*FACTORS AFFECTING CUCURBITA-PEPO CROP SEED LOSSES AND DAMAGE BY USING A SEED EXTRACTING MACHINE PROTOTYPE

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ABSTRACT

Ninety seven percent of seed extracting of cucurbita crops are accomplished by manual methods. Many Workers are needed for one feddan which costing to much money. Consequently, increasing the production cost and reducing the farmer's profit. Increasing the planted area of cucurbita crops requires increase of the propelled seed extractors, with high capacity. The present study is conducted to study the effective factors on cucurbita pepo crop seeds damage and losses by using seed extracting prototype. (Common names: cucurbita pepo L, pumpkin, vegetable marrow, summer pumpkin, autumn pumpkin) In addition the physical and mechanical properties of cucurbita fruits and seeds were studied. The results revealed that the seed-extracting machine operated successfully under field conditions. The combination of 0.116Mg/min feed rate, 2.48m/s drum speed,15 mm drum-concave clearance and six days time span after harvesting achieved the minimum values of seed damage. The feed rate of 0.116Mg/min, drum speed of 3.38 m/s, drum-concave clearance of 5 mm, the extracting cylinder – curved plate clearance 5mm, rotational speed of separating sieve 25 rpm and extracting time after six days achieved the minimum value of seed losses (4.1%).

INTRODUCTION

Cucurbita crops seeds are important and strategic vegetable products in Egypt, which can be exported to other countries. Almost of these seeds considered of the most Egyptians like to eat. Also, consider valuable source of much needed protein and vegetable oil. Recently, cucurbita crops have been widely

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cultivated in northern regions of Egypt, such as Kafr- Elsheakh, Dakahlia , El Bohira and the new lands like Nubaria.

E. M. A. (2006) reported that the total area of cucurbita crops (squashes) was about 91054 Fed./year, However, the area of summer squashes were about 59595Fed. Cucurbita pepo varieties represent the most of that area, which generally were produced for seeds. Most of crop fruits are varying in shape and volume (wide variation). It is very labor intensive (about 100-man h/Fed.). Extracting seeds are mainly conducted manually and seed extracting machines are not available. However, mechanical extracting is necessary to remove the tedium involved in manual extracting of the fruits. Based on relevant physical properties of the cucurbita pepo fruits, an extracting prototype machine was used to separate seeds from the pulp and placenta. The extracting machine prototype consists of four processes: first is cutting and crushing stage, second is extracting seeds from cut fruits, third is separating seeds from peels, and the fourth is cleaning seeds from placenta and debris.

Abd-Elmoniem (1994) classified the seed extraction methods as follows:

1- Methods of separating dry vegetable seeds. These methods are varied based on whether the fruits are dehiscent or indehiscent

2- Methods of extracting seeds from soft fruits, these methods include.

a) Manual or mechanical separation, by using washing water.

b) Chemical extraction, by using fermentation or acids and alkaline.

Buyanov and Voronyuk (1985) and ***Mohsenin*** (1986) stated that the differences in the physical and mechanical properties of seeds and fruits are considered the basis for separating and grading. They reported that among these properties the weight and shape, specific gravity, the coefficient of dynamic friction, density, moisture content, the fruit hardness, impact resistance, and surface texture are the basic characters that affecting construction of seed extracting equipment. They also defined that the quantity of seeds is usually 4- 5% of fruit weight. The individual weight of fresh wet seeds is 1.5 to 2 times the weight of dry seeds.

Baldwin (1990) mentioned that mechanical damage during harvest is caused largely by fast moving parts of the threshing-drum of the combine.

***Vergano** et al.* (1992) stated that the performance data of the axial-flow vegetable seed-extracting machine about different vegetable fruits and data about manual seed extraction have shown feeding rate of vegetable fruits through seed extracting machine varied from 310 to 1930 kg/h for different vegetables. Such as cucumber, watermelon, tomato, summer squash, brinjal, squash melon and chillies, respectively. The seed loss for all vegetables except squash melon was below 5.86 %.

***Kholief** et al.* (2005) showed the relation between drum speed and seed damage for three various drum shape and three levels of watermelon feed rates. The results showed clearly that the increase of drum speeds tends to increase the seed damage and these may be due to the increase of impact during the separation of seeds.

Fouad (2004) showed that the drum speed had a great effect on the seed losses under studied variables such as feed rate, drum-knives number during and crushing time. The author noticed that increasing drum speed tends to increase visible seed damage at all other variables under study. In addition, the Period between harvesting and separation process affect the visible seed damage.

The present study aims to:

Study the factors that affect seed damage and seed losses of the cucurbita pepo crop by using the extracting machine prototype.

MATERIALS AND METHODS

To estimate cucurbita-pepo visible seed damage and seed losses that occurs by using the extracting machine prototype. In addition, to recognize the main factors that has effect the ratio of seed damage and seed losses.

The following variables were studied:

1- Feeding rate (116, 174 and 232kg / min)
2- Drum speed (2.48, 2.98 and 3.38m/s)
3- Cutting drum and concave clearance (5, 10 and 15mm)
4- Extracting cylinder fingers and plate fingers Clearance (5, 10 and 20mm)
5- Separating sieve speed (25, 30 and 35rpm)
6- Time of extracting after harvesting (1, 3, 6 days)

1. Physical and mechanical properties of cucurbita pepo:

Physical and mechanical properties of cucurbita pepo crop (table:1) such as dimensions of fruits and seeds, volume of fruits, density of fruits, coefficient of friction between cucurbita fruits and steel surface, also rolling angle of fruits were carried out according to the standard methods.

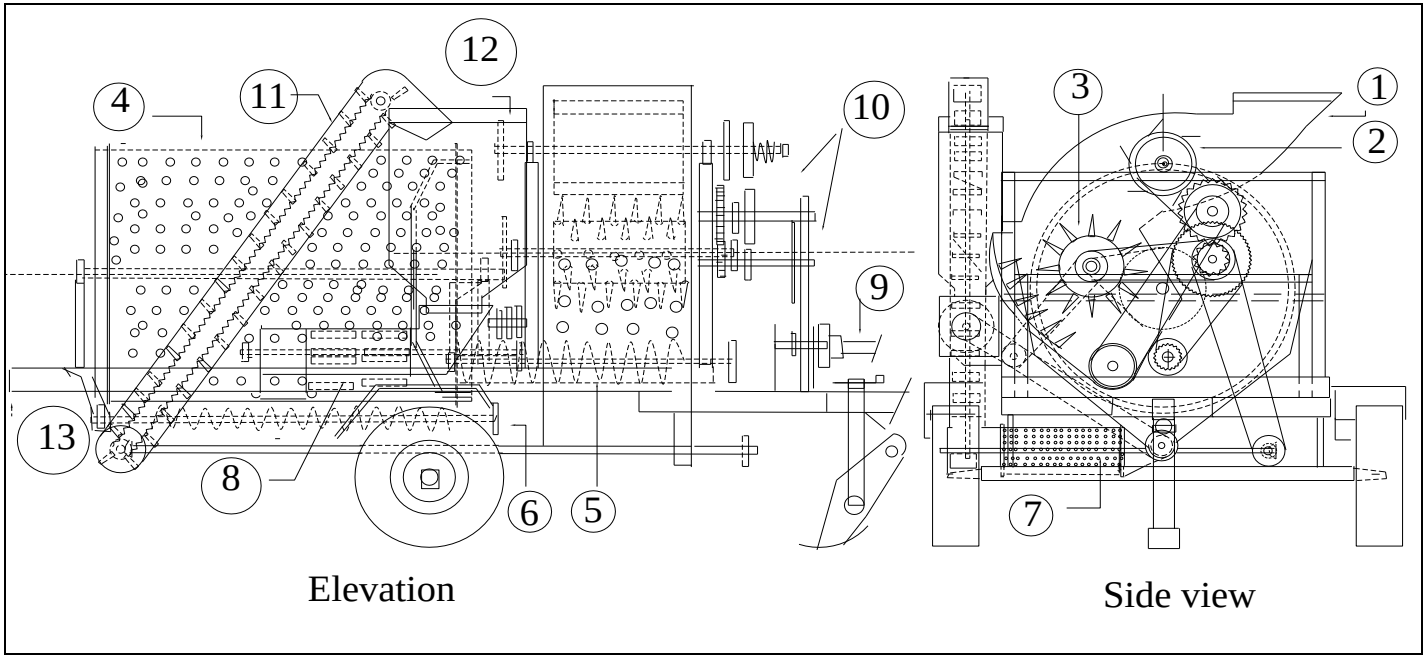
2- Seed extracting prototype machine:

Engineering concepts and developed parts of the machine prototype were carried out at Ganaklies central workshop at the new land district

Table (1): physical properties of cucurbita Pepo fruits and seeds

Characteristics	Average	C.v.
1. Dimensions:		
a) Cucurbita-pepo fruit:		
- Mid diameter, cm	15.4	21%
- Length, cm	25.8	27%
- Thickness of pulp, cm	2.5	23%
b Cucurbita pepo seed:		
- length, mm	16.1	26%
- width, mm	12.14	17%
- thickness, mm	3	29%
2. Mass:		
- mass of cucurbita pepo fruit, g/fruit	2.6	55%
- mass of seeds per fruit, g (wet basis)	0.1	50%
- mass of rind, pulp and placenta per fruit, g	95 :96%	
- mass of total cucurbita pepo fruits ton /fed	15	
3. Number of fruits/m² (in the field)	3	
4. Volume of fruit, cm^3	2700	90%
5. Density of fruit, kg/m^3	670	15%
6. Density of cut fruit, kg/m^3	970	
7. Coefficient of friction	0.65	
8.Rolling angle on inclined steel surface	35°	

Mechanization sector, Ministry of agriculture. Main parts dimensions of the machine prototype were constructed depending on the measured physical and mechanical properties of fruits. Therefore, the construction was carried out for each part and component of the machine to suit the intended performance of the extracting machine.



1) Hopper 2) Cutting drum 3) Extracting cylinder-curved plate 4) Separating sieve 5) Crop auger 6) seed auger
7) Primary cleaning cylinder 8) Extra cleaning cylinder 9) power source 10) Transmission system
11) Flight conveying elevator 12) Seed tank 13) Frame

Fig.(1): The main parts and units of the extracting seed machine prototype.

The extracting machine operated by a tractor PTO. Cucurbita seed extracting machine is shown in Fig.(1) some technical specifications of extracting machine prototype are listed in table (2)

3. Determination of seeds damage and seed losses:

Visible seed damage was measured but the invisible seeds damage neglected because the maximum production of seeds is eaten as toasted seeds or extracting oil from seeds.

A) Seed damage measurement:

The visible seeds damage, which have any damage due to the using of extracting machine, estimated by the formula:

$$Damaged seeds\% = \frac{M_d}{M_u + M_d} \times 100 \qquad \text{---------- (1)}$$

M_d =mass of damage seeds, g. M_u = mass of undamaged seeds, g

Table (2): The technical specifications of extracting machine prototype:

Item	Specification
Manufacture	Ganaklees, central workshop, Agricultural engineering sector
Total length, cm	485
Width, cm	218
Height, cm	225
Mass, kg	1750
Source of power	Tractor PTO.
Length of the cutting drum, cm	60
Diameter of the drum, cm	31
Peripheral diameter of the drum, cm	43
Total cutting knives on the drum, cm	6 knives (L60cm, W6.5cm and t 0.6cm).
Hopper Feeding opening of fruits, cm	50 x 60
Cylindrical separating sieve, cm	Inner diameter 118, total length 170
Cylindrical sieve opening diameter, cm	1.6
Cylindrical sieve effective area, m²	5.5
Primary cleaning sieve	22cm D,55cm L, effective area 0.34m²
Extra-cleaning sieve	30cm D,50cm L, effective area 0.47m²
Entire cut crop conveying auger	D_1 5cm, D_2 20cm, tread 15cm, L 110cm
Bottom seed conveying auger	D_1 3cm, D_2 10cm, tread 10cm, L 150cm

B) Seed losses:

The seed losses were determined by rescuing the expelled peels from the cylindrical separating sieve at different feeding rates. Seeds manually collected and weighted.

$$Seed\ losses\ \% = \frac{M_l}{M_t + M_l} \times 100 \quad \text{-------- (2)}$$

M_l = mass of the total seed losses expelled out of the machine, g.

M_t = mass of collected seeds, g.

The machine productivity was calculated by the following equation:

$$M.pr. = \frac{60\ M_t}{T_E \times 10^3} \quad \text{---------- (3)}$$

where: *M.pr.* = Machine productivity, kg/h;

M_t = mass of collected seeds, g, and

T_E = machine running time, min.

RESULTS AND DISCUSSIONS

Obtained results through out several laboratory and field experiments presented and discussed through the following points:

1. Seed damage:

Most of seed damage occurs in the cutting and crushing unit of the machine prototype. That damaged seeds affected many factors such as feeding rate, drum speed, drum-concave clearance and time of extracting after harvesting.

The results during the experiments gave some information on seed damage ratio that affected different variables. As shown in the Figures (2), (3) and (4). Increasing the drum-concave clearance from 5 to 10 t0 15mm Fig.(2) tended to decrease the seed damage during the extracting cucurbita pepo seeds. In addition, The presented data in Fig.(3) cleared that increment of spent time between harvesting and extracting process decreases seed damage. The obtained values of seed damage, increased by increasing the feeding rate from 116kg/min to 174kg/min to 232kg/min, due to increasing friction forces on the wet seeds, in addition the obtained values of seed damage increased through increasing the drum speed from 2.48m/s to 2.98m/s to 3.38m/s.

Generally, the feed rate of 116 kg/min., drum speed of 2.48 m/s, drum-concave clearance of 15 mm, and 6 days time of extracting after harvesting represent the minimum values of seeds damage.

2. Seed losses:

The average values of seed losses were affected the feeding rate, drum speed, drum-concave clearance, extracting cylinder-curved plate clearance,

speed of separating sieve and time of extracting after harvesting, are indicated in Figures (5), (6), (7) and (8). It was observed that increasing the drum speed tends to decrease the seed losses at all parameter levels. The data indicated that increasing feed rate from 116 to 174 to 232kg/min and using drum speed of 3.38m/s increased the seed losses from 4.1 to 6.5 to 8.5% respectively.

The Presented data in Fig.(5) explains that the losses of seeds affected the rotational speed of separating sieve. Increasing separating sieve speeds from 25 to 30 to 35rpm tend to increase seed losses.

Regarding to the effect of feeding rate, the presented data in Fig.(6) showed that the feeding rate had an implemented effect on the seed losses under studied variables. The 3.38 m/s drum speed gave the minimum percentage of seed losses. The drum speed of 2.48 m/s recorded the highest percentage of losses that trend was because of increasing the kinetic energy and the inertia of the cut fruits, which make them under a smash force, consequently, the sticky seeds inside the placenta moves out from their hidden bed The presented data in Fig.(7) explains that the losses of seeds affected the clearance between extracting cylinder rubber fingers and the plate rubber fingers. Increasing the extracting–cylinder clearances from 5.0 to 10 to 20mm tend to increase seed losses.

Fig.(8) indicates the effect of extracting time on the seed losses at different feeding rates (kg/min), different drum speeds, drum-concave clearance 10mm, extracting cylinder – curved plate clearance 5mm and the speed of separating sieve 25rpm, declared that extracting of cucurbita-pepo seeds after six days from harvesting realized the lowest value of seed losses.

CONCLUSION

The mechanical seed extracting of cucurbita crops is one of the important agricultural operations. This study aims to test and evaluate the field data obtained by the experiments and the observation of the machine prototype. The seed-extracting machine was operated successfully under field conditions. Three feed rates of cucurbita pepo fruits nominated 116, 174 and 232 kg/min, three drum speeds: 2.48, 2.93 and 3.38 m/s, three drum-concave clearances 5, 10 and 15mm, three clearances of extracting cylinder-plate fingers 5, 10, and 20mm, three separating sieve speeds 25, 30 and 35 rpm,

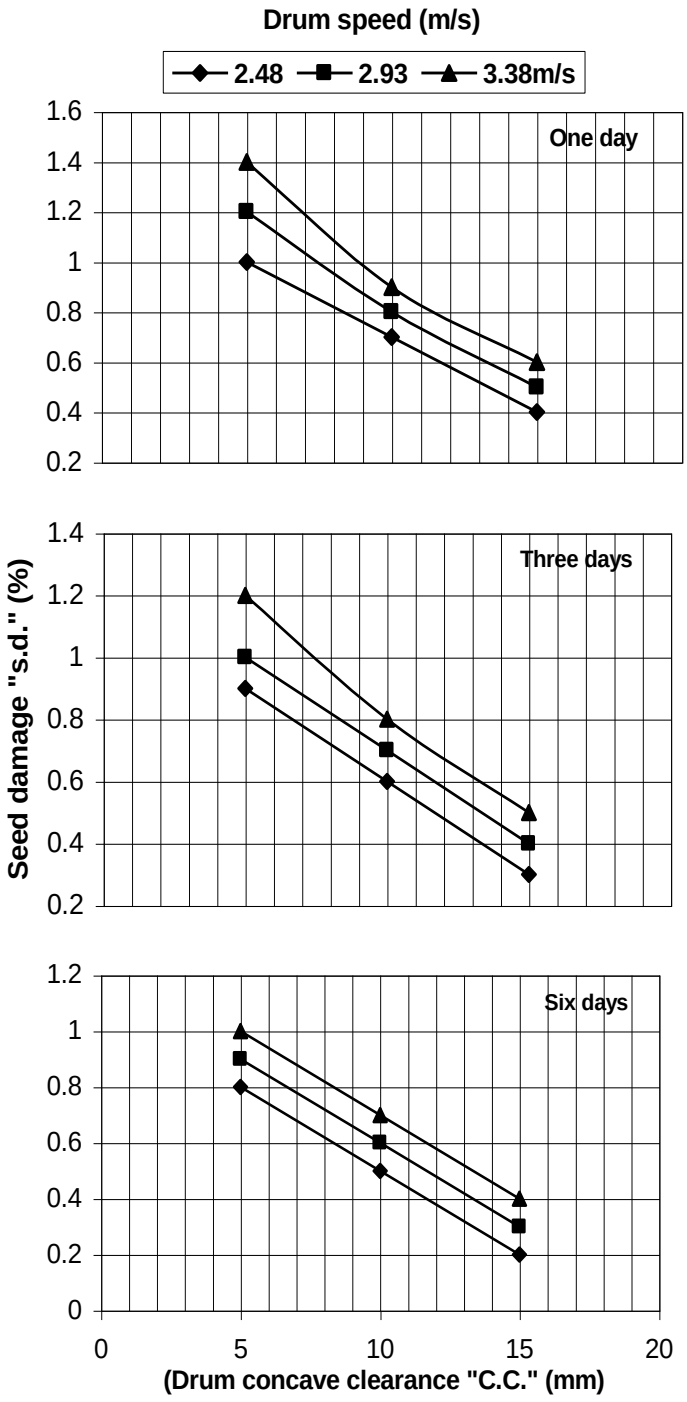


Fig.(2): Cucurbita pepo seed damage (%) Vs. drum-concave clearance

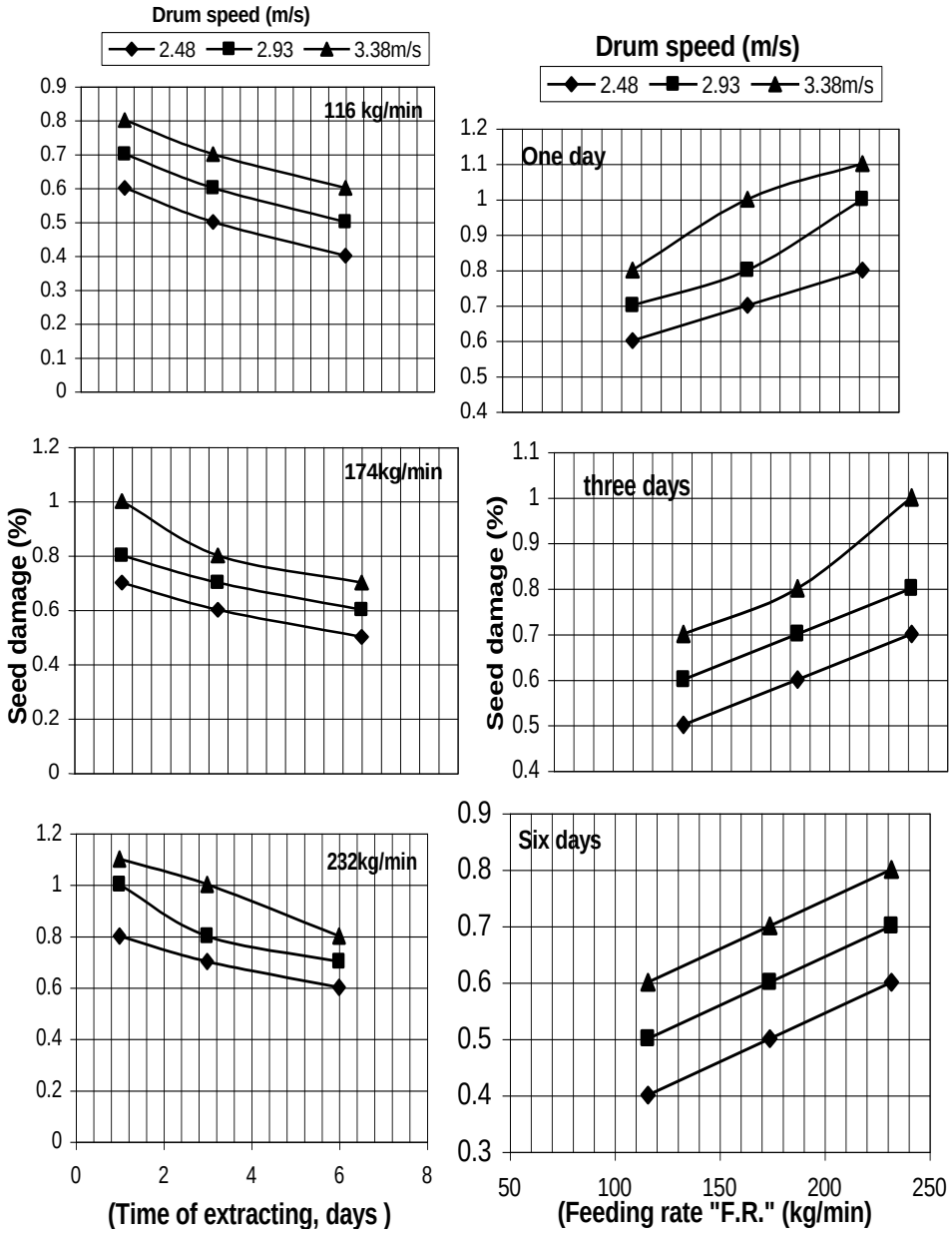
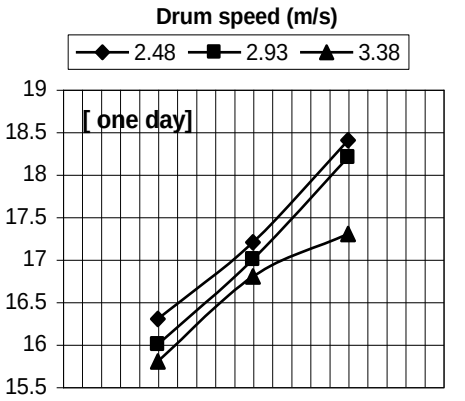
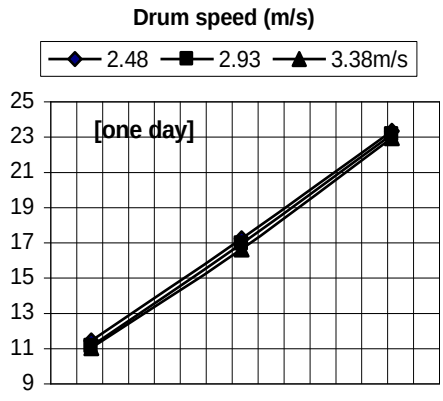
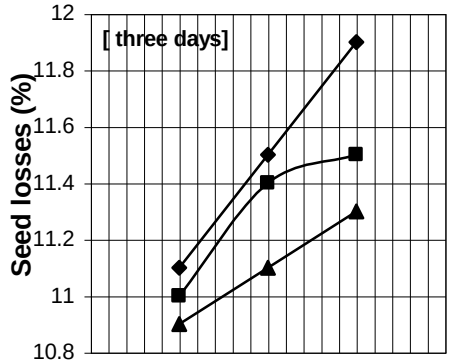


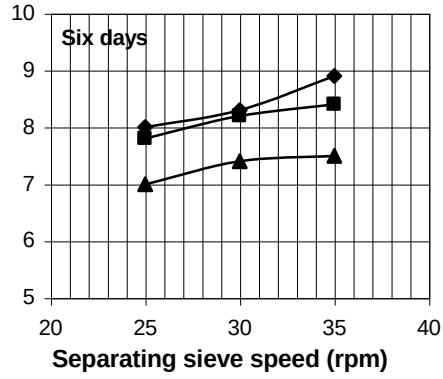
Fig.(3):Cucurbita pepo seed damage (%) Vs. time of extracting after harvesting (Sp.T.)

Fig.(4):Cucurbita pepo seed damage (%) Vs. feeding rates (kg/min)









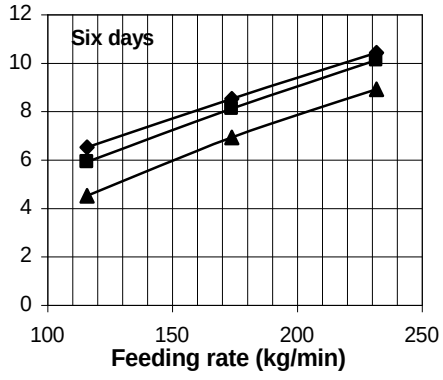


Fig.(5):Cucurbita pepo seed losses (%) Vs. separating sieve speed (rpm)

Fig.(6):Cucurbita pepo seed losses(%) Vs. feeding rates, (kg/min)

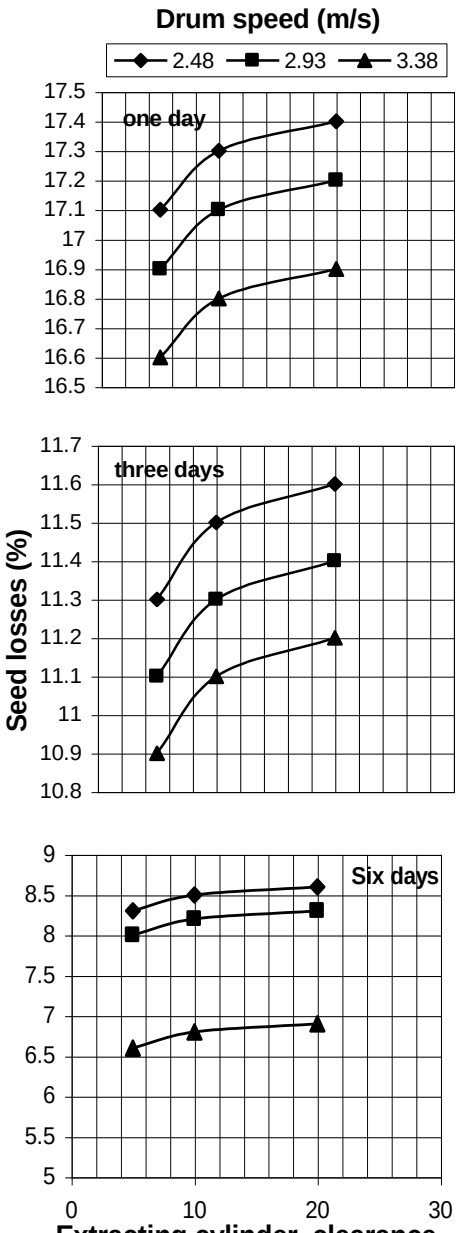


Fig.(7):Cucurbita pepo seed losses (%)Vs. extracting cylinder clearance (mm))

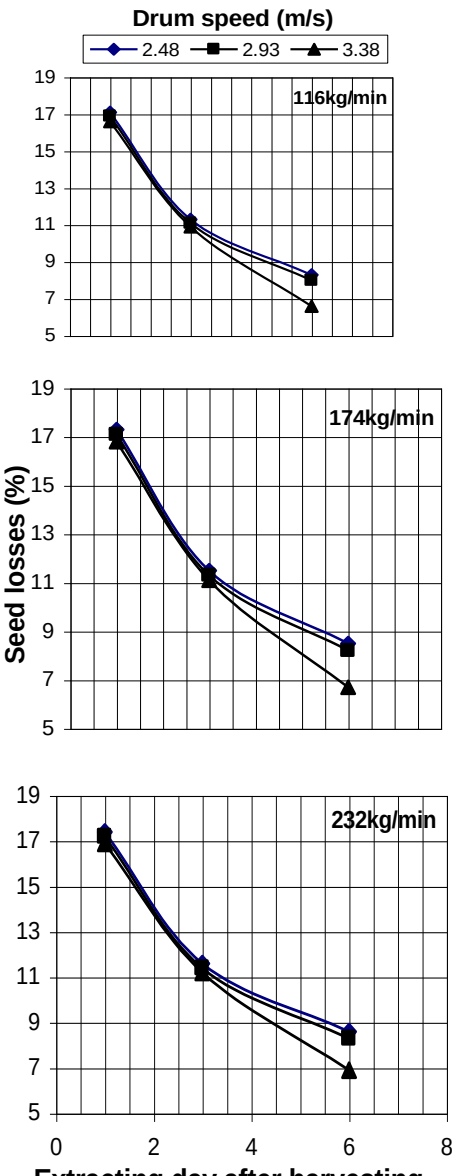


Fig.(8):Cucurbita pepo seed losses (%) Vs. extracting time after harvesting (days)

three operational times for extracting after harvesting 1, 3 and 6 days. Those variables were used during the operating of the machine prototype. The results summarized as follow:

1. Seed damage:

Seed damage is affected many factors during extracting cucurbita pepo seeds such as feeding rate, drum speed, drum-concave clearance and time of extracting after harvesting.

* The combination of feed rate 116 kg/min, 2.48 m/s drum speed, 15 mm drum-concave clearance and six days time span after harvesting realized the minimum value of seed damage.

2. Seed losses:

it could be concluded that the feed rate of 116 kg/min., drum speed of 3.38 m/s, drum-concave clearance of 5 mm, the extracting cylinder – curved plate clearance 5mm, rotational speed of separating sieve 25rpm and extracting time after harvesting six days realized the minimum value of losses 4.1% compared with the other levels of variables under study.

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الملخص العربى

*العوامل المؤثرة على الفاقد والمتكسر من بذور محصول الكوسة بإستعمال آلة فصل بذور تجريبية

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إنتاج بذور محاصيل الخضر وخاصة بذور القرعيات ذات أهمية إستراتيجية فى جمهورية مصر العربية. ويصل محصول القرعيات الصيفى إلى ٥٩٥٩٥ فدان بمتوسط ٨,١١ طن/فدان (**نشرة وزارة الزراعة ٢٠٠٦**) ويتم إستخلاص ٩٧% من هذه البذوريدويا ويحتاج الفدان من ١٢ إلى ١٤ عامل للإنتهاء منه خلال يوم واحد بتكلفة استخلاص ٩٠٠ جنيه للفدان. ونظرا لزيادة المساحات المنزرعة بمحاصيل القرعيات من أجل الحصول على البذور (اللب) أصبحت الحاجة ملحة إلى الآت استخلاص مقطورة خلف الجرار.

هذا البحث يهدف إلى دراسة العوامل المؤثرة على الفاقد والمتكسر من بذور محصول الكوسة باستعمال آلة فصل بذور تجريبية محلية الصنع مقطورة خلف الجرار. والقيام بتجارب حقلية للحصول على نتائج فعلية للفاقد والمتكسر من البذور. وتتكون الآلة من أربعة وحدات أساسية:

١- وحدة تكسير الثمار (الدرفيل والصدر).
٢- وحدة إستخلاص البذور من الثمار المقطعة (إسطوانة الفصل ذات الأصابع المطاط).
٣- وحدة غربلة لفصل البذور عن القشور (غربال الفصل).

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* هذه الدراسة جزء من النتائج المتحصل عليها من رسالة دكتوراه

١- أستاذ الهندسة الزراعية المتفرغ – كلية الزراعة – جامعة الأزهر – القاهرة.
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٣- رئيس بحوث - معهد بحوث الهندسة الزراعية – الدقى – القاهرة.
٤- مهندس زراعى – قطاع الزراعة الآلية - مركز البحوث الزراعية - وزارة الزراعة.

٤- وحدة تنظيف البذور عن المشيمة والأجزاء اللينة (إسطوانات التنظيف الإبتدائية والإضافية). إلى جانب جهاز نقل الحركة من الجرار وإلى أجزاء الآلة مع توفير السرعات المناسبة لكل جزء لتحقيق أعلى كفاءة للآلة.

من النتائج التى تم التوصل إليها:

١- حقق معدل تلقيم ١١٦ كجم/دقيقة وسرعة درفيل ٣,٣٨ م/ث ، وخلوص بين الدرفيل والصدر٥مم ،وخلوص بين إسطوانة الإستخلاص والأصابع المطاط للستارة ٥مم, وسرعة غربال فصل ٢٥ لفة/دقيقة, و الإستخلاص بعد ستة أيام من حصاد الثمار حقق أقل نسبة للفواقد من البذور ٤,١%.

٢- حقق معدل تلقيم ١١٦ كجم/دقيقة وسرعة درفيل ٢,٤٨ م/ث ، وخلوص بين الدرفيل والصدر١٥مم , و الإستخلاص بعد ستة أيام من حصاد الثمار حقق أقل نسبة للمتكسر من البذور ٠,٢ %.