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Development of A Vertical Roller with Double Grooved Rows Metering Device for Garlic Cloves Planting

Cross Mark

Fatma Abd El Gawad*

Agric. Eng. Res. Inst., Agric. Res. Center, Dokki, Giza, Egypt.

ABSTRACT

The aim of the present investigation is to develop a vertical roller with double grooved rows metering device for garlic cloves planting. Laboratory and field experiments were carried out to evaluate the performance of the developed metering device. Laboratory experiments were conducted using a laboratory test rig under different metering device speeds, agitator speeds and cloves size to estimate cloves discharge and cloves damage. Field experiments were conducted under different planter forward speeds to measure plant emergence percent, garlic-cloves spacing, missing-hills, double-cloves percent and total crop yield. The main results can be summarized in the following points: The maximum garlic-clove discharges of 24, 22, 21 and 66 clove/metering-device revolution were obtained with metering device speed of 150 rpm(1.5 m/s)and agitator speed of 135 rpm(0.41 m/s)by using small, medium, large and random (mixed) clove-sizes respectively. The minimum garlic-clove damage was obtained with metering-device speed range of 50 - 350 rpm(0.5 - 3.6 m/s)and agitator speed of 85 rpm(0.26 m/s)using medium and large garlic-clove sizes of zero %.By increasing forward speed from 1.4 to 4.7 km/h plant-emergence percent decreased from 99.62 to 97.66 and from 99.93 to 99.76 %, double cloves decreased from 10.6 to 6.1 and from 4.2 to 4.1 %,the total crop yield decreased from 7.33 to 5.12 and from 8.67 to 6.22 Mg/fed using one and double grooved-rows, respectively. While, averages of garlic cloves spacing increased from 9.2 to 10.5 cm, missing hills increased from 0.21 to 1.77 and zero to zero %, under the same previous conditions.

Keywords: Garlic cloves planter, metering device, garlic cloves damage, garlic cloves distribution, garlic cloves emergence.

INTRODUCTION

Garlic (Allium sativum L.) is a crop with a long history of plantation in Egypt. The cultivated area of garlic crop in Egypt is 15.503 thousand feddans in 2019 producing about 318.800 thousand Mg (FAO, 2019). Because of the high costs of the traditional methods of garlic planting, cultivation and harvesting which consuming more time and labor intensive, its large scale production is not economical and is therefore very limited.

Gajakos *et. al*., (2015) found that conventional method of garlic planting is very expensive as about 60 - 65 man-day/ha costs about 17.3 % of total production-cost. So, they developed a walk-behind garlic-cloves planter and found that field efficiency was 84.79 % and missing hill was 28.33 %. Yasmeen *et. al*., (2018) designed, developed and evaluated a manually operated garlic-cloves planter. The planter consists of frame, bucket chain conveyor (18 buckets having dia. 27 mm have been fastened to the chain), ground wheel, power transmission and seed hopper. They concluded to that field efficiency of garlic planter was 81 %, working capacity was 3 man-days/ha, missing hill was 8.9 % and uniformity index was 88.7 %.

Such researches were carried out concerning the mechanical methods of garlic planting, Harb and Abdel-Mawla (1997) developed a metering belt system garlic-planter to plant cloves at 10 cm spacings. Field experiments showed that machine planted cloves with more uniformity at low forward speeds. At high speed (above 3 km/h) the percentage of unsuccessful fed increased to more than 20 %, and accordingly, the mean number of cloves dropped per meter along the furrow decreased. Yehia (1997) and Awady *et. al*. (2000) designed a garlic clove metering device with vertical wheel with groove device. They studied the effect of feeder speeds, groove shapes (rectangle, trapezoidal, and triangle), and groove widths on cloves discharge, damage and longitudinal cloves-distribution. They found that the groove width of 24 mm, of a triangular shape and feeder speed of 20 rpm had the best longitudinal cloves distribution. Jarudchai *et*. *al*. (2002) constructed and tested two models of garlic planters with different metering devices namely: (a) a vertical metering plate with triangular grooves and (b) 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 of 0.23 %. The planter was attached to a 5 hp power tiller and was tested in actual field conditions. The maximum forward speed was 2.63 km/h and planter wheel skid was high at about 23 %. The planter field capacity was 0.73 fed/h. El-Ashry (2004) modified a potato planting machine to suit garlic crop by replacing the original metering tray by adjustable one which has diameter of 40 cm and 14 cells, each cell cone have diameter of 7.0 cm at upper hole and 5.0 cm at lower hole. The field experiments were carried out under different machine forward speeds and planting spaces and their affecting on planting density, planting uniformity, field efficiency, required energy and

*** Corresponding author.**
E-mail address: f.aly@arc.sci.eg
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total yield. The optimum values for the operation conditions were obtained at operating forward speed of 0.78 km/h and planting space of 8.0 cm. Helmy *et. al*. (2005) modified and evaluated the feeding mechanism of the mechanical (Gaspardo) planter to plant garlic cloves under four levels of planting forward speeds and two speeds of planter speed ratio with three levels of seed hopper capacity. They found that the best limit of planting forward speed is between 1.5 and 2.5 km/h, planter speed ratio of 0.6 and seed hopper capacity is more than 50% of its capacity. Bakhtiari1 and Loghavi (2009) developed and evaluated an innovative garlic clove 3-row precision planter tractor-mounted. Seed metering-drum has three rows of 40 elliptical seed holes (30×20 mm) for accommodating garlic clove. The performance parameters measured during the field tests included planting depth, seeding rate, seed spacing, miss index, multiple index and clove damage. They showed that the new machine was capable of planting 92400 plants/fed at the average clove placement depth and spacing of 12.3 and 22.7 cm, respectively. Other performance parameters included miss and multiple indices of 12.3 % and 2.43 %, respectively. El-Sharabasy and Ali (2011) developed and evaluated the planter (Gaspardo) to plant garlic cloves. The tested parameters were three cell-diameters and three disc-thicknesses and four machine forward-speeds. It was found that the maximum plant emergency ratio of 97.10 %, the minimum missing hills of 5.1 %, the minimum longitudinal scattering of 0.48 cm and the maximum garlic yield of 8498 kg/fed were obtained at machine forward speed of 1.17 km/h, cell diameter of 30 mm and disc thickness of 30 mm. Abd Elgawad (2012) developed and tested metering-device speed range of 10 – 60 rpm, agitator-speed range of 10 – 60 rpm, cut off clearance range of 0 – 15 mm and clove sizes. The optimum metering device speed of 20 rpm, agitator speed of 50 rpm, and cutoff clearance of 15 mm were recommended which gave garlic-clove damage of 0.8 – 2.5 % for small, medium and large garlic-clove sizes. Abdrabo *et. al*., (2015) developed and evaluated a garlic-clove planter. A vertical-disc metering device with cells was tested. The tested two types of cell were parallelogram cells with dimensions of 4, 2.5 and 2 cm length, width and height and a half-cylindrical shape cells with 4 cm length and 2 cm. It was concluded that the maximum germination-percentage of 95, % was obtained at forward speed of 2.5 km/h, planting depth of 4 cm and parallelogram cell. El Shal and Awny (2019) designed a feeding device consists of two long-chain has 18 metal spoons with spacing of 10 cm. Spoon dimensions were 3.6 cm outer diameter, 3.2 cm inner diameter and 15 mm depth. 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 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. Kushwaha *et. al*., (2020) designed and tested a metering device for garlic cloves which has vertical disc with cups. The cups were designed according to the clove dimensions of 2.99, 0.9 and 0.9 cm length, width and thickness respectively. According to these dimensions of garlic cloves the dimensions of the cup were 3.0, and 1.0 cm length and width respectively. The height of cup was selected as 0.5 cm (along the length) and 0.9 cm (along the width). The result of testing of the clove spacing, depth of clove, number of cloves per hill, missing hills, operating speed and field capacity were found 7.36 cm, 4.98 cm, 1.1, 13.46 %, 3.31 km/h and 0.0367 ha/h respectively. Zilpilwar *et. al*., (2020) developed a tractor operated garlic clove planter which was having miss index, multiple index, quality of feed index, mechanical clove damage, effective field capacity and field efficiency is 3.64 %, 5.64 %, 90.72 %, 5.70 %, 0.32 ha/h and 79.02 %, respectively. Payback period and benefit cost ratio of developed garlic clove planter is 5.05 years and 1.98, respectively.

The academic and applied researches indicated that the drop in garlic yield, occurring through different stages of garlic production. Garlic crop is too sensitive to planting operation, due to the high percentage of non-germinated cloves and non-uniformity of cloves distribution affecting on the total yield. For this reason, such care had to be taken to design, develop and operate garlic planting machines with an accurate scientific guidance taking into consideration machine efficiency, cloves uniformity, energy and cost requirements.

Therefore, the objectives of the present research were to:

- Develop and test a vertical roller with double grooved rows metering device for garlic cloves.
- Study the effect of metering device, agitator speeds and garlic-clove size on cloves discharge and damage.

MATERIALS AND METHOD

Laboratory and field experiments were carried out in Agricultural Engineering Research Institute and a private farm in Sharkia Governorate at year of 2020.

Materials

The test-rig

The test-rig was developed specifically for this work. Fig. (1) shows photographs of the test-rig.

The main parts of the test-rig are as follows:

- **Frame**

The frame is made of steel L-sections of 25 x 2.5 mm with 207 mm length and 86 mm width. The frame is carried on four legs of 523 mm height. The planting unit was hinged to the frame by two bolts.

- Cloves hopper

The cloves hopper was built from sheet steel 2 mm thick, with dimensions of 188 × 150 × 235 mm and 62º sloping bottom.

- Agitator

A straight crank agitator with 3-wings (which designed by Yehia, 1997) was developed. The agitator was assembled inside the cloves hopper and operated a DC motor in laboratory and by means of sprockets and chains, in the field.

- Cutoff

The cutoff (Fig. 2) was made of rubber with 19 mm thickness, 122 mm length and 100 mm width. The cutoff has two rectangular gates in the middle with different dimensions according to cloves size. The cutoff is fixed on the top of metering device and the bottom of hopper by two long bolts passed across the two sides of the hopper.

Clearance between metering device and cutoff is 15 mm (according to Abd Elgawad *et. al*., 2012). Three gates were tested for three garlic cloves grades as shown in Table 1.

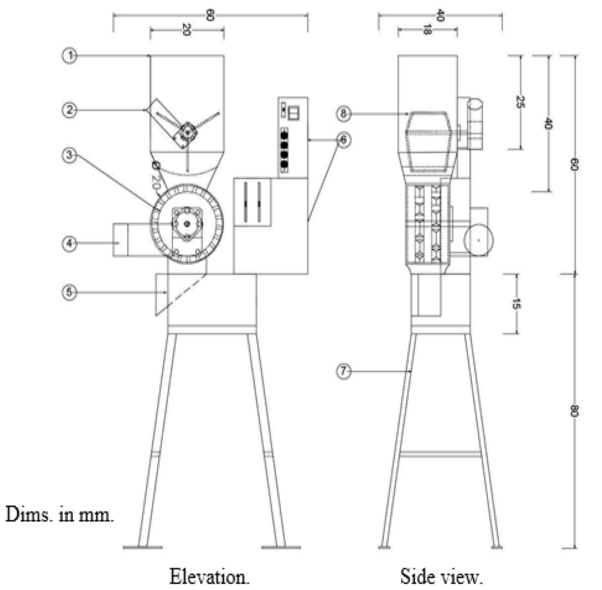

Fig. 1. The test rig

(1) Cloves hopper, (2) Agitator DC-motor, (3) Metering device, (4) Metering-device DC-motor, (5) Frame, (6) Electrical circuit, (7) Legs and (8) Agitator.

- Metring-device housing

The housing of metering device was made of sheet steel with 2 mm thick, dimensions of 96 mm width, 200 mm rear diameter and 213 mm front diameter. Two flanges (sides) with diameter of 200 mm and thickness of 8 mm are bolted with the two sides of the housing to support the metering device shaft by two bearings.

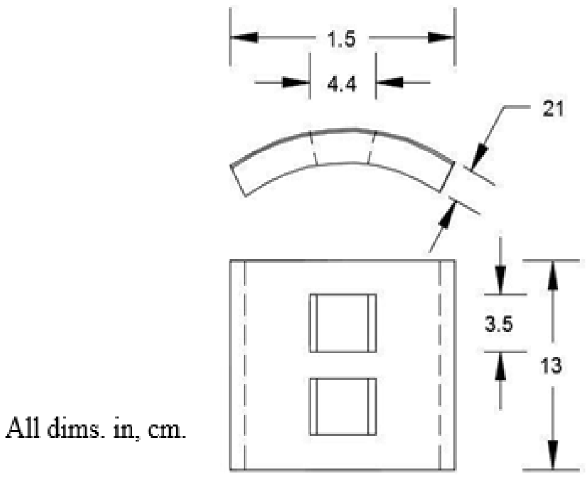

Fig. 2. The Cutoff.

Table 1. Tested gates for three garlic cloves grades (according to Abd Elgawad *et. al.*, 2012).

Cutoff dimensions	Cloves grade		
	Small	Medium	Large
Length, mm	37	39.5	44
Width, mm	31	33	35

- Metering device

A vertical-axis metering-wheel with triangles grooves (designed by Yehia, 1997 and developed by Abd Elgawad *et. al*., 2012 and Abd Elgawad, 2012) was developed according to seed physical and mechanical properties (Fig. 3). The double row grooves on metering wheel were located at the periphery. Cloves are picked up by each groove from the hopper and dropped into the seed tube.

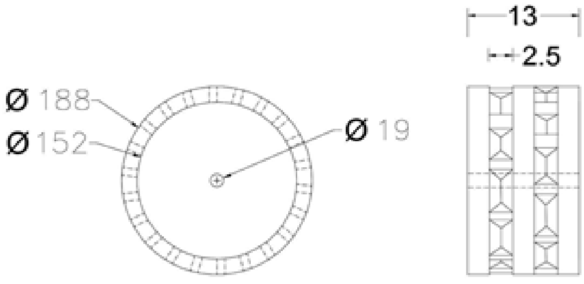

Fig. 3. Metering device of garlic-cloves.

The designed and tested grooves dimensions for the three sizes (classes or grades) of Chinese garlic cloves were shown in table 2.

- Metering-device shaft

A shaft of 300 mm length and 20 mm diameter is connected to the metering-device housing by two ball bearings which bolted with two flanges. The metering device was fitted with the feed shaft by a bolt.

Table 2. Grooves dimensions for the three sizes of Chinese garlic cloves.

Cloves size	Groove number	Groove dimensions, cm		
		Length	Width	Depth
Small	2 x 13	3.0	2.0	2.0
Medium	2 x 12	3.5	2.5	2.5
Large	2 x 11	4.5	3.3	3.0

- Transmission system

The transmission system is consisted of chains and sprockets.

- Power circuit

Power circuits used to give a variable speeds for metering device and agitators. The power circuits were shown in Figs. 4 and 5.

(a) The power circuit for metering device (Fig. 4) consists of 12 volt DC-motor, multiple transformer, bridge, rheostat and 3 switches. The DC-motor used to operate the metering device. The multiple transformer was used to obtain the voltages which gave variable speeds. The multiple transformer was connected with three switches. The switches were connected with a rheostat to give a wide range of speeds for each switch. The rheostat was connected with the bridge. The bridge changes alternating to direct current.

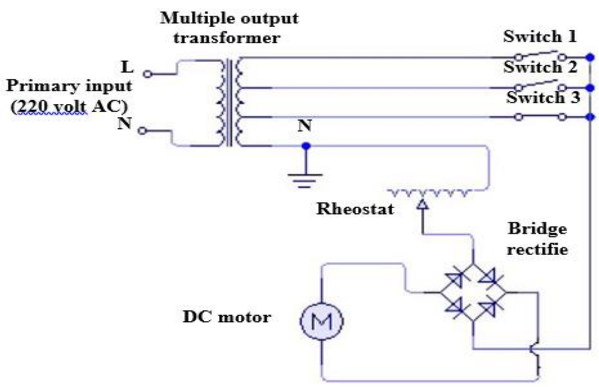

Fig. 4. Power circuit of metering device.

(b) The power circuit for agitator (Fig. 5) consists of 12 volt DC-motor, multiple transformer, bridge, rheostat and one switch. The DC-motor used to operate the agitator.

Garlic-cloves planter

Two rows garlic cloves planter which operated by Nasr tractor of 50 kW (65 hp) was used for operating the planter (Fig. 6) (Abd Elgawad *et. al*., 2012) was used in field experiments. The first planter unit had one grooved-row metering device and curved crank agitator and the second unit had the designed double grooved-rows metering device (with half speed ratio of one grooved-row) and designed straight crank agitator.

The used crop

Garlic cloves Chinese variety was used. Table 3 shows the physical properties of Chinese garlic-cloves. These data were measured on 100 cloves sample, according to the standards set in (Mohsenin, 1986).

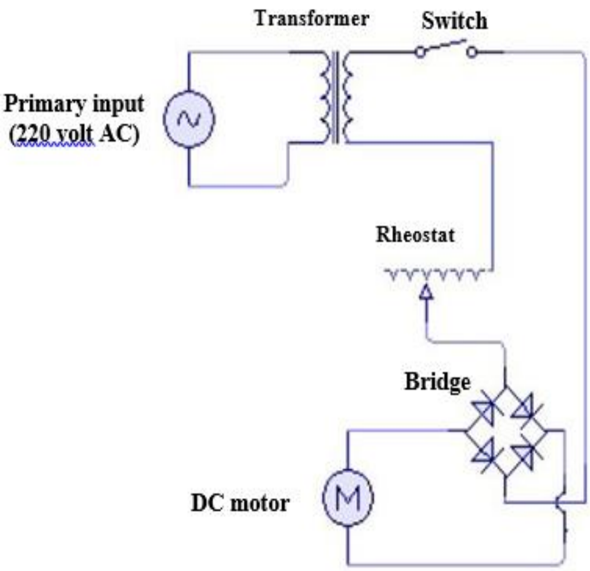

Fig. 5. Power circuit of agitator.

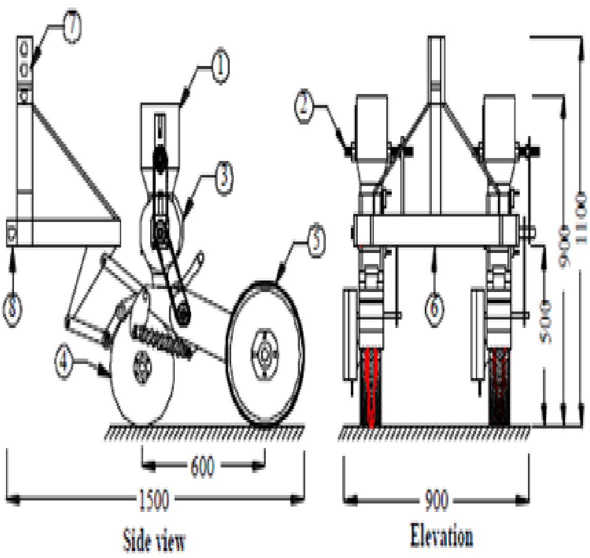

Fig. 6. Elevation and side views of the two-units garlic cloves planter.

(1) Cloves hopper, (2) Agitator, (3) Metering device, (4) Double-disc furrow opener, (5) Ground and covering wheel, (6) Tool bar, (7) upper hitching-point and (8) Two lower hitching-points.

Table 3. Physical properties of garlic cloves of Chinese variety.

Cloves Size	Physical properties	Max.	Min.	Average	S. D.(1)	C. V.(2)
Large	L, mm	40	35	36.8	1.67	4.54
	W, mm	30	21	25.2	2.16	8.56
	T, mm	21	9	15.2	3.30	21.69
Medium	L, mm	34	30	31.9	1.27	4.00
	W, mm	27	21	24	1.65	6.87
	T, mm	17	8	13.0	2.29	17.55
Small	L, mm	29	25	27	1.14	4.21
	W, mm	25	19	22	1.38	6.34
	T, mm	14	9	12	1.43	11.92
Large	Mass, g	7	2.6	4.68	1.08	23.10
Medium		4	1.4	3.95	0.72	18.30
Small		2	0.8	1.52	0.31	20.14
Large	Volume, cm^3	6.65	2.54	4.36	0.98	22.53
Medium		3.49	1.20	3.82	0.70	18.29
Small		2.22	0.76	1.36	0.32	23.16
Large	D_g, mm	29	21	42.03	2.33	9.70
Medium		23	18	21.46	1.44	6.71
Small		21	16	19.18	1.23	6.39
Large	Bulk density, g/cm^3		0.52		-	-
Medium			0.54		-	-
Small			0.55		-	-
Large	Real density, g/cm^3	1.15	0.99	1.22	0.07	5.39
Medium		1.17	0.92	1.61	0.11	6.53
Small		1.40	0.9	1.11	0.15	13.38

(1) S. D. is standard deviation. (2) C. V. is coefficient of variation.
L, W, T are length, width and thickness, respectively and D_g is geometric mean diameter.

Methods

Laboratory and field experiments were carried out to develop a vertical roller with double grooved rows metering device for garlic cloves planting.

Tested parameters

Laboratory experiments

Laboratory experiments were conducted at a constant cutoff clearance of 15 (According to Abd Elgawad, 2012) under the following parameters:

(a) Metering-device speed: For one grooved-row metering device, six metering-device speeds of 10, 20, 30, 40, 50 and 60 r.p.m (0.10, 0.21, 0.31, 0.42, 0.52 and 0.63 m/s) were tested. Meanwhile, for double grooved rows metering device, seven metering-device speeds of 50, 100, 150, 200, 250, 300 and 350 rpm (0.5, 1.0, 1.5, 2.1, 2.6, 3.1 and 3.6 m/s) were tested.

(b) Agitator speed: For double grooved rows metering device, five straight-crank agitator speeds of 30, 60, 85, 100 and 135 rpm (0.13, 0.18, 0.26, 0.30 and 0.41 m/s). Meanwhile, the one grooved-row metering device was tested at optimum curved-crank agitator speed of 60 rpm (0.27 m/s)

(c) Cutoff clearance: A constant cutoff clearances of 15 (According to Abd Elgawad, 2012) was tested for one and double grooved-rows metering device.

(d) Garlic-cloves size: Three cloves-sizes (categories) of 25 – 29, 30 - 34 and 35 - 40 mm and random size were tested for one and double grooved-rows metering device were tested for one and double grooved-rows metering device.

Field experiments

Two planting-units were tested in the field experiments using large cloves-size of 35 - 40 mm as follows:

(a) Planting unit which was developed by “Abd Elgawad *et. al*., 2012” has a single grooved-row metering device and curved crank agitator with optimum speed of 60 rpm (0.27 m/s). This planting unit was tested at forward-speed of 1.4, 2.4, 3.4 and 4.7 km/h (metering device speeds of 21.6, 37.0, 52.4 and 72.4 rpm).

(b) Planting unit which developed in this study has the developed double grooved-rows metering device and straight crank agitator with optimum speed of 85 rpm (0.26 m/s). This developed planting-unit was tested at four forward-speed of 1.4, 2.4, 3.4 and 4.7 km/h (metering device speeds of 10.8, 18.5, 26.2 and 36.2 rpm).

Measurements

- Cloves discharge

The fed cloves were collected in plastic bag during a certain number of feeding-shaft revolutions to estimate cloves discharge under the previously mentioned factors.

- Cloves damage

For the previously-mentioned factors, the visible damage of cloves after passing through the metering device was calculated by the following equations (Yehia, 1993):

$$\text{Visible cloves damage, }\% = \frac{\text{No. of damaged cloves}}{\text{Total No. of cloves}} \times 100 \qquad (1)$$

- Missing hills and double cloves or plants:

$$\text{Missing hills} = \frac{\text{Number of missing cloves in meter}}{\text{Number of adjusted cloves in meter}} \times 100 \qquad (2)$$

$$\text{Double plants} = \frac{\text{Number of double cloves in meter}}{\text{Number of adjusted cloves in meter}} \times 100 \qquad (3)$$

- Emergence percentage

The number of plantings per meter of the row was counted for the four tested speeds (1.4, 2.4, 3.4 and 4.7 km/h) to determine emergence percent according to the following formula:

$$\text{Emergence ratio} = \frac{\text{Average plant No. per meter}}{\text{Average No. of delivered cloves per meter}} \times 100 \qquad (4)$$

- Final garlic yield

Two rows of garlic crop with 3 m length for each forward speed were harvested by manual tool and weighed by analog balance. The total bulbs and clove yields were calculated according to the following formula:

$$\text{Yield, kg/fed} = \frac{\text{Mass (kg)}}{\text{Area (fed)}} \qquad (5)$$

RESULTS AND DISCUSSION

Effect of metering-device, agitator speeds and clove size on garlic-cloves discharge.

Double grooved-rows metering device.

Figs. 7 and 8 show effect of metering-device and agitator speeds on garlic-cloves discharge for different clove sizes.

Results show that the maximum garlic-clove discharges of 24, 22, 21 and 66 clove/metering-device revolution were obtained with metering-device speed of 150 rpm (1.5 m/s) and agitator speed of 135 rpm (0.41 m/s) by using small, medium, large and random (mixed) clove-sizes respectively. Meanwhile, the minimum garlic-clove discharges of 14, 12. 10 and 5 clove/metering-device revolution were obtained with metering-device speed of 350 rpm (3.6 m/s) and agitator speed of 30 rpm (0.31 m/s) by using small, medium, large and random (mixed) clove-sizes respectively.

By increasing metering-device speed from 150 to 350 rpm the garlic-clove discharges decreased by 22.22, 25.69, 28.28 and 67.02 % by using small, medium, large and random (mixed) clove-sizes respectively at all tested agitator-speeds. Meanwhile, by increasing agitator speed from 30 to 135 rpm (from 0.13 to 0.41 m/s) the garlic-clove discharges increased by 15.06, 15.79, 17.99 and 61.99 % by using small, medium, large and random (mixed) clove-sizes respectively under the same previous speeds.

It was recommended to adjust metering-device speed of 50 - 200 rpm (0.5 – 2.6 m/s) and agitator speed of 85 rpm (0.26 m/s) to achieve the acceptable garlic-clove discharges of about 26, 24 and 22 clove/metering-device revolution by using small, medium and large clove-sizes respectively. The decreasing of garlic-cloves discharge by increasing metering-device speed is due to that the time is not enough to fill all grooves of metering-device by cloves.

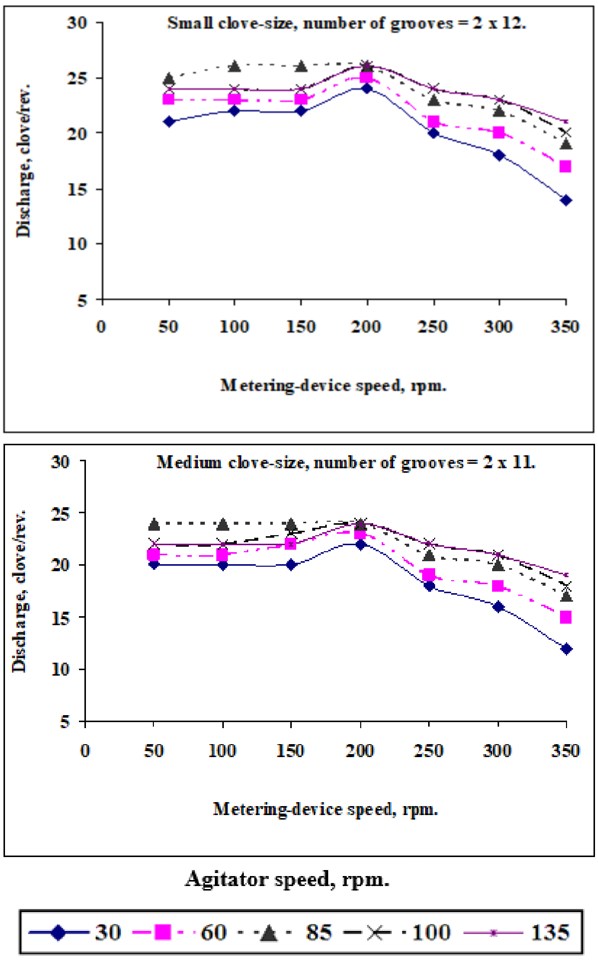

Fig. 7. Effect of metering-device and agitator speeds on garlic-cloves discharge for small and medium clove-sizes.

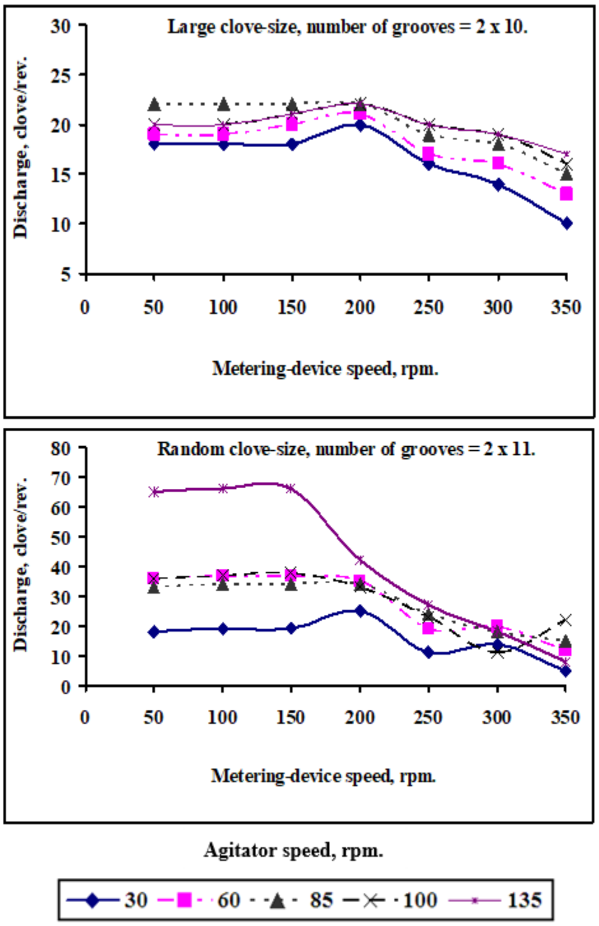

Fig. 8. Effect of metering-device and agitator speeds on garlic-cloves discharge for large and random clove-sizes.

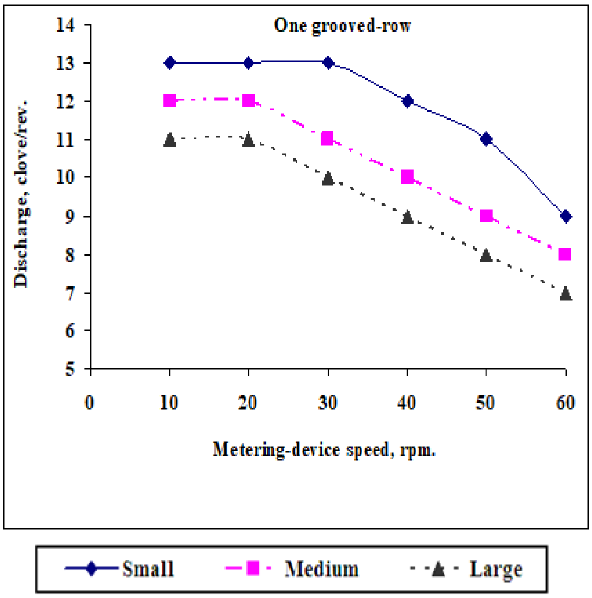

Fig. 9. Effect of metering-device and groove size on garlic-cloves discharge for one grooved-row metering device.

In addition to, the increase in cloves discharge by increasing agitator speed is due the increase in cloves numbers, which are pushed by crank wings of agitator to the metering device grooves.

One grooved-row metering device.

Fig. 9 shows effect of metering-device and groove size on garlic-cloves discharge for one grooved-row metering device.

Results show that by increasing metering device speed from 10 to 60 rpm the garlic-cloves discharge decreased from 13 to 9, 12 to 8 and 11 to 7

cloves/metering device revolution using small, medium and large garlic-clove sizes receptively at optimum crank agitator speed of 60 rpm.

Effect of metering-device, agitator speeds and clove size on garlic-cloves damage percent.

Double grooved-rows metering device.

Figs. 10 and 11 show effect of metering-device and agitator speeds on garlic-cloves damage percent for different clove sizes.

Results show that the maximum garlic-clove damages of 1.31, 1.13, 1.22 and 3 % were obtained with metering-device speed of 350 rpm (3.6 m/s) and agitator speed of 30 rpm (0.13 m/s) by using small, medium, large and random (mixed) clove-sizes respectively. Meanwhile, the minimum garlic-clove damage using small garlic-clove size of zero % was obtained with metering-device speed range of 200 - 350 rpm (2.1 - 3.6 m/s) and agitator speed of 85 rpm (0.26 m/s). In addition to, the minimum garlic-clove damage using medium and large garlic-clove sizes of zero % was obtained with metering-device speed range of 50 - 350 rpm (0.5 - 3.6 m/s) and agitator speed of 85 rpm (0.26 m/s). Also, the minimum garlic-clove damage using random (mixed) garlic-clove size of zero % was obtained with metering-device speed range of 150 - 300 rpm (1.5 - 3.1 m/s) and agitator speed of 85 rpm (0.26 m/s).

It was recommended with the optimum metering-device speed of 50 - 200 rpm and agitator speed of 85 rpm (0.26 m/s) which gave the acceptable garlic-clove damage of 0.04 – 0.08, zero and zero % by using small, medium, large and clove-sizes respectively. The increase in garlic-clove damage by increasing metering device speed is due to increasing momentum of cloves (momentum = mass x velocity) and increasing impact force accordingly. The decrease in cloves damage by using medium clove-size is due to a good flow of cloves because of uniform shape of cloves and the groove take only one clove. Whereas, the maximum clove-damaged was obtained by using small size is due entering more than one cloves in the same groove.

One grooved-row metering device

Fig. 12 shows effect of metering-device and groove size on garlic-cloves damage percent for one grooved-row metering device. Results show that by increasing metering-device speed from 10 to 60 rpm the garlic clove ranges were 3.3 – 4.7, 1.6 – 3.1 and 2.9 – 4.5 % using small, medium and large garlic-clove sizes receptively at crank-agitator speed of 60 rpm.

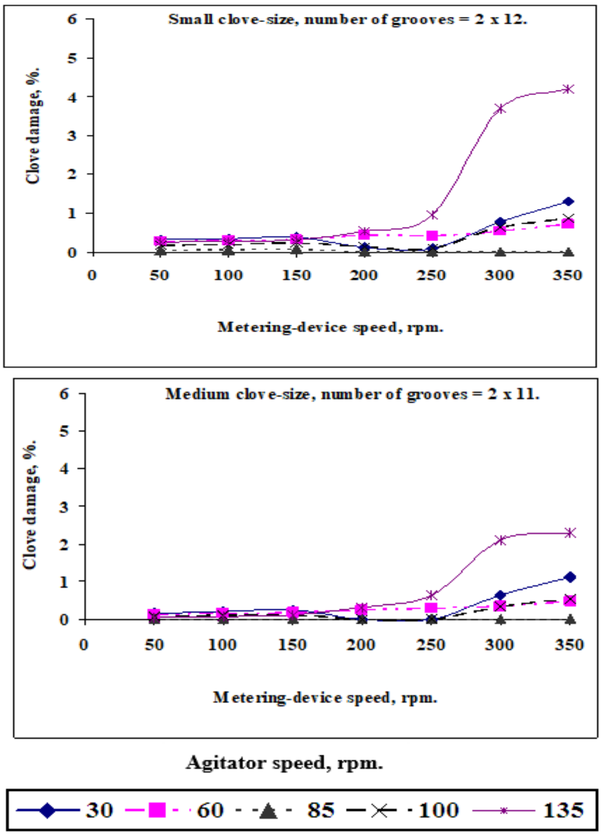

Fig. 10. Effect of metering-device and agitator speeds on garlic-cloves damage percent for small and medium clove-sizes.

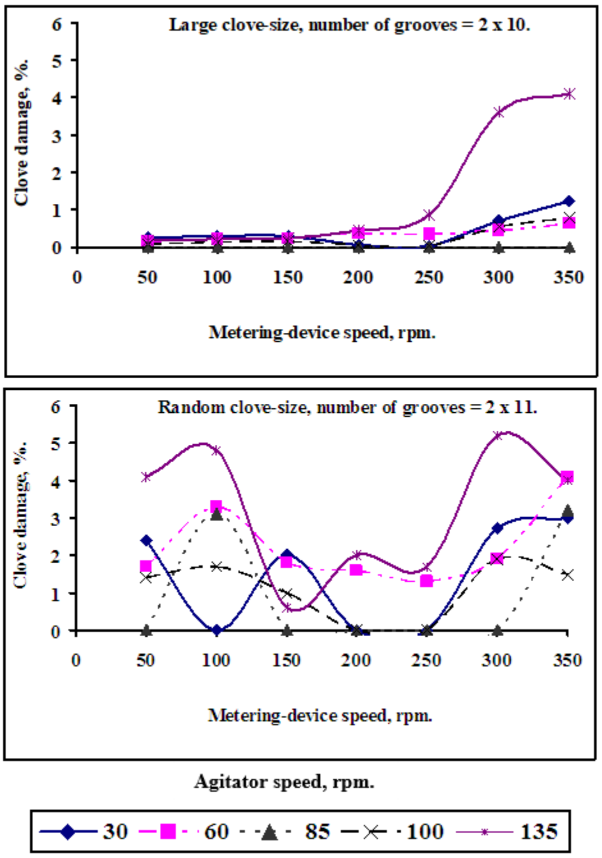

Fig. 11. Effect of metering-device and agitator speeds on garlic-cloves damage percent for large and random clove-sizes.

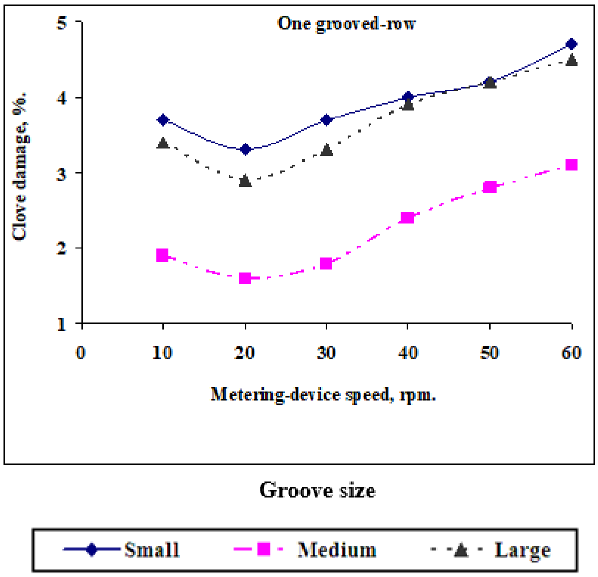

Fig. 12. Effect of metering-device and groove size on garlic-cloves damage percent for one grooved-row metering device.

Effect of planter forward-speed on plant emergence percent using one and double grooved-rows.

Fig. 13 shows effect of planter forward-speed on plant emergence percent using one and double grooved-rows.

Data shows that by increasing forward speed from 1.4 to 4.7 km/h plant-emergence percent decreased from 99.62 to 97.66 and from 99.93 to 99.76 %. using one and double grooved-rows respectively.

The decreasing of plant emergence by increasing forward speed is due to increasing garlic-cloves damage.

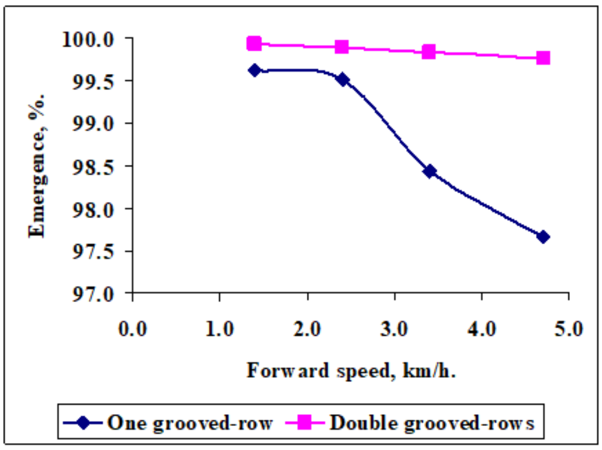

Fig. 13. Effect of metering-device on plant-emergence percent for one grooved-row metering device.

Effect of planter forward-speed on average of garlic-cloves spacing, missing-hills and double-cloves percent using one and double grooved-rows.

Figs. 14 show effect of planter forward-speed on average garlic-cloves spacing, missing-hill and double-cloves percent using one and double grooved-rows. Results show that by increasing planter forward-speed from 1.4 to 4.7 km/h averages of garlic cloves spacing increased from 9.2 to 10.5 cm, missing hills increased from 0.21 to 1.77 and zero to zero %, and double cloves decreased from 10.6 to

6.1 and from 4.2 to 4.1 % using one and double grooved-rows respectively.

The results show that the double grooved-rows gave more garlic-cloves uniformity than one grooved-row metering device. It is due to more cloves free movement on metering-device grooves using double grooved-rows.

5. Effect of planter forward-speed and total yield of garlic crop.

Fig. 15 shows effect of planter forward-speed on total yield of garlic crop. Data shows that by increasing forward speed from 1.4 to 4.7 km/h the total crop yield decreased from 7.33 to 5.12 and from 8.67 to 6.22 Mg/fed. using one and double grooved-rows respectively.

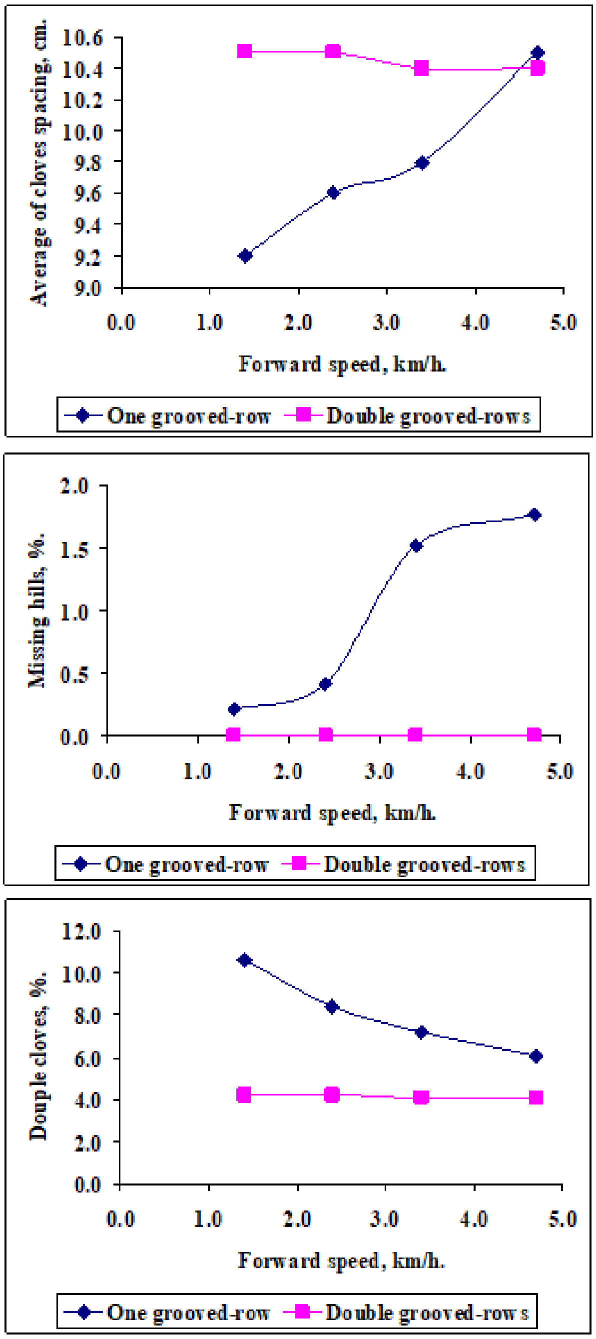

Fig.14. Effect of planter forward-speed on average garlic-cloves spacing and missing hills percent using one and double grooved-rows.

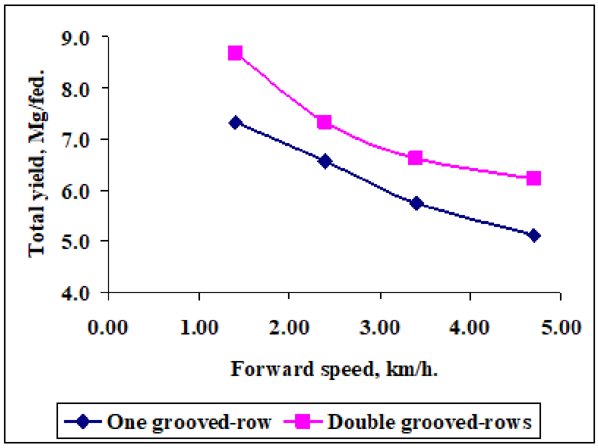

Fig. 15. Effect of planter forward-speed on average double-cloves percent and total crop-yield using one and double grooved-rows.

CONCLUSION

- It is recommended to use the double grooved-rows metering device under conditions of 50 - 200 rpm and agitator speed of 85 rpm for small, medium and large clove sizes to achieve garlic-cloves discharge range of 22 to 26 clove/metering-device revolution and damage percent of zero %
- It is recommended to use the one grooved-rows metering device under conditions of 20 rpm and agitator speed of 60 rpm for small, medium and large clove sizes to achieve 11 – 13 clove/metering device /revolution and seed damage of 1.6 – 3.3 %.
- It is recommended to adjust planter speed in the range of 1.4 – 4.7 km/h to achieve plant-emergence percent ranges of 97.66 - 99.62 and 99.76 - 99.93 %., averages garlic cloves spacing of 9.2 - 10.5 cm, and total crop yield ranges of 5.12 -7.33 and 6.22 - 8.67 Mg/fed, using one and double grooved-rows respectively.

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تطوير جهاز تلقيم ذو عجلة رأسية ذات صفين من التجاويف لزراعة فصوص الثوم

فاطمة الزهراء على عبد الجواد
معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية – الدقي – الجيزة - مصر.

يهدف البحث إلى تطوير جهاز تلقيم ذو عجلة رأسية ذات صفين من التجاويف لزراعة فصوص الثوم و قلاب مرفقى مستقيم بثلاثة أجنحة. وتم تطوير جهاز معملى لأختبار جهاز التلقيم والقلاب المطورين. وتم إجراء مجموعتين من التجارب: التجارب المعملية وأجريت على ثلاثة أحجام من فصوص الثوم الصينى (25 – 29، 30 – 34، 35 – 40 مم) باستخدام ثلاثة أبعاد للتجاويف مثلثة الشكل (30 × 20 × 20، 35 × 25 × 25، 45 × 33 × 30 مم): وتم فيها دراسة العوامل الآتية على جهاز التلقيم المطور ذو الصفين من الخلايا: ، سبع سرعات لجهاز التلقيم (50، 100، 150، 200، 250، 300، 350 لفة/د أو0.5، 1,0، 1,5، 2,1، 2,6، 3.1، 3.6 م/ث)، خمس سرعات للقلاب من النوع الكرنك المستقيم (30، 60، 85، 100، 135 لفة/د أو 0.13، 0.18، 0.26، 0.30، 0.41 م/ث)، بينما تم دراسة ست سرعات على جهاز التلقيم ذو الصف الواحد من الخلايا وهى: (10، 20، 30، 40، 50، 60 لفة/د أو0.10 ، 0,21 ، 0,31 ، 0,42 ، 0,52 ، 0.63 م/ث) عند أفضل سرعة قلاب من النوع الكرنك المقوس وهى 60 لفة/د (0.27 م/ث)، تمت دراسة هذه العوامل على معدل التلقيم، تلف الفصوص لجهاز التلقيم المطور ذو الصفين من الخلايا وجهاز التلقيم ذو الصف الواحد. وتم إجراء تجارب حقلية وتمت على أنسب سرعة قلاب وهى 85 لفة/د (0.26 م/ث) لجهاز التلقيم ذو الصفين من الخلايا، وسرعة قلاب 60 لفة/د (0.27 م/ث) لجهاز التلقيم ذو الصف الواحد، وحجم فصوص 35 – 40 مم، وتم دراسة أربع سرعات أمامية لآلة الزراعة وهى: 1.4، 2.4، 3.4، 4.7 كم/س وكانت النتائج كالآتي: - أعطت سرعة جهاز تلقيم ذو الصفين من التجاويف 50 - 200 لفة/د وسرعة قلاب من النوع الكرنك المستقيم 85 لفة/د عند خلوص 15 مم معدل تصرف للفصوص 22.0 ، 26 فص/لفة جهاز تلقيم وأقل نسبة تلف للفصوص 0 % لفصوص الثوم الصغيرة والمتوسطة والكبيرة الحجم على الترتيب.- أعطت سرعة جهاز تلقيم ذو الصف الواحد من التجاويف 20 لفة/د وسرعة قلاب من النوع الكرنك المقوس 60 لفة/د عند خلوص 15 مم معدل تصرف للفصوص 11 - 13 فص/لفة جهاز تلقيم وأقل نسبة تلف للفصوص 1.6 – 3.3 % لفصوص الثوم الصغيرة والمتوسطة والكبيرة الحجم.- أعطى مدى السرعة الأمامية للآلة 1.4 – 4.7 كم/س أفضل مدى لنسبة الإنبات للفصوص 97.66 – 99.62، 99.76 – 99.93 %، متوسط مسافة بين الفصوص 9.2 – 10.5 سم، كمية محصول كلية 5.12 – 7.33، 6.22 – 8.67 ميجاجرام/فدان وذلك باستخدام جهازى التلقيم ذو الصف وذو الصفين على الترتيب.