop that has been cultivated for thousands of years. It is renowned throughout the world for its distinctive flavor as well as its health-giving properties. Garlic is considered as the most important and widely cultivated vegetable in Egypt, due to its nutrition value. It is planted for local consumption or export. The total cultivated area 12607 hectares and product 274668 tons in Egypt (FAO, 2017).

Garlic has an irregular shape, so the planting garlic usually requires the position of the garlic tip upward, which causes the result that garlic planting is usually finished by hand. The manual planting has high labor intensity but in low production efficiency, resulting in high production cost. It has been planted in hundreds of countries in the world. Garlic has been proved to own notable edible and medical value. Garlic has been a subject of considerable interest as a medicine worldwide since ancient times. Garlic is planted in dry or wet fields, as a single or inter-cropped by manual planting method, which has some disadvantages. Manually method needs to high labor requirements in a short period. Also, manual planting cannot achieve the planting uniformity and non-uniformity of growth. With the expansion of garlic cultivation and aggravation of human resources shortage, it is urgent to fabricate a garlic mechanical planting machine, which can efficiently reduce labor intensity. Hassan (1991), described two methods of garlic planting in Egypt. In the first method, the garlic cloves are planted manually on both sides of the furrow (furrow width 50-60 cm). The cloves are placed between 5 to 7 cm and the field is then irrigated. In the second method, the garlic cloves are planted in rows spacing 30 cm on the flat soil divided into 3 x 3 m plot. The first method is the prevailing garlic-planting practice in Egypt.

Harb and Abdel-Mawla (1997), developed a metering belt system garlic planter to plant seeds at 10 cm distance between cloves along the rows. The machine opens a furrow for irrigation and plants two rows of garlic on both sides of the furrow top. Field experiments showed that the machine plants garlic cloves more uniformly at low forward speeds. At high forward speeds above 3 km/h, the percentage of unsuccessful fed increased to more than 20 %.

Kual and Egbo (1985), showed that the hopper in seed drill may be trapezoidal, rectangular or oval. The capacity of the hopper also varies, depending upon the size of the machine. Making the hopper trapezoidal in shape help to insure a free flow of seed. El Zawahry (1994), indicated that increasing planter forward speed would decrease the depth of seeds in the soil and increase the seed scattering around the furrow centerline. Metwalli *et al.* (1998), showed that by increasing planting forward speed both longitudinal and transverse scattering increased. Korayem (1986), found that seed size had an important effect on the accuracy of seed spacing, seed rate and damage. Increasing cell speed generally reduced cell fill, increased seed damage and seed spacing along the row. Kepner *et al.* (1982), studied some factors affecting cell fill and seed damage. They reported that, the most uniform seed distribution is usually obtained with combinations of seed size, cell size, and cell speed that gives about 100 % average cell fill, they also showed that the cell diameter or length should be about 10 % greater than the

[*] Corresponding author.
E-mail address: elshal36@gmail.com
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maximum seed dimension and the cell depth should be about equal to the average seed diameter or thickness. The percentage of damaged seeds increases as the cell speed is increased. Damage is also greater if the cells are too large. Damage can be minimized by making the cutoff device flexible and gentle or by employing designs in which individual seeds are lifted out the seed mass so that no cutoff is needed, as with inclined plate, pneumatic, and vacuum type metering units.

Moussa (1999), found that the percentage of seeds dropped per meter along the furrow decreased by about 20 % for the different crops by increasing operating speed. Also, he indicated that lateral and longitudinal deviation of seeds along the row increased by increasing operating speed and decreasing seed size. Chinnan *et al.* (1975), studied the effects of seed level in the hopper and found that when the level of seed in the hopper decreased, the average spacing increased.

Helmy *et al.* (2005), studied the performance of the planter with modified seed plates A and B were studied under four levels of planting forward speeds of 1.5, 2.5, 4.0 and 6.0 km/h and two levels of planter speed ratios of 0.6 and 0.8 with three levels of seed hopper capacity of 4.5, 2.25, and 1.125 kg. Manual planting of garlic was also studied and compared with mechanical planting method. The results indicated that the lowest longitudinal and transverse scattering of garlic was obtained with plate A at seed hopper capacity of 4.5 kg and a speed ratio of 0.6 with a forward speed of 1.5 km/h. The lowest value of missing hills was 3.75 % obtained at planting forward speed of 1.5 km/h. by using plate B. The beset results of planting uniformity, planting density, yield and appropriate levels of operation costs by using mechanical (Gaspardo) planter with modified cell plate A under limit of planting forward speed of 1.5 to 2.5 km/h, planter speed ratio of 0.6 and seed hopper capacity is more than 50 % of its capacity. Jarudchai *et al.* (2002) designed and developed a garlic planter in Thailand. They constructed and tested two models with different metering devices which included (1) a vertical metering plate with triangular grooves and (2) a bucket type device. The bucket type metering device presented the most impressive results regarding uniformity of the metering system and low garlic clove damage 0.23%.

Bakhtiari and Loghavi (2009), designed, fabricated, tested a tractor mounted with ground-wheel drive, triple unit and row crop precision planter capable of planting three rows of garlic cloves on each raised bed. The results showed that the new machine was capable of planting 220,000 plants/ha. Miss index, multiple index and seed damage were measured as 12.23, 2.43 and 1.41 percent, respectively. Nare *et al*. (2014), observed that the machine for planting garlic was operated at a speed of 1.8 km/h and no skidding was observed during the experiment.

The aim of this study to fabricated planter prototype for planting Chinese garlic cloves with the new metering device and investigate the performance of the machine with the effect of forward speed and garlic clove size.

MATERIALS AND METHODS

Materials

The planter prototype was accomplished at a private workshop at Abu Kebir, Al Sharkia Governorate, Egypt. The experiment was carried out on clay soil at a private farm in Abu Kebir for the season (2018/2019) and for planting the Chinese garlic variety. A Kubota tractor with water-cooled, four-stroke diesel engine with direct injection with the power of 14.7 kW and 4 WD was used to mount the planter prototype during all test runs.

The experimental field was prepared by using chisel plough twice, followed by disc harrow and levelled by hydraulic land leveller for mechanical planting.

Chinese garlic cloves

Characteristics of the Chinese garlic cloves are provided in Table 1.

Table 1. Characteristics of the Chinese garlic cloves.

Chinese garlic cloves characteristic	Average value (Big)	Average value (Small)
Length, cm	3	2
Width, cm	1.7	1
Thickness, cm	1.6	0.95
Mass of one, g	3	1
Bulk density, kg/m^3	550	580
The angle of repose, degree	35	30
Coefficient of friction,	0.38	0.41
Sphericity,%	67	62

Fabricated planter prototype

The planter prototype consists of eight main parts: the mainframe, ground wheels, cloves hopper, power transmission system, feeding device, cloves tube, furrow openers and covering plate.

The mainframe

The mainframe of the machine was constructed from iron bars with dimensions of 40×60 mm (Fig.1). The dimensions of the main base were 1230 mm length and 730 mm in width. The shaft rotates between two high-speed bearings that are fixed on the machine stand, and three sprockets are coupled to the shaft.

Ground wheels

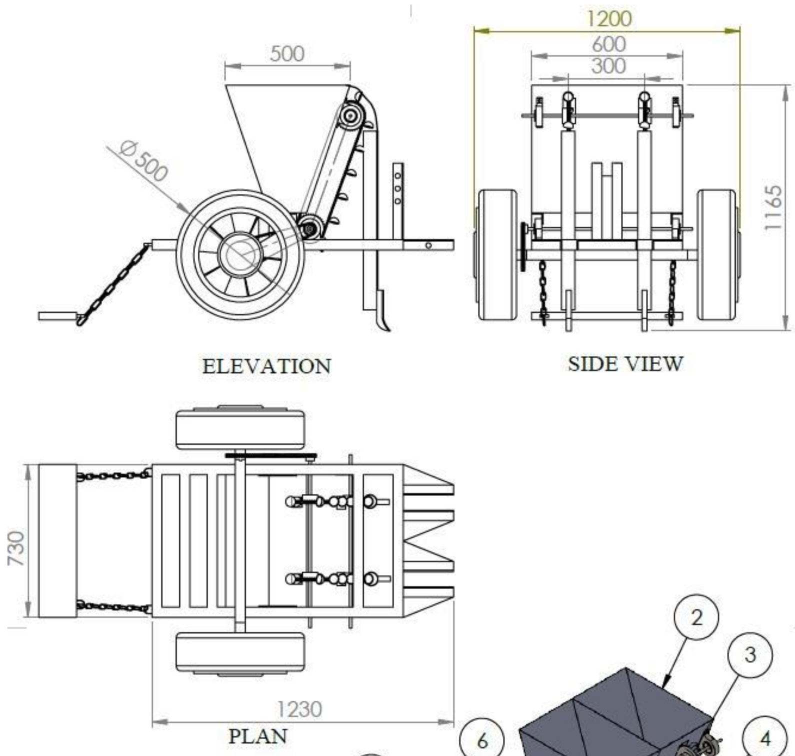
There are two rubber wheels each one has diameter 50 cm and 15 cm width.

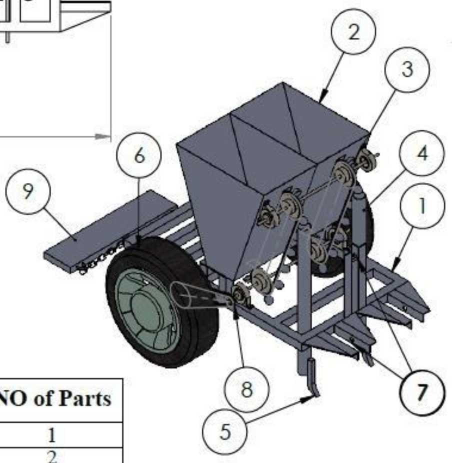
Cloves hopper

The garlic hopper was fabricated of 1.5 mm thickness galvanized steel sheet, divided into two portions, one of them with a capacity of 24 kg and located above the mainframe. The shape of the hopper is trapezoid 70×50×15 cm with a width of 60 cm for two hoppers (Fig.2A). The hopper is sloped to facilitate the flow of garlic cloves toward the spoons. Hopper was provided with a proper cover and the inclination of walls hopper to be more the maximum angle of repose and friction of garlic cloves. In the bottom of the hopper square rubber 13×13 cm to prevent cloves from lost after spoon take a position to move up from hole bottom of the hopper (Fig.2B).

Power transmission system

The power transmission system consists of sprockets and chains as shown in Fig. 3. Power is transmitted from the ground wheel of planter shaft operating with sprocket 49 teeth with 20.2 cm diameter then transmitted movement by a chain to a second shaft fixed on it sprocket 15 teeth with 6.5 cm diameter. There are another two sprockets fixed on the second shaft have the same 38 teeth with each one 16 cm diameter transmitted movement by another two long chains to a third shaft on the front top of hopper fixed on it two sprockets have each one 15 teeth with 6.5 cm diameter.





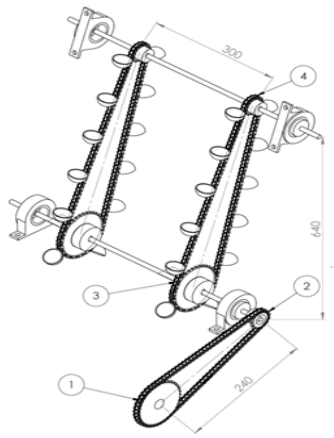
part NO.	Part Name	NO of Parts
1	Frame	1
2	Cloves Hopper	2
3	Metering Device	2
4	Cloves Tube	2
5	Furrow Opener	2
6	Ground Wheel	2
7	Hitching points	3
8	Transmision System	1
9	Covering Plate	1

All dimensions in mm.

Fig. 1. Engineering drawing of fabricated planter prototype.

Fig. 2A. The planter prototype mounted on the tractor.

Fig. 2B. Cloves hopper.



All dimensions in mm.

Part NO.	Part Name	No. of Part
1	The ground wheel drive sprocket	1
2	Driven sprocket	1
3	Metering device (drive sprocket)	2
4	Metering device (driven sprocket)	2

Fig. 3. Power transmission system

Feeding device

The feeding device consists of two long-chain has 18 metal spoons fixed on it, the distance between each spoon on the same chain 10 cm. Spoon dimension 3.6 cm outer diameter, 3.2 cm inner diameter and 15 mm depth. The metering device run by the ground wheel movement, the cloves were picked up by spoons which pass in the hopper at picking point and take the cloves upwards to release point above the tube. Clove spacing 10 cm in a row; the ground wheel of 50 cm diameter was used giving the circumference of 157 cm. Therefore, in one revolution the ground wheel would cover 157 cm distance dropping about 15 garlic cloves.

Forces acting on clove

Forces acting on clove in the spoon when reached upper sprocket in Fig (4)

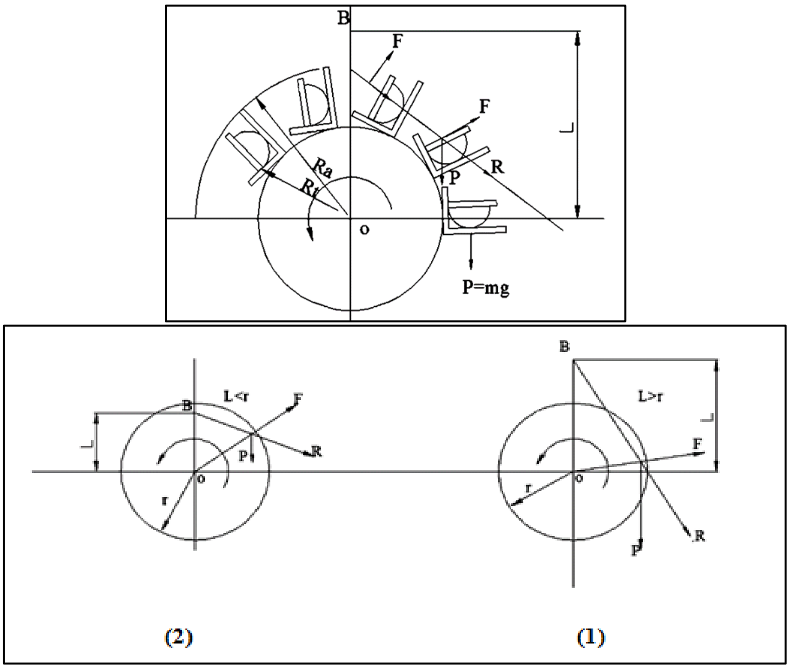


Fig. 4. Forces analyses on cloves during movement from hopper to clove tube (El Banna and Hassan, 1990).

$$P = mg$$

Where: **m = Mass of clove; g = Gravitational acceleration, m/s^2.**

$$F = m\,\omega^2 r$$

Where: **F = Centrifugal force, N; r = Radius of pulley, cm.**

$\omega = 2\,\pi N$ ω = Angular velocity, rad/s.

Must be P > F (Fig.4-1) until to point of release of clove in an upper orifice of seed tube will be F >P (Fig.4-2).

Cloves tube

There are two cloves tube one for each unit 6 cm diameter and 92 cm length plus funnel on top of tube for giving the right direction of cloves to enter tube.

Furrow openers

There are two furrow opener one for each unit chisel plough type have 16 cm height, 1.7 cm width and 1.7 cm thickness.

Covering plate

Wooden plate mounted on the backside of the mainframe of planter passes on the soil surface to cover cloves.

Specifications of fabricated planter prototype, as shown in Table 2.

Table 2. Fabricated planter prototype specification.

Specification	value	Specification	value
The overall length of planter, cm	123	Length of tube, cm	92
The overall width of planter, cm	120	The diameter of tube, cm	6
The overall height of planter, cm	116.5	Mounted of planter,	3 points by tractor hydraulic system
Number of planting units,	2	Distance between spoons, cm	10
One planting unit has spoons, No.	18	Distance between rows, cm	30
Individual hopper capacity, kg	24	Distance between cloves in the same row, cm	10

Distance between two cloves in the same row

It is calculated according to El Banna and Hassan (1990).

$$dc = DP/di$$

Where:

dc = Distance between two cloves in the same row, cm; D = Diameter of ground wheel, cm; P = Distance between two spoon, cm; d = Diameter of sprocket, cm; i= Ratio speed.

Instruments

A balance scale

A balance scale (OHAUS U.S.A) was used to find the mass of the cloves. The maximum mass of the balance was 2610 g. Its accuracy was 0.1 g.

Digital Vernier

A digital Vernier calliper with an accuracy of 0.01 mm was used to measure the dimensions of cloves.

Tapes

Two tapes 50 and 5 m for measuring plots of field, longitudinal scattering, transverse scattering, the distance between cloves in the same row and between two rows.

Methods

The performance of the fabricated prototype was studied under the following parameters:

1. Four forward speeds: 1.2, 1.7, 2.2 and 2.9 km/h,
2. Two garlic size big and small cloves.

The planter was calibrated to plant garlic cloves with about 420 kg/fed. for big cloves and about 200 kg/fed. for small cloves at 30 cm spacing between rows and about 10 cm between hills in the same row and 5 cm depth.

Laboratory experimental test to germinate big and small cloves in many situations for one month. It is noticed that the first germinate upward cloves, the second upside down and the third clove on two sides. There is no significant difference between big or small cloves, similar results.

Measurements

Physical properties of cloves variety

Chinese garlic (big and small) the length (L), width (W) and thickness (T). The size was used to calculate the volume (V), Bulk density (ρ) and percent of sphericity (S). The following equations according to EL Raie *et al.* (1996) were used to calculate the values of the above-mentioned properties:

$$V = (\pi/6)\, LWT \quad , mm^3 \qquad (1)$$

$$S = (LWT)^{1/3} / L \times 100 \quad , \% \qquad (2)$$

Bulk density(ρ)

$$\rho = m/V \qquad (3)$$

Where:

ρ = Bulk density of the cloves, g/cm^3; m = Mass of cloves, g; V = Bulk volume of the cloves, cm^3

Emergency

The emergency ratio was counted after three weeks from planting in a one-meter square by the following equation:

$$E = ((\text{Number of plants}/m^2) / (\text{Theoretical number of plants}/m^2)) \times 100 \qquad (4)$$

Cloves Damage

The sample of cloves passed through the metering device and cloves tubes at the treatments at four speeds, the number of cloves that were damaged mechanically including any significant bruising, skin removal or crushing was counted and their percentage was calculated as the cloves damage percentage by following equation:

$$D = (\text{No. of cloves damage} / \text{No. of cloves sample}) \times 100 \qquad (5)$$

Actual field capacity

Actual field capacity was computed using the following formula:

$$\text{Actual field capacity (fed./h)} = 1/\text{Total time in hours required per fed.} \qquad (6)$$

The field efficiency

The field efficiency(η_f) was computed using the following formula:

$$\eta_f = (\text{Actual field capacity} / \text{Theoretical field capacity}) \times 100 \qquad (7)$$

Longitudinal scattering

The distance between 20 hills in the row for all treatments was measured. The longitudinal scattering of seed placements was determined statistically by the standard deviation of the measured distances according to Steel and Torrie (1980).

$$\sigma = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}} \qquad (8)$$

$$C.V. = (\sigma / \bar{x}) \times 100 \qquad (9)$$

Where:

σ = Standard deviation; C.V. = Coefficient of variation in row from average distance, %; x = Distance between hills on row, cm;

$\bar{x}$ = The average distance, cm; n = Number of readings.

Transverse scattering

The transverse scattering was calculated by the same method mentioned with longitudinal scattering but around the centerline of row (Metwalli *et al.*, 1998).

Planting depth

Three replicate of actual planting depth in 1 m long distance in the same row were measured chosen randomly and smoothly removing the soil cover over and measuring the covering height.

Missing hills percentage

The theoretical adjusted hill numbers in 5 m long distance in the same row were estimated and the actual were accounted and the missing hill numbers were found in the same distance. The percentage of the missing hills was given by Helmy *et al.*, (2005) using the following equation:

$$\text{Missing hills, \%} = (\text{No. of missing hills} / \text{No. of theoretical hills}) \times 100 \qquad (10)$$

Percentage of hills have double cloves:

The percentages of hills have double cloves were calculated according to Helmy *et al.* (2005) by using the following equation;

Percentage of hills have double cloves =

$$((\text{No. of hills have double cloves/m}) / (\text{No of theoretical hills/m})) \times 100 \qquad (11)$$

Fuel consumption

Volumetric fuel consumption per unit time was determined by measuring the volume of the consumed fuel. It was calculated as the following:

$$VFC = V/t \qquad (12)$$

Where: VFC = The volumetric fuel consumption rate, l/h;
V = The volume of consumed fuel, l;
t = The duration of the experiment, h.

Power

The following formula was used to estimate Power (*P*) as provided by Hunt (1983):

$$P = (FC/c) \times (\eta_{th}/100) \times HV \qquad (13)$$

where P = Required power, kW; FC = Fuel consumption, kg/h; η_{th} = The thermal efficiency, %; HV = The fuel heating value, kJ /kg; c = Constant, 3600.

Specific energy requirement

The following formula was used to calculate the specific energy requirements:

Specific energy requirement (kW.h /Fed.) = (Power, kW)/ (Actual field capacity, Fed./ h) (14)

Cost

The hourly cost was determined by El Awady (1978):

$$C = p/h\,(1/a + i/2 + t + r) + (1.2\ W.F.\ S) + m/144 \qquad (15)$$

Where: C = Hourly cost, EGP/ h; P = Price of the machine, EGP; h =Yearly working hours, h/y; a = Life expectancy of the machine, y; i = Interest rate / year, %; t = Taxes over heads ratio, %; r = Repairs and maintenance ratio, %: W = Consumed Power, kW; F = Fuel price, EGP/l; S = Specific fuel consumption, l /kW .h; m = Operator monthly salary, EGP; 1.2 = Factor a counting for ratio of rated power and lubrications; 144 = The monthly average working hours; h.

$$\text{Operating cost }(EGP/fed.) = \frac{\text{Machine cost, }EGP/h}{\text{Actual field capacity, }fed./h} \qquad (16)$$

RESULTS AND DISCUSSION

Actual field capacity and field efficiency

Forward speed is the principal parameter governing the actual field capacity and field efficiency of the fabricated garlic planter prototype. Fig (5) shows that, by increasing the forward speed from 1.2 to 2.9 km/h, actual field capacity increased from 0.14 to 0.28 and from 0.15 to 0.30 fed./h for big and small cloves, respectively.

Results for the field efficiency by increasing the forward speed from 1.2 to 2.9 km/h, field efficiency decreased from 83 to 67 and from 86 to 72 % for big and small cloves, respectively. This is due to the portion of lost time to turn, repair and refill hopper was a big-time for planting operation in the fast speeds. Manual planting needs 16 labours working for one day for about 6 hours.

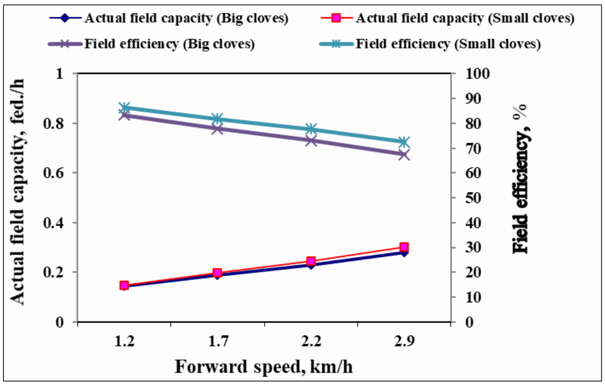


Fig. 5. Effect of forward speed and clove size on the actual field capacity and field efficiency.

Plant emergency

Fig.6 shows that, increasing the forward speed from 1.2 to 2.9 km/h, the emergency ratio decreased from 95 to 86 % and from 96 to 89 % for big and small cloves, respectively after three weeks of planting, this result may attribute to increasing in more scratching cloves and damage percentage in feeding device led to harmful cloves in the soil, more longitudinal and transverse scattering.

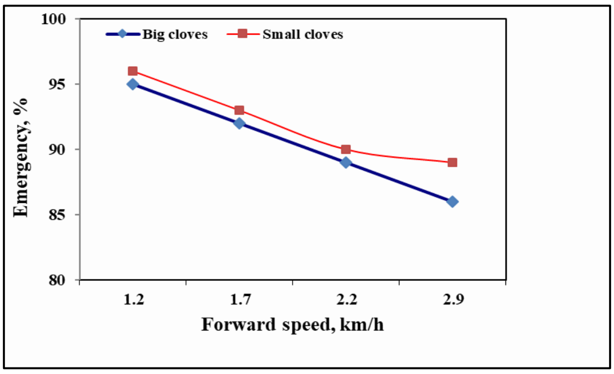


Fig. 6. Effect of forward speed and clove size on emergency.

Longitudinal scattering and transverse scattering

Fig.7 shows that, increasing the forward speed from 1.2 to 2.9 km/h, longitudinal scattering increased from 11.7 to 16.7 and from 10 to 15 % for big and small cloves, respectively. These can be understood that when forward speed increases the cloves drops with increasing of inertia forces whish made long scattering.

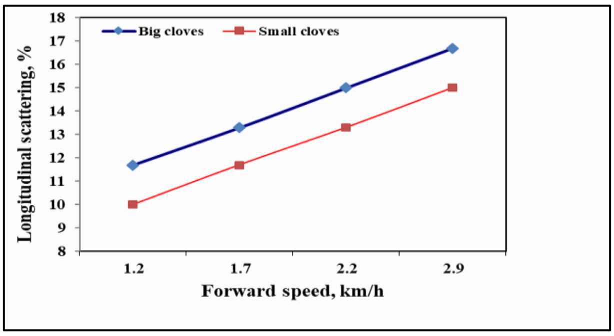


Fig. 7. Effect of forward speed and clove size on longitudinal scattering.

Fig.8 shows that, increasing the forward speed from 1.2 to 2.9 km/h, transverse scattering increased from 3.3 to 5 and from 2.2 to 4.4 % for big and small cloves, respectively.

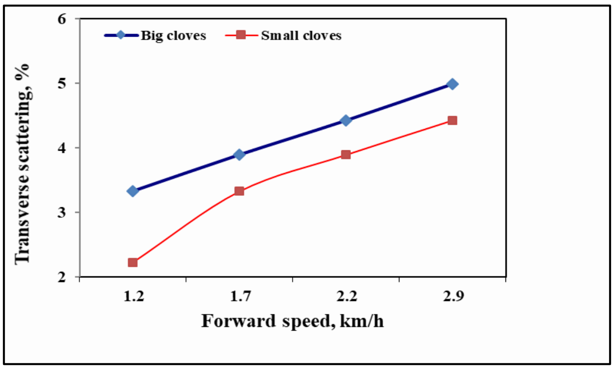


Fig. 8. Effect of forward speed and clove size on transverse scattering.

Planting depth

Fig.9 shows that, increasing the forward speed from 1.2 to 2.9 km/h, planting depth decreased from 5 to 2 cm for big and small cloves. These may attribute to the increasing reaction soil force on furrow opener with increasing forward speed.

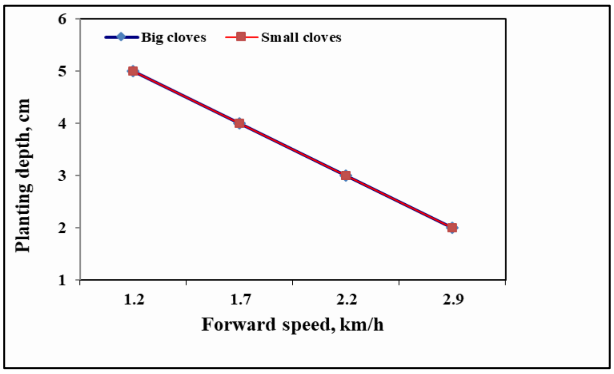


Fig. 9. Effect of forward speed and clove size on planting depth.

Missing hills and hills has double cloves:

Fig.10 shows that, increasing the forward speed from 1.2 to 2.9 km/h, missing hills increased from 5 to 15 % and from 3 to 13 % for big and small cloves, respectively. These can be understood that when forward speed increases the movement of the spoons faster and did not handle cloves carefully, so a lot of cloves drops from spoon again in hopper or did not have a stable position in a spoon. Thus, a lot of hills did not have cloves by increasing forward speed. Small cloves have miss hills less than big cloves this may attribute to small cloves more chance to take place on spoon than big cloves with faster speeds. At high speeds the vibration of the machine should be reduced by levelling the ground well because the vibrations cause the cloves to fall from the hoppers after being picked up, thus causing irregularity in the cloves implants.

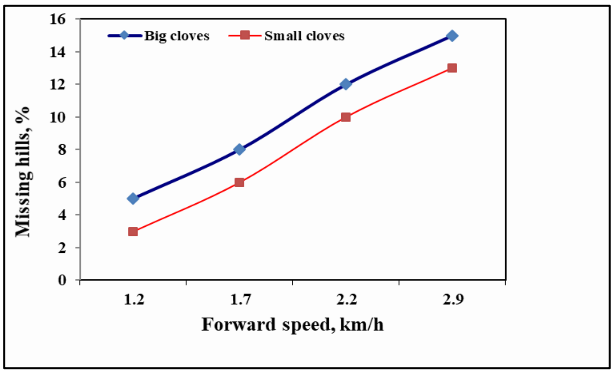


Fig. 10. Effect of forward speed and clove size on missing hills.

Fig.11 shows that, increasing the forward speed from 1.2 to 2.9 km/h, hills have double cloves decreased from 10 to 4 % and from 15 to 9 % for big and small cloves, respectively. This can be understanding on slow forward speed it is stability to have one or more clove in one spoon by stabile but when speed increased number of cloves did not have stability to be in one spoon and more vibration make cloves drops again from the spoon in the hopper after reach top of the hopper. Fig.11 shows that small cloves have a percentage of double cloves more than with big cloves this may attribute to small cloves more chance to take place on spoon than big cloves with faster speeds.

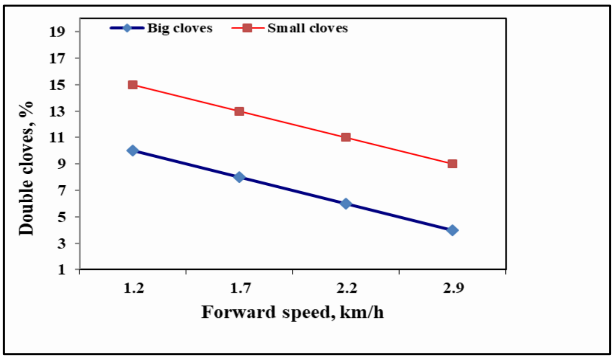


Fig. 11. Effect of forward speed and clove size on hills have double cloves.

Clove damage

Fig.12 shows that, increasing the forward speed from 1.2 to 2.9 km/h, increased clove damage from 0.2 to 0.8 % and 0.1 to 0.4 % for big and small cloves, respectively. The percentage of damaged cloves increased as the speed of feeding device increased with forward speed and make some mechanical damage.

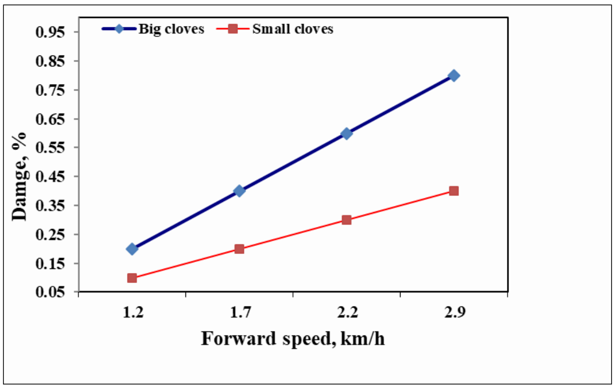


Fig.12. Effect of forward speed and clove size on clove damage.

Power and specific energy requirement

Results in Fig.13. Shows that, increasing the forward speed from 1.2 to 2.9 km/h, increased the power required from 3.45 to 5 kW inverse relation specific energy requirement decreased from 24.18 to 18 and from 23.31 to 16.73 kW. h/fed. for big and small cloves, respectively. The power for two sizes is approximately the same.

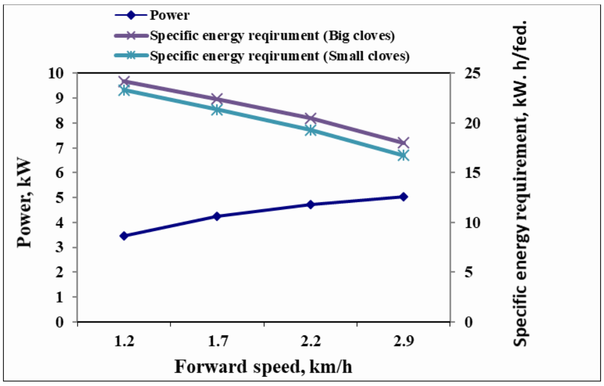


Fig. 13. The power and specific energy requirements for two sizes of garlic under different forward speeds.

The specific energy requirement decreased by increasing the forward speed because of the increasing of actual field capacity is more than the increasing of power consumption. The optimum specific energy requirement for the fabricated planter was achieved at a forward speed of 1.7 km/h about 22.4 and 21.3 kW. h/fed. for big and small cloves, respectively.

Operating cost

Results in Fig 14. Indicated that, increasing forward speed from 1.2 to 2.9 km/h, the operating cost decreased from 495.5 to 268 and from 478 to 249 EGP/fed. for big and small cloves, respectively. This can be attributed to the high influence of forward speed on decreased operating cost as well operating cost of forward speed is attributed to higher actual field capacity increased than increasing of machine cost. In manual planting, the cost per fed. costs about 2000 EGP to be planted manually, in addition to the need for a full day to plant it, by 16 workers. The prototype saved about 81% less than manual planting.

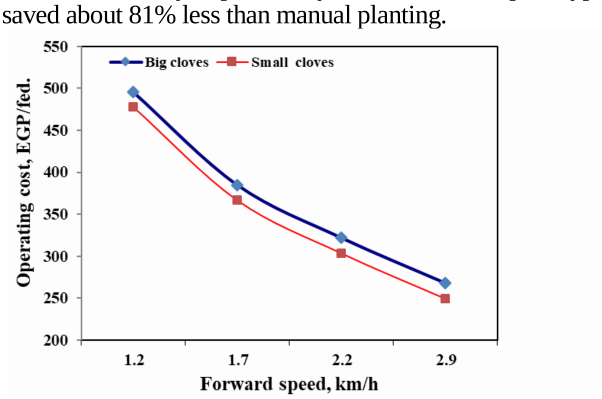


Fig. 14. Effect of forward speed on operating cost for two sizes of garlic cloves.

CONCLUSION

The fabricated planter prototype is recommending to planting Chinese garlic and operating it on about 1.7 km/h forward speed, the actual field capacity of 0.19 and 0.2 fed./h, the field efficiency of 78 and 82 %, the specific energy requirement of 22.4 and 21.3 kW. h /fed., and operating cost of 385 and 366.5 EGP/fed., the missing hills of 8 and 6 %, longitudinal scattering of 13.3 and 11.7 %, transverse scattering of 3.9 and 3.3 %, the double hills of 8 and 13 % by using big and small Chinese garlic cloves, respectively. It was found that a positive effect on the performance of the prototype for planting two sizes of Chinese garlic cloves saved labour, energy, time and money.

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تصنيع وتقييم أداء نموذج آلة زراعة فصوص الثوم الصيني

أحمد محمد الشال و علاء عوني

قسم الهندسة الزراعية – كلية الزراعة – جامعة الزقازيق

يعتبر محصول الثوم من المحاصيل البستانية الهامة في مصر وذلك لأهميته الصحية والاقتصادية ويزرع الثوم في مصر يدويا حيث تحتاج إلى عمالة كثيرة ووقت ومجهود وتكاليف كثيرة وبالإضافة إلى عدم انتظام خطوط الزراعة وعدم انتظام المسافة بين الفصوص في الصف الواحد وعدم انتظام عمق الزراعة. تهدف هذه الدراسة إلى تصنيع نموذج لآلة زراعة ثوم في خطين ذات جهاز تلقيم جديد يتم تعليقها على الجهاز الهيدروليكي لجرار كوبوتا 20 حصان (14.7 كيلو وات) وتم تقييمها عند زراعة الثوم الصيني عند أربع سرعات (1.2 و1.7 و2.2 و2.9 كم\ ساعة) وحجمين لفصوص الثوم كبير وصغير. كانت اهم النتائج المتحصل عليها أن أفضل سرعة للزراعة 1.7 كم\ساعة عندها إنتاجيه حقلية فعلية 0.19 و0.2 فدان \ساعة وكفاءة حقلية 78 و82 % والطاقة النسبية المستهلكة 22.4 و21,3كيلو وات ساعة \فدان وتكاليف زراعة 385 و366.5 جنيه\فدان والجور الغائبة 8 و6 % وتشتت طولي 13.3 و11.7 % وتشتت عرضي 3.9 و3.3 % والفصوص المزدوجة 8 و13 % عند حجم فصوص كبير وصغير على التوالي. ووجد أن النموذج المصنع لا يحدث تلف يذكر لفصوص الثوم نظرا لأنه يتم التقاط الثوم بهدوء وانسيابية من أسفل إلى أعلى داخل خزان الفصوص فلا تزيد نسبة التلف عن 0.8 و0.4 % عند حجم فصوص كبير وصغير على التوالي. بمقارنة الزراعة بالنموذج المصنع بالزراعة اليدوية في التكاليف وجد أنه يوفر حوالي 81 % من تكاليف الزراعة اليدوية بالإضافة إلى توفير الوقت.