

MODIFICATION OF A LOCAL MACHINE THRESHING UNIT FOR THRESHING SUN FLOWER

Arafa, G. K.*

ABSTRACT

The objective of the present study is to test and evaluate the performance of Mabrouk type threshing machine for threshing sunflower heads (variety of vidok) after modification of the threshing drum and the cleaning unit. The machine performance was evaluated in terms of threshing efficiency, percentage of un-threshed seeds, percentage of seed losses, seeds purity, fan losses and losses behind sieves. The experimental work was carried out to investigate the effects of some engineering parameters of the machine threshing and cleaning units included threshing drum speeds of 300, 400, 500 and 600 rpm (10.99, 14.65, 18.31 and 22.78 m/s), heads feeding rates of 300, 450, 600 and 750 kg/h, air velocity of 3.5, 4.5, and 5.5 m/s. suction fan, and sieve tilt angles of 2, 5 and 8 degree. The obtained results indicated that, considering the lower percentage of un-threshed and broken seeds and the higher threshing efficiency with acceptable machine capacity, the machine feed rate of 600 kg/h. and drum speed of 400 rpm is recommended for threshing sunflower heads. Meanwhile, considering both seed purity and total seed losses, it can be said that the air velocity of 4.5 m/sec with sieves tilt angle of 5 degree recorded proper seed purity of 98.5 % with total seed losses of 0.42 %.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the world's most important oilseed crops after soybeans for oil production in the world. Sunflower oil is considered to be of very high quality (Downey *et al.*, 1989). (Rizvi *et al.*, 1993) mentioned that the oil content of sunflower is 40%, which is higher than any other oilseed crops he also compared. The performance of different threshing drums for sunflower threshing. The spike/peg teeth, rasp bar and mummer strip cylinder with their respective concaves were used.

* Senior Researcher, of Agr. Eng. Res. Inst., Agric. Res. Center.

The study showed that the peg –type cylinder with a speed range of 400-500 min⁻¹ and concaves clearance rang from 25-30 mm can be used for a sunflower threshing unit . In Egypt, 1,129000 Mg of oils is consumed annually but till now Egypt produce only 153,000 Mg. This means that the oil production cover only about 13.55% of all our needs and the import approached about 86.45% (976,000 Mg). (*Oilseed situation and outlook 2002*) So, Egypt costs about 3220 million Egyptian pound (LE.) to cover this deficiency. Therefore, sunflower oilseed production occupies a key position in the overall economy of Egypt. *Awady and El Sayed (1994)* stated that when air stream is used for separation of product from its associated foreign materials, knowledge of terminal velocity of all particles is involved. For these reasons, terminal velocity has been used as an important aerodynamic characteristic of materials such applications as pneumatic conveying and separation from foreign materials. *Ebaid (1995)* concluded that for rice crop the highest purity of 98.8 % and lowest fan losses of 0.13 % were obtained at sieve tilt angle of 5 degrees, feeding rate of 2.2 t/h, air speed 21 m/s and 110 x 30 cm² sieve area. Losses behind sieve increased from 0.11 to 0.128 % as the sieve tilt angle increased from 2 to 8 degrees at feed rate of 2.2 t/h, air speed of 21 m/s and sieve area of 110 x 20 cm². *Anil et al. (1998)* designed and developed a prototype threshing machine for sunflower seeds, using basic principles adopted for cereal threshers. Test results indicated that the optimal thresher performance was achieved at 9–13% moisture content, 180 kg/h feed rate and 500 rpm cylinder speed. *Helmy et al. (2000)* tested the performance of the modified spike tooth drum used for sunflower threshing. He indelicate that the spike-tooth drum (D3) and the clearance ratio of 1.8 gave always better results of the performance evaluation for the modified thresher. Results also indicated that, for optimum performance the thresher's drum speed should be about 9.53 m/s and the seeds moisture content ranged from 15.4% to 20.9%. Also they found that the modified thresher gave better results of the total grain losses, grain damage and fuel consumption. *Sudajan et al. (2002)* studied the effect of drum type, drum speed and feed rate on sunflower threshing. They indicated that the grain damage increased with an increase in drum speed for all drums and feed rates. This increase was

due to higher impact levels imparted to the crop during threshing at higher drum speeds. *El-Sahrigi et al. (2002)* studied the effect of using the general purpose combines to harvest, thresh and clean sunflower crop. They indicated that, the optimum forward speed for harvesting sunflower plant was 3.5 km/h which gave the lowest total losses and maximum level of cleaning efficiency. Moisture content of 16% (w.b.) gave the lowest level of total losses and seed damage and achieved the highest level of cleaning and threshing efficiency while optimum cylinder speed and concave clearance were 500 rpm and 2.2cm, respectively. *El-Sayed et al. (2002)* studied the effect of using the general purpose combine (Case International) to solve the problems appeared in manual or conventional harvesting of sunflower crop. They indicated that, by increasing forward speed from 1.7 to 2.7 km/h the harvesting losses, unthreshed, total losses, and field capacity increased from 3.2, 1.95, 8.75%, 1.1fed./h to 4.1, 2.1, 9.36%, 1.38 fed./h, respectively. While the damaged losses, performance efficiency, decreased from 0.9 , 94.06 %, to 0.7, 92.6%, respectively. *Khater (2000)* indicated that threshing efficiency, cleaning efficiency and seed damage of sun flower increased by decreasing moisture content. Also he mentioned that the best moisture content is that given the lowest seed damage and seed losses, and the highest threshing and cleaning efficiency. *Billy (2004)* reported that, sunflower harvesting at high moisture content (18 to 20%) normally results in higher yields, less bird damage, and less shattering or dropping of heads than when seeds are harvested at a lower moisture content. *Sudajan et al.,(2002)* conducted a study to compare the performance of the rasp bar drum and the peg tooth type in threshing sunflower heads . The results show that ,sunflower threshing capacity of a rasp bar drum was higher than peg tooth type (both with open and closed threshing drums). The threshing efficiency was also found to be higher than 99%.visible grain damage increased with an increase in threshing drum speed and feed rate of each type of threshing drum . Also ,the rasp bar drum showed reduction in the proportions of grain damage, grain losses and material other than grain separation compared to the peg tooth type In Egypt nowadays , there is no a local made threshing machine to thresh sunflower is available. Farmers in most areas thresh sunflower using a

rice or wheat local threshing machines without any modification. However, the result obtained indicated that these threshers are not appropriate for threshing sunflower in terms of higher grain losses and lower cleaning efficiency. The main objective of this study is modifying the threshing and cleaning unit of the local made Mabrouk type threshing machine for threshing and cleaning sun flower heads. Also, to evaluate factors affecting the modified unit performance and efficiency in terms of threshing losses, machine capacity, seed purity and total seed cleaning losses.

MATERIAL AND METHODS

1-Materials:

Tested crop:

The commonly grown sunflower (variety vidok) was used for the experimental work. It was harvested by the traditional method. The moisture content of the seeds, heads and straw was determined by the oven-drying method at 105 °C for 3 hr. as recommended by (AOAC, 1990). The average initial moisture content of sunflower seeds was 16.05% w.b. Physical properties and characteristics of sunflower heads and seeds are summarized in Table (1). All the experimental tests were done during the harvesting season of 2012 at Manshiya location, Billbaes distract, Sharkia Governorate.

Table (1): Some physical properties of sunflower plants, heads and seeds of variety vidok.

Moisture content, % w.b.	16.05
Seed Length, mm	11.69
Seed Width, mm	6.15
Seed Thickness, mm	1.14
Seed Projected area, mm ²	56.01
Seed Hardness, N	34.11
Seeds Coefficient of friction on surface (Galvanized iron)	0.66641
Seeds Terminal velocity, m/s	5.86
Head diameter, mm	214
Stem diameter, mm	27
Seed yield/plant, g	170.50
Mass of 1000 seeds, g	83.5

Machine structure and specifications before modification:

A local made axial flow threshing machine (Mabrouk type threshing machine) was used for the experimental work. The machine overall length, width, and height were 4150, 2080, and 2000 mm, respectively. The machine consists of main frame, cover, threshing drum, concave, oscillating screen assembly, suction fan and ducts. It has one input counter shaft connected to the tractor P.T.O. The power transmission from the counter shaft to the threshing drum conducted through three V-belts. Details of the machine structure are presented as follows:

Cover and feeding opening:

The machine has cover of overall length and width of 1260 and 800 mm respectively and a feeding opening of 1180 x 500 mm.

Threshing drum :

A peg tooth closed type threshing drum is installed for the threshing process. The drum dimensions are 750 mm for diameter and 1180 mm for length. The total number of threshing teeth are 120 arranged in four sets each set (30 tooth). The tooth dimensions are 240 mm long 30 mm wide and 6 mm thick. The drum concave was constructed from a perforated sheet metal with a round shape with 20 mm diameter perforation.

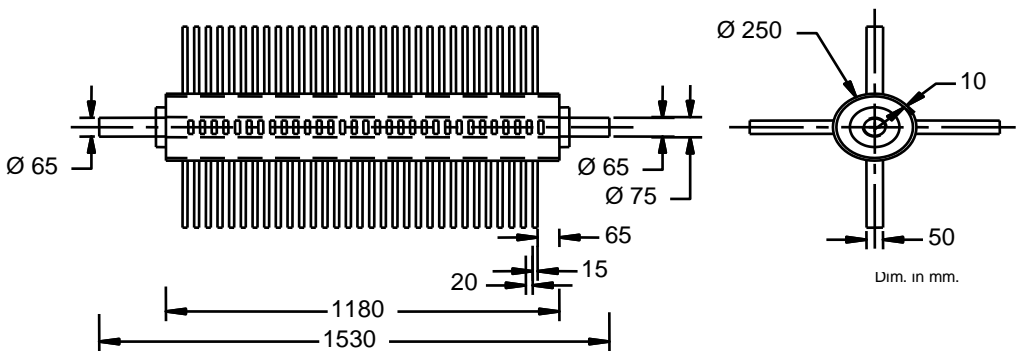


Fig. 1:A peg tooth type threshing drum before modification.

The concave clearance can be adjusted at the rang of 25 to 45 cm. The length of the concave was 1180 mm. for equivalent separation of seeds over the length of the threshing drum.

Cleaning screen:

An oscillating screens made of metal sheet of 5 mm thickness installed in the machine cleaning and separation section. The sieves were consisted of upper and lower screens hanged on four link rods. The upper screen has two parts (solid and 15 mm diameter holes), while the lower screen is mounted 10 cm below parallel to the upper screen It was consists of three parts (solid - 1 mm diameter holes and 9 mm diameter holes).

Suction fan and ducts:

The suction fan consists of six radial blades. The fan housing has two suction ducts, the front is to pick large straw pieces over the upper sieve and the rear is to pick up chaff and light impurities from the lower screen.

Machine modifications to suit threshing of sunflower seeds:**Drum cover**

The drum cover was modified to be with five adjustable spiral louvers which can be set to change the movement of the heads along the axis of the threshing drum, and the angle of louvers is $15 - 20^{\circ}$. It has overall length and width of 1260 and 800 mm respectively and the feeding opening was enlarged to be 250 x 500 mm. to suit the feeding of sunflower heads without any obstruction.

Threshing drum: As obtained from the preliminary experiments. Due to the lower capacity of the peg tooth drum in comparison with the rasp bar drum and also the higher percentages of grain damage (4-5%), grain losses (7-8%) and the lower cleaning efficiency 85-90 % of this type. The peg tooth closed type threshing drum was replaced by a rasp bar type, closed threshing drum having four equidistant stationary bars built on the periphery of the drum in a parallel orientation as shown in fig. (2).The rasp bar dimensions are 1180 mm long 50 mm wide and 15 mm thick. The drum concave was constructed from a perforated sheet metal with elliptical holes of 15 mm by 60 mm. The distance between adjacent holes was 11 mm and between the hole axes was 22 mm. Meanwhile the concave clearance was fixed at 35 mm which proved satisfied for threshing sunflower seeds as obtained from the preliminary tests. On the same time the upper oscillated screen of the original machine was left without changes. While the lower screen parts was modified to be (solid, 1 mm diameter holes and 13 mm diameter holes screen). The air

velocity of the suction fan was adjusted to different levels based on the results of terminal velocity tests of sunflower seeds at 16.05 % w.b. moisture content.

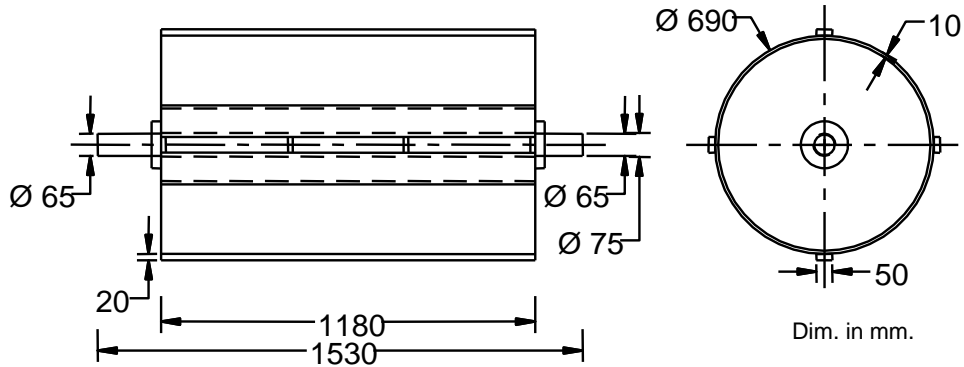


Fig. 2: A rasp bar type threshing drum after modification.

Instrumentation

Tachometer.

A Japanese made tachometer was used to measure the rotation speed of the threshing drum with a measuring range. of 100 to 5000 rpm, and accuracy of ± 1 .

Anemometer.

A hot wire anemometer made in Japan by SATAKE CO was used for measuring air velocity. The reading of the anemometer ranged from 0 to 50 m/s with accuracy of ± 0.5 .

Digital dial caliper.

Dimensions of sunflower seeds were determined considering the three axes xx, yy, and zz. A digital caliper reading up to 15 cm was used. Its accuracy is 0.05 mm.

Electronic balance.

An electronic balance model LB-25x (made in Japan) was used for weighing samples before and after cleaning. Its scale ranged from 0 to 5 kg max., with accuracy of 0.2 g.

Seed moisture content.

Seeds moisture content in wet basis was measured by taking random samples in electric oven at 105 °C for three hours according to **AOAC (1990)**. The moisture content was calculated using the following equation:

$$\text{Moisture content (\%w.b)} = \frac{M_w - M_d}{M_w} \times 100 \quad \text{----- (1)}$$

Where: Mw = Mass of wet samples, (g).

Md = Mass of dry samples, (g);

seeds terminal velocity:

Terminal velocity appartue consists of 0.25 kW, centrifugal fan connected to 70 cm PVC horizontal tube and 60 cm vertical transparent glass tube and a hot wire anemometer was used for determination of seeds terminal velocity.

Experimental Treatments:

The following parameters were considered during the threshing process to show their effect on threshing efficiency of the modified machine:

- 1-Drum speed: four different drum speeds were tested 300, 400, 500 and 600 rpm (10.99, 14.65, 18.31 and 22.78 m/sec.)
- 2-Head feed rate: four different feed rates were tested 300, 450, 600 and 750 kg/h.
- 3-Air speed: three different air speeds were tested 3.5, 4.5, and 5.5 m/s.
- 4-Sieve tilt angle: three different angles were tested 2, 5 and 8 degrees.

Experimental measurements:

Measurements of the threshing process:

Percentage of unthreshed grain:

$$\% \text{ Unthreshed seeds} = \frac{\text{Weight of unthreshed seeds}}{\text{Seed production} + \text{Losses}} \times 100 \quad \text{----- (2) seeds}$$

damage:

The damaged seeds were sorted manually and weighed. The percentages of seeds-damage were calculated as related to the total weight of sample.

Threshing efficiency.

The threshing efficiency was calculated using the following relation:-

$$Eth = \frac{Ms - Mth}{Ms} \quad \text{----- (3)}$$

where: Eth = threshing efficiency, %

Mth = mass of un-threshed seed, kg

Ms = total seed mass, kg

Total threshing losses.

The threshing losses were calculated using the following relation:

$$\text{Threshing losses, \%} = \frac{\text{Mass of seeds loss (kg)}}{\text{Total mass of seeds (kg)}} \times 100 \text{ -- (4)}$$

Measurements of the cleaning process:

Seeds purity: Seed ratio after removing the impurities (on mass basis) was calculated as follows.

$$\text{Purity \%} = \frac{\text{mass of clean sample}}{\text{mass of sample before cleaning}} \times 100 \text{ ----- (5)}$$

Fan losses: mass of seeds lost with the fan outlet was calculated as follows:-

$$\text{Fan losses \%} = \frac{\text{seeds collected from fan outlet}}{\text{total seeds output}} \times 100 \text{ ----- (6)}$$

Losses behind sieves: mass of seeds lost behind sieve was calculated as follows:

$$\text{Losses behind sieves \%} = \frac{\text{seeds collected behind sieves}}{\text{total seeds output}} \times 100 \text{ -- (7)}$$

RESULTS AND DISCUSSION**A) Threshing experiments:****1) Effect of drum speed and feed rate on percentage of unthreshed seeds :**

Fig, (3-a) illustrates the percentage of unthreshed seeds as related to feed rate of sunflower heads at different speeds of the rasp bar drum. As shown in the fig. (3-a) the percentage of unthreshed seeds increased with the increase of heads feed rate. While it was decreased with the increase of drum speed. At the minimum feed rate of 300 kg/h. the percentage of unthreshed seeds decreased from 0.19 to 0.038 % with the increase of drum speed from 300 to 600 rpm. While at the maximum feed rate of 750 kg/h. it was decreased from 1.89 to 0.95 %. In general the percentage of unthreshed seeds was ranged from 0.038 to 1.89 %.

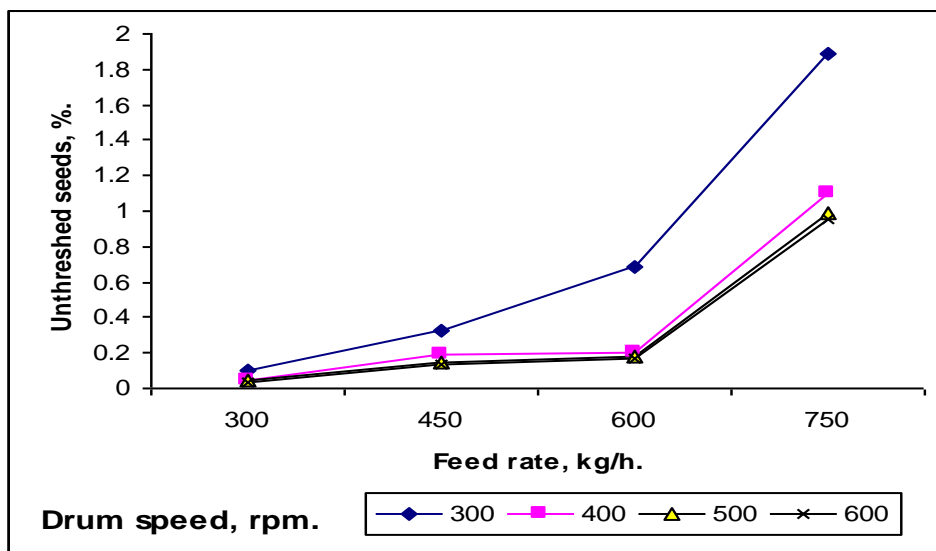


Fig. 3-a: Relationship between feeding rate and unthreshed grain.

2) Effect of drum speed and feed rate on percentage of damaged seeds :

Fig, (3-b) presents the relationship between the percentage of broken seeds and the heads feed rate at different drum speeds. As shown in the figure, the seed damage increased with the increase of both drum speed and heads feed rate and it was ranged from 0.16 to 2.89 %.

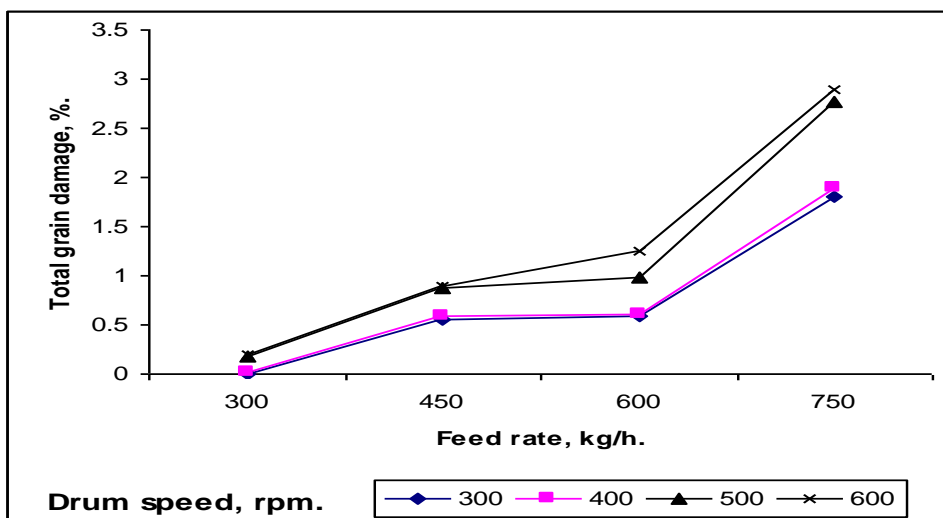


Fig. 3-b: Relationship between feeding rate and total grain damage.

However it was clear that the difference between the percentages of seed damage was very close at the drum speeds of 400 and 500 rpm. And also at feed rates of 450 and 600 kg/h. (less than 2 %). While it was increased over 2 % at the feed rate of 750 kg/h. The above mentioned results revealed that, the higher feed rate and drum speed increased the seed damage due to the impact imparted to the crop during the threshing process. However the recommended parameters are those at which the visible seeds damage should be within the range of less than 2 % as recommended by (Vejasit,1991) to maintain better storage qualities. This means that drum speed of 400 rpm and feed rate of 600 kg/h. were found to be suitable to obtain reasonable level of damaged seeds.

Effect of drum speed and feed rate on percentage of Seed losses

Fig, (3-c) shows the relationship between heads feeding rate and the percentage of seed losses at different drum speeds. As shown in the figure seeds losses increased by increasing feed rate, from 300 to 750 kg/h at all level of drum speeds while, the recorded seed losses were relatively close at 300 and 400 rpm, while it was higher at the levels over 400 rpm. The recorded losses of seeds were 0.09, 0.19, 0.21 and 0.55 % at feed rates of 300, 450, 600 and 750 kg/h respectively and the drum speed of 400 rpm.

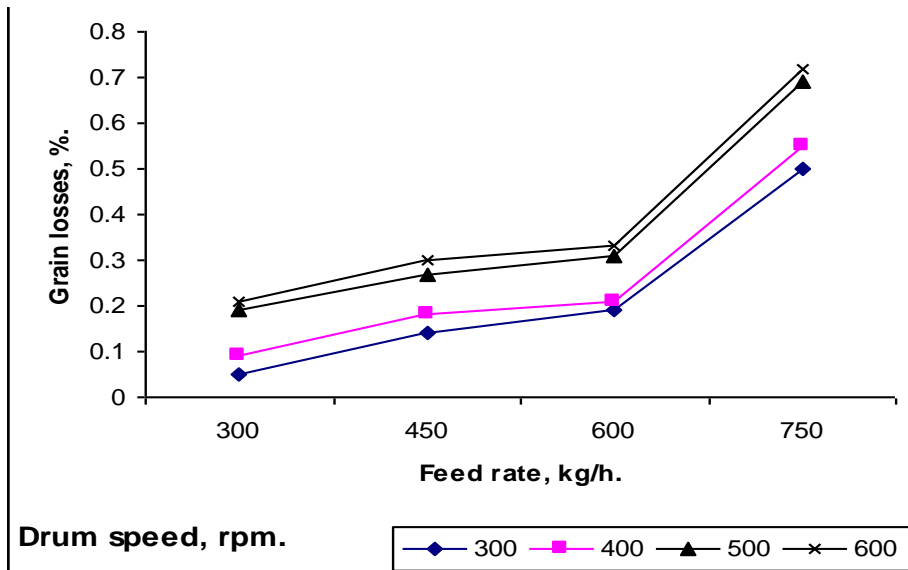


Fig. 3-c: Relationship between feeding rate and grain losses.

Fig. 3-d: Relationship between feeding rate and threshing efficiency. The results indicated that the threshing efficiency was within the range of 90.11 to 99.8 %. Also, the threshing efficiency increased with the increase of drum speed while it was decreased with the increase of feed rate. In general the feed rate of 450 and 600 kg/h. at drum speed of 400 showed very narrow values of threshing efficiency ranged from 98.21 to 98.95 %. The above mentioned results revealed that, considering the lower percentage of unthreshed and broken seeds and the higher threshing efficiency with acceptable machine capacity it can be said that the machine feed rate of 600 kg/h. and drum speed of 400 rpm is recommended for machine of threshing sunflower heads.

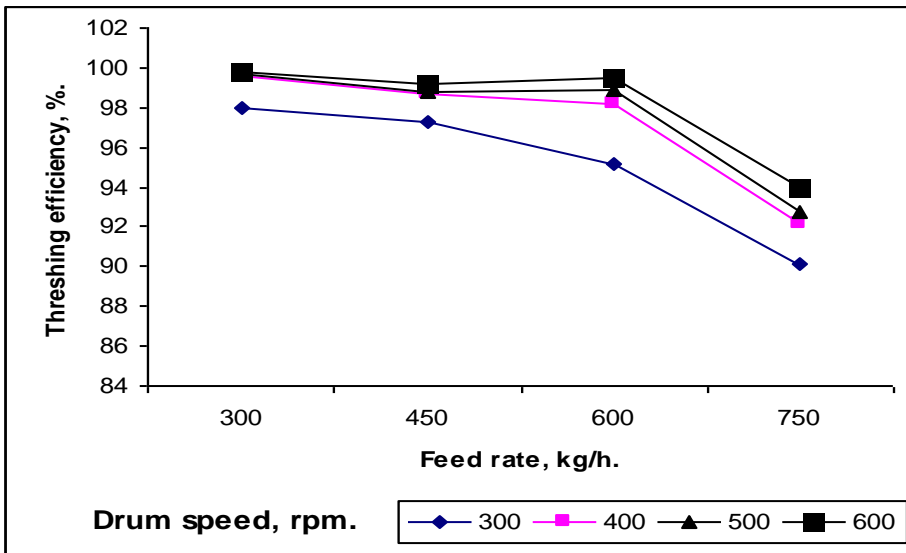


Fig. 3-d: Relationship between feeding rate and threshing efficiency.

B)Cleaning Experiments:

All the experimental work for the cleaning process was conducted at the optimum operational condition of the threshing unit of the machine. This condition included a drum speed of 400 rpm and a feed rate of 600 kg/h.

Seed Purity .

Fig. 4-a and 4-b illustrates the effect of air velocity on the purity of the threshed seeds at different tilt angles of the cleaning sieves.

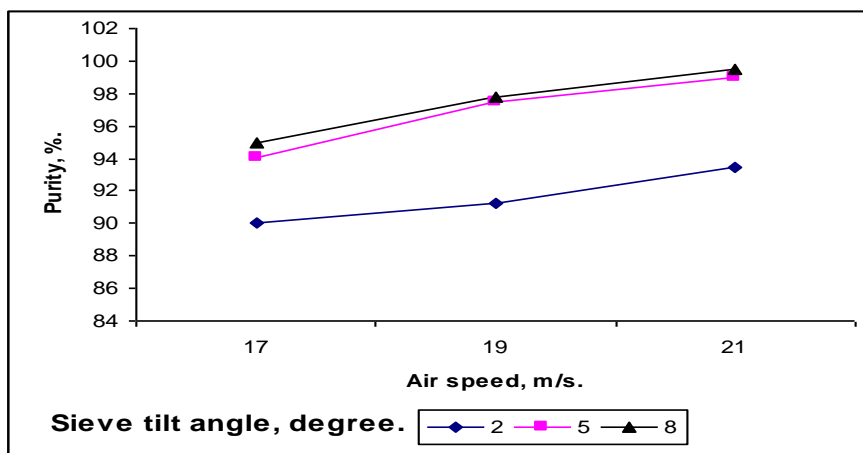


Fig.4-a: Relationship between air speed and purity.

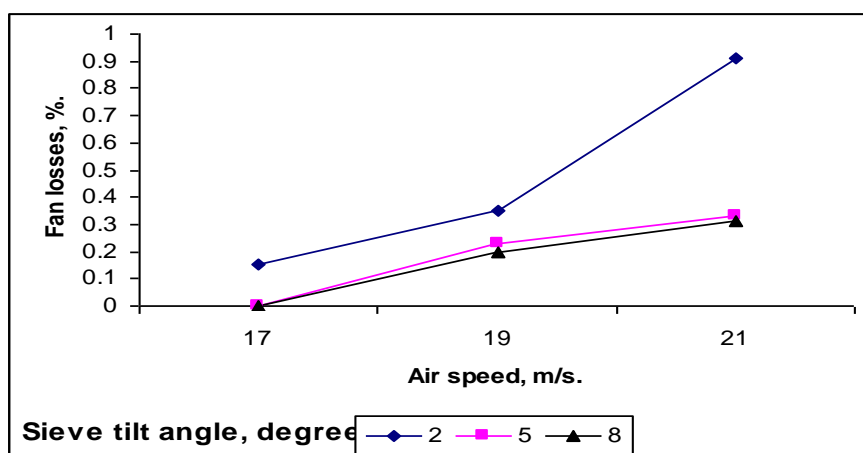


Fig4-b: Relationship between air speed and fan losses.

As shown in the figure, the seed purity was increased with increasing of both the air velocity and the sieves tilt angle.. As, the air velocity increased from 3.5 to 5.5 m/s. the seed purity increased from 90 to 93.5 %, from 94.1 to 98.7 % and from 95 to 98.9 % at sieve tilt angles of 2, 5 and 8 degree respectively. This means that at higher air velocity the impurities are thrown out of the seeds. Also as the sieve tilt angle increased the chance for impurities to separate out of the seeds is increased and the seed purity increased.

Total seed losses of the cleaning unit.

Table (2) presents the relationship between total seed losses including (fan losses + losses behind sieves) as related to air velocity at different sieve tilt angles. As shown in the table, the total seed losses of the cleaning unit increased with the increase of air velocity and also with the

increase of sieve tilt angle. As the air velocity increased from 3.5 to 5.5 m/s., the total seed losses increased from 0.35 to 0.49 %, from 0.39 to 0.52 % and from 0.44 to 0.69 % at sieve tilt angles of 2, 5, and 8 degree respectively. In general considering both seed purity and total seed losses, it can be said that the air velocity of 4.5 m/sec with tilt angle of 5 degree recorded proper seed purity of 98.5 % with total seed losses of 0.42 % in comparison with other studied combinations.

Table (2): Effect of different sieve tilt angle and air velocity on total seed losses (fan losses + losses behind sieves).

Air velocity m/sec.	Sieve tilt angle Degree	Fan losses %	Losses behind sieves %	Total seed losses %
3.5	2	0.24	0.11	0.35
	5	0.23	0.16	0.39
	8	0.15	0.29	0.44
4.5	2	0.27	0.13	0.40
	5	0.25	0.17	0.42
	8	0.22	0.32	0.54
5.5	2	0.35	0.14	0.49
	5	0.33	0.19	0.52
	8	0.31	0.38	0.69

COUNCLOUSION

A modification for the threshing drum and the cleaning unit was carried out for (Mabrouk type) threshing machine to be used for threshing sun flower heads. The performance of the machine threshing and cleaning units was conducted under four different threshing drum speeds 300, 400, 500 and 600 rpm (10.99, 14.65, 18.31 and 22.78 m/s), four different feeding rates 300, 450, 600 and 750 kg/h, three different air speeds of the suction fan 3.5, 4.5, and 5.5 m/s., and three different sieves tilt angles 2, 5 and 8 degrees. The obtained results indicated that, considering the lower percentage of un-threshed and broken seeds and the higher threshing efficiency with acceptable machine capacity, the machine feed rate of 600 kg/h. and drum speed of 400 rpm are recommended for machine operation of the threshing unit. Meanwhile, considering both seed purity and total seed losses during the cleaning process, it can be said that the air velocity of 4.5 m/sec with sieves tilt angle of 5 degree recorded the most proper seed purity of 98.5 % with the lowest total seed losses of 0.42 %.

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- التقرير الصادر عن قطاع الشؤون الاقتصادية بوزارة الزراعة واستصلاح الاراضى عن موقف البذور الزيتية ومستقبلها (2002 Oilseed situation and outlook)

الملخص العربى

تعديل وحدة الدراس لآلة دراس محلية الصنع لدراس عباد الشمس

د/ جمال كمال عرفة *

يعتبر عباد الشمس أحد المحاصيل الزراعية فى مصر التى يمكن إستخدامه للتغلب على مشكلة نقص الزيوت فى مصر وكذلك إستخدامه فى كثير من الصناعات الغذائية. وتعتبر عملية الدراس والتذرية الخطوة الأولى فى عمليات التداول للمحاصيل الزيتية، وذلك بهدف ايجاد بعض الحلول التى قد تساعد على زيادة المساحة المزروعة من محصول عباد الشمس. وقد تم تعديل درفيل الدراس وكذلك وحدة التنظيف لآلة الدراس والتذرية (موديل مبروك) الشائعة لدراس بعض المحاصيل الاخرى وذلك بهدف إستخدامها فى دراسة وتذرية أفراس عباد الشمس. وقد تم التعديل من خلال تغيير درفيل الدراس من النوع peg-tooth type إلى النوع rasp-bar type. حيث أثبتت التجارب المبدئية إنخفاض السعة الإنتاجية للنوع الأول وكذلك زيادة نسبة الحبوب المفقودة ونسبة الحبوب المكسورة بالإضافة إلى إنخفاض كفاءة التنظيف. ويتناول هذا البحث تحديد العوامل المؤثرة فى كفاءة عملية الدراس ونسبة الروؤس الغير مدروسة، ونسبة البذور المكسورة، ونسبة فواقد الدراس للبذور، والنسبة المئوية للنظافة وفواقد المروحة والفواقد الكلية خلف الغربال وذلك للحصول على أفضل نظام لتشغيل الآلة المعدلة. وقد تم تغيير سرعة الدرفيل فى المدى ٣٠٠ - ٦٠٠ لفة/دقيقة (١٠.٩٩ - ٢٢.٧٨ م/ث)، معدل التغذية فى المدى ٣٠٠ - ٧٥٠ كجم/ساعة، وسرعة الهواء فى المدى ٣.٥ - ٥.٥ م/ث، وزاوية ميل الغربال فى المدى ٢ - ٨ درجة.

خرجت النتائج بالتوصيات التالية: وجد أنه عند سرعة الدرفيل ٤٠٠ لفة/دقيقة (١٤.٦٥ م/ث)، ومعدل التغذية ٦٠٠ كجم/ساعة، وسرعة الهواء ٤.٥ م/ث، وزاوية ميل الغربال ٥ درجة قد مثلت أفضل عوامل تشغيل للآلة (تحت المدى التجريبي لمستويات عوامل الدراسة). تم الحصول على أعلى كفاءة دراس، وأقل نسبة روؤس غير مدروسة وأقل نسبة للبذور المكسورة وكذلك أقل نسبة للفواقد فى البذور خلال مرحلة الدراس وكذلك أقل فواقد مروحة وفواقد خلف الغربال أثناء عملة التنظيف والتذرية

وتحت هذه الظروف بلغت نسبة الروؤس الغير مدروسة ٠.٢٠ %، ونسبة البذور المكسورة ٠.٦١ %، ونسبة فواقد الدراس للبذور ٠.٢١ %، وكفاءة الدراس ٩٨.٢١ %، والنسبة المئوية للنظافة ٩٨.٥ %، والنسبة المئوية لفواقد المروحة ٠.٢٥ % والنسبة المئوية للفواقد خلف الغربال ٠.١٧ % ونسبة الفواقد الكلية لمرحلة التنظيف ٠.٤٢ %.

* باحث أول - معهد بحوث الهندسة الزراعية - مركز البحوث الزراعية - الجيزة - مصر.