EVALUATION OF LOCALLY MADE CLOVER THRESHER AND SEPARATOR

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ABSTRACT

The present study was to evaluate the performance efficiency of stationary threshing and separating machines of wheat crop (locally manufactured). The same thresher was used to thresh and separate clover crop. To extend the operational use of this machine and consequently decrease the operating cost per hour, reduce threshing and separation losses and increase seed quality, the performance of local manufacture machine was tested to suit clover crop. Threshing drum speeds tested were 350, 450, 550 and 650 r.p.m and feed rates 6, 10, 14 and 18 kg /min with straw moisture contents 9.8 %, seed moisture contents 10.5 %, air speed in cleaning 6 m/s, slope of sieves was 3^0 with horizontal and vibrating screen speed of 350 rpm. The experimental results revealed machine productivity, total seed damage, un-threshed seed losses with straw, machine efficiency and the unit-energy consumption. The optimum operating conditions for threshing and separating clover were found to be ٥٥0 r.p.m at feed rate 14 kg/min with straw moisture content 9.8 %, seed moisture content 10.5 %, air speed in cleaning 6 m/s, slope of sieves at 3^0 with horizontal and vibrating screen speed at 350 rpm, to avoid the highest rate of resulted with losses and seed damage. ***Threshing capacity of 4.43 kg / min, total seed damage of 3.6 %, un-threshed seed of 0.91%, seed losses with straw of 0.29 % threshing efficiency of 95.2%, consumed power of 9.57 kW and energy consumed of 35.97 kW .h /ton including operation and losses.*

INTRODUCTION

In Egypt, clover is the primary food crop for animals. Annually, Egypt cultivates around 2.5 million feddans of clover for cattle consumption. The locally manufactured threshing machines producing a cleaned grain is important process in clover crops production to separate grain from straw with high separation efficiency and least losses as well as lowest cost.

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Awady et al. (2003) showed that cleaning efficiency and losses were positively affected by air speed and sieve tilt angle, but purity was negatively affected by moisture content and feed rate. The total losses were negatively affected by moisture content and feed rate. Purity increased when using round-hole sieve compared with slotted sieve. The optimum performance of cleaning rice crop was at air speed of 4 m/sec, moisture content of 18 %, sieve tilt angle of 2 degree, round-shape sieve and feed rate of 1200 kg/h. Purity at these conditions was 98.98 % and total loss was 0.21 %.

Sharma and Devnani (1980) reported that threshing efficiency increased with the increase of drum speed but decreased with the increase of feed rate. Also, they added that energy consumption was directly proportional to drum speed and feed rate. **Helmy (1988)** studied the effect of drum speed and feed rates of local threshing machine on un-threshed grain, total grain damage and energy consumption for wheat crop. The results showed that increasing drum speed from 11 to 36.65 m/s tends to reduce the un-threshed grain from 13.42 to 2.39 %. The total grain damage exponentially increased from 5.11 to 18.48 % at the same feed rate and grain moisture contents and the unit energy consumption increased from 0.89 to 1.27 kw-h/t. He also indicated that increasing feed rates from 0.06 to 0.31 kg/s tends to increase the un-threshed grain from 0.76 to 0.90 % and unit-energy from 0.63 to 1.15 kW.h/t. However, the percentage of grain damage was exponentially decreased from 11.89 to 5.49 %. **Abo El-Naga (1995)** showed that the optimum seed moisture content and the drum speed of the threshing machine were 14.36 % and 350 rpm, respectively for threshing of balady bean crop. **El-Behery (1995)** concluded that the optimum cylinder speed for threshing soybean was determined as 300 – 400 rpm and the clearance between cylinder and concave was 18mm. **Abdelmotaleb et al. (1999)** reported that drum speed of threshing machine ranging from 450 and 550 rpm and seed moisture content from 13.56 to 19.1 % for soybean crop which are considered the proper result of seed losses, damage and specific fuel consumption. **Baiomy (2002)** reported that at the thresher drum peripheral speeds of 23.5, 22, 19.5 and 17.3 m/s, the total grain losses were 3.6, 1.1, 2.2 and 3.1 % respectively during threshing paddy rice.

Meanwhile, the grain purities were 0.9, 1.33, 3.6 and 5.8 % straw at the above mentioned speeds. **Sudajan et al. (2002**) reported that the type of threshing drum, drum speed and feed rate affected the output capacity, threshing efficiency, grain damage and grain losses during sunflower threshing. **Abo-El-Naga et al. (2005)** reported that the optimum conditions for operating the threshing machine to thresh lentil crop were at seed moisture content of 10.31 %, drum speed of 11.78 m/s and feed rate of 11.67 kg/min, resulting in seed damage of 0.62 %, un-threshed seed of 0.15 %, total seed losses of 0.77 %, seed output of 302.1 kg/h, threshing efficiency of 99.79 %, consumed energy 0.116 kW.h/kg and criterion cost of 85.83 LE/ton.

Unfortunately, there are no sufficient data concerning threshing and separating processes of clover crop in Egypt. It is well known that threshing and separating characteristics of clover vary from one variety to the other.

The main objective of the present research was evaluate the machine local manufactured (El-Shams) the optimum operating parameters of threshing and separating clover crop efficiently. The specific objectives were:

- Determine the effect of drum speed and feed rates during threshing and separating clover variety (AL-Mesqawei) on the performance indicators of the machine such as threshing capacity, un-threshed seed, losses seed with straw, total seed damage, threshing efficiency, unit-energy consumption .

MATERIALS AND METHODS

The experiment was carried out in Kafr El-Sheikh governorate during 2008-2009 seasons. The variety of clover used in this experiment was AL-Mesqawei.

The local Egyptian manufactured machines (El-Shams) used in this study with some developed to suit clover crop. Its specification is shown in Table (1) and fig. (1). 60 hp (40 kW) tractor was used to operate the threshing and separating machines and the power was transmitted by means of a belt pulley from a tractor pulley.

To achieve the objectives of this research work, several effects of the independent variables, drum speed (350, 450, 550,and 650), and different feed rates (6, 10, 14 and 18 kg/min) were ward with mean grain moisture content of 10.5 % (wet basis) and mean straw moisture content of 9.8 % on the threshing capacity, un-threshed seed, seed losses with straw, total seed damage, threshing efficiency, unit-energy consumption .

Measurements:

The moisture contents of straw and grain were determined by oven drying method using 100g samples placed in air oven method at 386^0 K ($105\ ^0$ C) for 72 hrs to determine moisture content on wet basis as described by ASAE 2000. The samples were taken periodically from the machine outlet and placed in polyethylene bags. A tachometer that engaged to the cylinder drum pulley was used to measure the cylinder drum speed of the threshing machine. The physical and mechanical properties of clover seeds were evaluated (Werby 2009). The laboratory test was carried out on a sample of threshed grain to determine the grain quality (visible and invisible damage). The visible grain damage percentage was determined by separating the broken grain from a mass of 100 grams sample taken randomly from the threshed grain. Meanwhile, the invisible grain damage percentage was calculated by the germination test. Four replicates of 100 seeds were germinated at Petri dishes on a paper filter covered with water and incubated at 25^0 C for 8 days. The visible and invisible grain damage represented the total grain damage. After threshing operation for each test, the amount of clover grain was recorded. An average of three replicates of this procedure was taken. The threshing output (threshing capacity), kg / min, the total losses(un-threshed seed, losses seed with straw, total seed damage),%: threshing efficiency,% and unit-energy consumption (kW .h / ton) were determined.

Threshing capacity:

Threshing capacity (Pth) was calculated by using the following formula:

Threshing capacity (Pth) = $M_{T.G.ou}$ / t (kg/h)---------------------------- (1)

Where:

($M_{T.G.ou}$) = the mass of total seeds output, kg

(t) = the time consumed in threshing operation, h.

Table (1): Specifications of clover threshers.

Item	specification
Overall dimensions	
Length cm	400
Width cm	225
Height cm	225
Method of feeding	Manual
Prime mover	Belt
Drum	
Type	Flails
Diameter, cm	7٠
Length, cm	120
No. of rows	4
No. of flails / row	11
Concave	
Length, cm	120
Width, cm	62
No. of holes /100, cm2	20
Concave clearance, cm	3
Area of feeding opening, cm2	7440
Area of straw opening, cm2	1754
Sieves	
No. of holes /100, cm2	185
Diameter of holes, mm	4
Fan	
Type	Centrifugal
No. of blades	6

Total threshing losses:

Threshing losses percentage (including both total seed damage, un-threshed seed and seed losses with straw).were calculated using the following equation;

$M_{T.G.S} = (M_{S.G} + M_{D.G} + M_{U.G}) / M_{T.G.in} \times 100$, %---------------------(2)

Where: $M_{T.G.S}$ = Total threshing losses, %

$M_{S.G}$: seed losses with straw, kg.

$M_{D.G}$: mass of damaged seed collected at outlet, kg

$M_{U.G}$: mass of un-threshed seed, kg

1- Seed losses with straw (%) = ($M_{S.G} / M_{T.Gin}$) x 100---------------(3)

2 - Total seed damage (%) = ($M_{D.G} / M_{T.Gin}$) x100--------------------(4)

3 - Un-threshed seed (%) = ($M_{U.G} / M_{T.Gin}$)x 100---------------------(5)

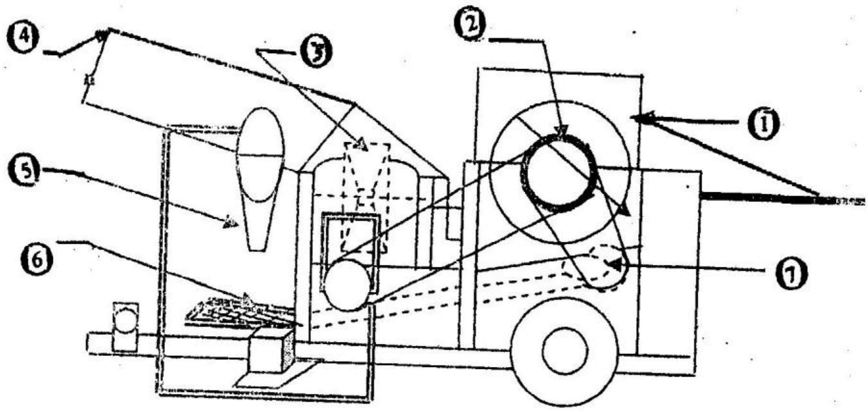

Fig. 1: Schematic diagram for thresher machine.
1- inlet of crop 2 – threshing drum 3- fan housing 4 – outlet of straw
5 – outlet of seeds 6 – screen assembly 7 – cam for moving of sieve.

Threshing efficiency:

$$Tf = (M_{T.G.ou} / M_{T.G.in}) \times 100 \text{---} (5)$$

Power Consumption :

Fuel consumption (Fc) was calculated during the threshing operation by measuring the volume of diesel fuel required to refill the fuel tank after each working period. A graduated glass cylinder was used to measure the added quantity of fuel. Threshing power was determined experimentally for the used tractor using the following : (Embaby, 1985).

Threshing power (kW) = 3.163 x fuel consumed (L / h).

$$\textbf{Energy requirement}\ (kW.h / ton) = \frac{\text{Threshing power (kW)}}{\text{Threshing capacity (ton / h)}}$$

RESULTS AND DISCUSSION

1- Effect of drum speed and feed rate on machine productivity, kg/min:

Fig. 2 shows the effect of drum speed on the machine productivity(threshed capacity) of clover crop at four feed rate. At 1٤ kg/min feed rate, the machine productivity increased from 4.19 to 4.43

kg/min with drum speed variation from 350 to 550 r.pm. Meanwhile, it slightly increased to 4.431 kg/min when drum speed increased to 650 r.p.m.. This result may be because to increasing drum speed tends to increase damage of grain into small pieces which go out with straw of threshed materials. Also, at the same drum speed, the threshed capacity was generally increased by increasing feed rates of threshed materials. At 550 r.p.m. drum speed, the threshed capacity increased from 1.8 to 5.66 kg/min with feed rate variation from 6 to 18 kg/min. The highest capacity was obtained with 650 r.p.m. drum speed and 18 kg/min feed rate.

2 - Effect of drum speed and feed rate on un-threshed seed losses,%:

Fig. 3 shows the results of un-threshed seed losses as affected by drum speed and feed rate. The data indicated that, generally, the un-threshed seed losses was decreased with increasing drum speed at all feed rates, while it increased with increasing feed rate at all drum speeds. At 14 kg/min feed rate, increasing drum speed from 350 to 550 r.p.m. tends to decrease un-threshed seed from 1.42 to 0.91 %, while at 650 r.p.m. drum speed, it was 0.7 %. Also, at 550 r.p.m. drum speed, increasing feed rate from 6 to 18 kg/min tends to increase un-threshed seed from 0.73 to 0.91 %.

3- Effect of drum speed and feed rate on total seed damage,%:

This damage is classified as follows :(1) visible seed damage (2) invisible seed damage. Damages reduce germination ratio, and the quality and value of product if seeds are for planting use. Total seed damage equals visible and invisible seed damages. Fig. 4 shows the effect of drum speed and feed rate on total seed damage during threshing of clover. Total seed damage increased from 2 to 4 % when increasing drum speed from 350 to 650 r.p.m at 14 kg / min feed rate, while, it decreased from 4.2 to 3.3 % when increasing feed rate from 6 to 18 kg/min at 550 r.p.m drum speed. These results, due to the impact of knives with seed related to the seed damage, increased with increasing drum speed and decreased by feed rate of threshed materials. These results confirmed the obtained result by Sudajan et al. (2002) and El-Haddad (2004).

4- Effect of drum speed and feed rate on seed losses with straw,%:

Fig. 5 shows the results of seed losses with straw as affected by drum speed and feed rate. The data indicated that, generally, the seed losses with straw decreased with drum speed at all feed rates, while, it decreased with feed rates from 6 to 14 kg / min, while it slightly increased at feed rate 18 kg /min at all drum speeds. At 14 kg/min feed rate, increasing drum speed from 350 to 550 r.p.m. tends to decrease seed losses with straw from 6.58 to 0.29 %, while it slightly increased to 0.3 % when drum speed increased to 650 r.p.m. Also, at 550 r.p.m. drum speed, increasing feed rate from 6 to 1٤ kg/min tends to decrease losses seed with straw from 5.07 to 0.29 %, while it slightly increased to 1.39 % at feed rate 18 kg /min.

5- Effect of drum speed and feed rate on threshing efficiency, %

Fig 6: shows threshing efficiency of clover as affected by drum speed and feed rate. The results indicated that threshing efficiency increased as the drum speed increased at feed rates from 6 to 14 kg / min, while it slightly decreased at feed rate 18 kg /min at all drum speeds. At 14 kg / min feed rate, increasing drum speed from 350 to 550 r.p.m tends to increase threshing efficiency from 90 to 95.2 %. Meanwhile, it slightly decreased to 95% when drum speed increased to 650 r.p.m.. At 550 r.p.m drum speed, increasing feed rate from 6 to 14 kg / min tends to increase the threshing efficiency from 90 to 95.2 %. while it slightly decreased to 94.4 % when feed rate increased to 18 kg / min.

6- Effect of drum speed and feed rate on consumed power

Fig . 7: shows that increasing drum speeds and feed rates tend to increase the power consumed for threshing. At feeding rate 14 kg /min, increasing drum speeds from 350 to 650 r.p.m tends to increase consumed power from 7.6 to 10.11 kW. Also at the same drum speed (550 r.p.m) increasing feed rate from 6 to 18 kg / min tends to increase the consumed power from 9.11 to 9.98 kW. The unit energy also increased as the drum speed increased while, it decreased with increasing feed rate as shown in Fig(8). At drum speed of 550 r.p.m, when feed rate increased from 6 to 18 kg / min, the unit energy decreased from 65.83 to 29.35 kW .h / ton. Also at the feed rate 14 kg / min, increasing drum speed from 350 to 650 r.p.m tended to increase unit energy from 30.2 to 38 kW .h / ton. This result was related to the torque and the speed. When drum speed increased, the capacity and the feed rate increased which results in more torque to thresh the crop. Similar results were obtained by Helmy (1988) and EI-Haddad (2004).

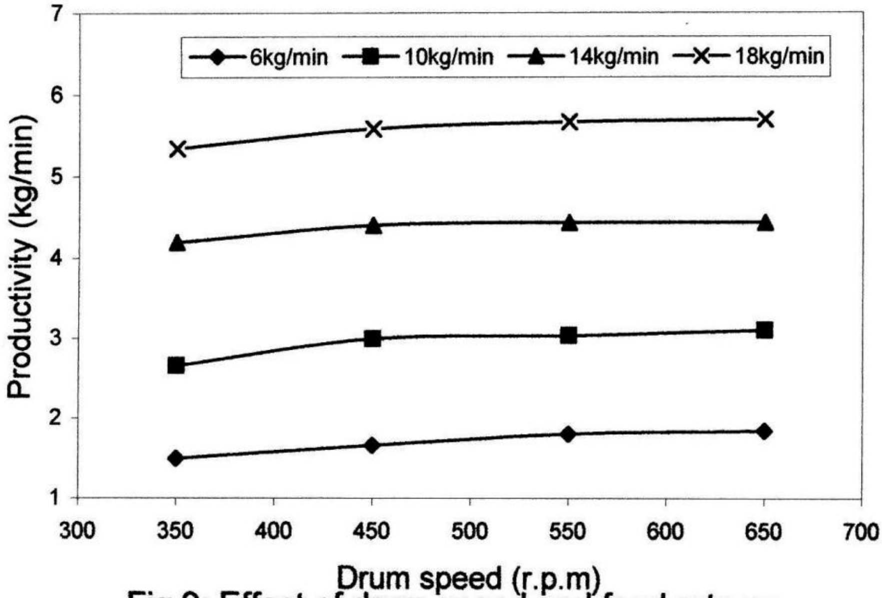

Fig 2: Effect of drum speed and feed rate on productivity of clover grain.

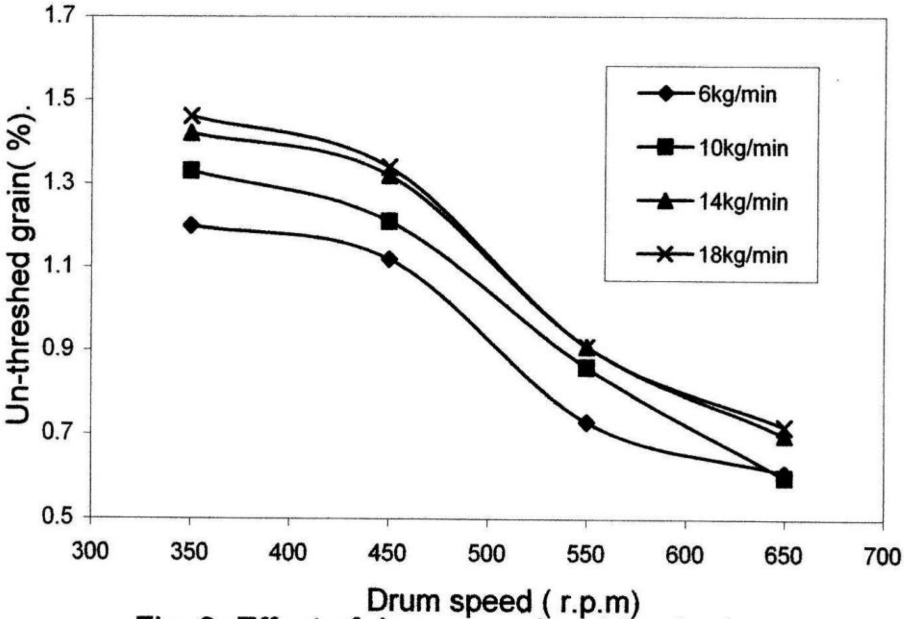

Fig. 3: Effect of drum speed and feed rate on un-threshed clover .

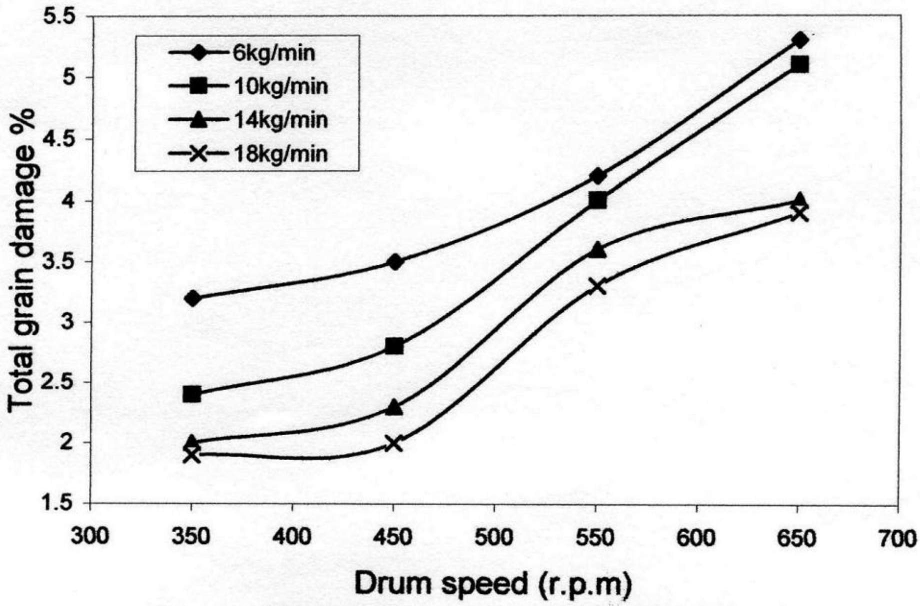

Fig. 4: Effect of drum speed and feed rate on total grain damage %.

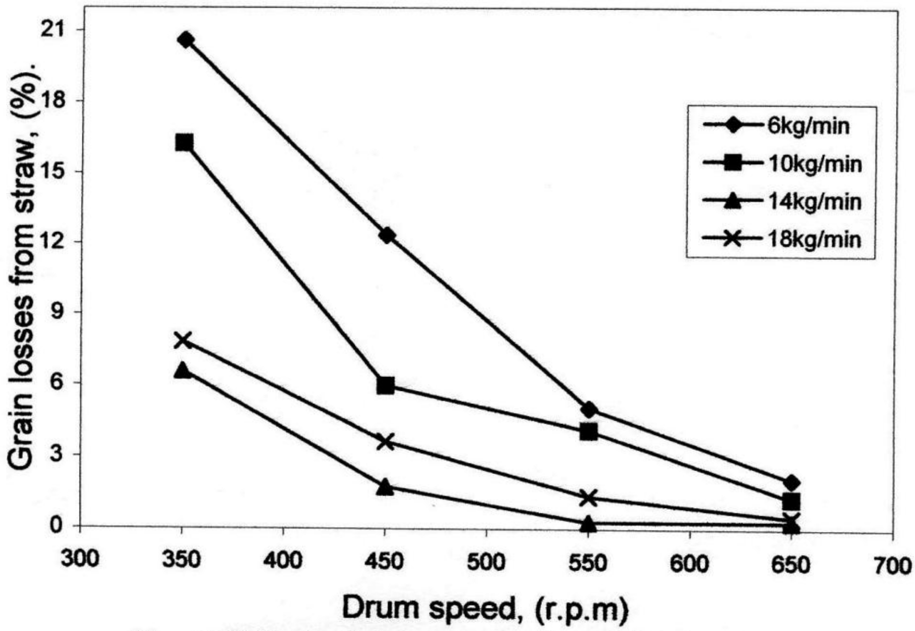

Fig. 5:Effect of drum speed and feed rate on grain losses from straw.

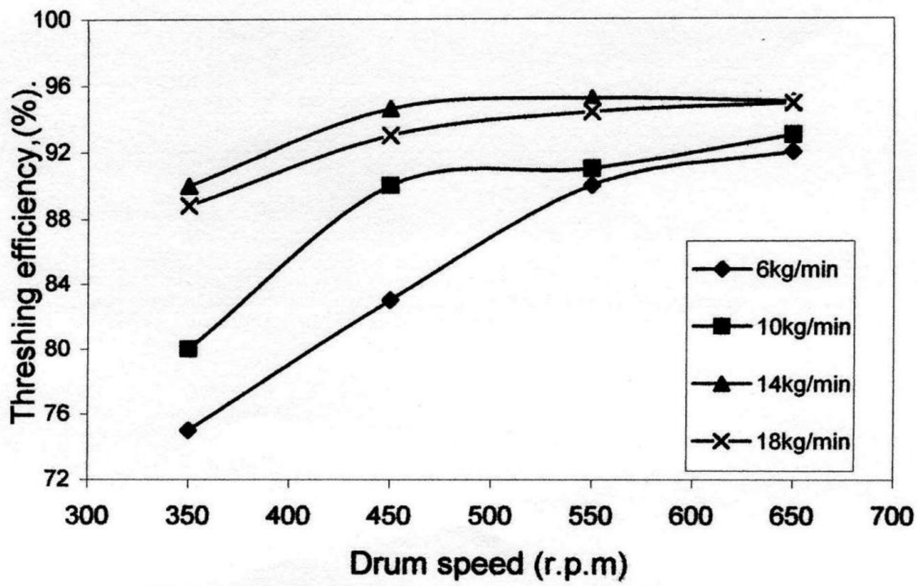

Fig. 6: Effect of drum speed and feed rate on threshing efficiency of clover.

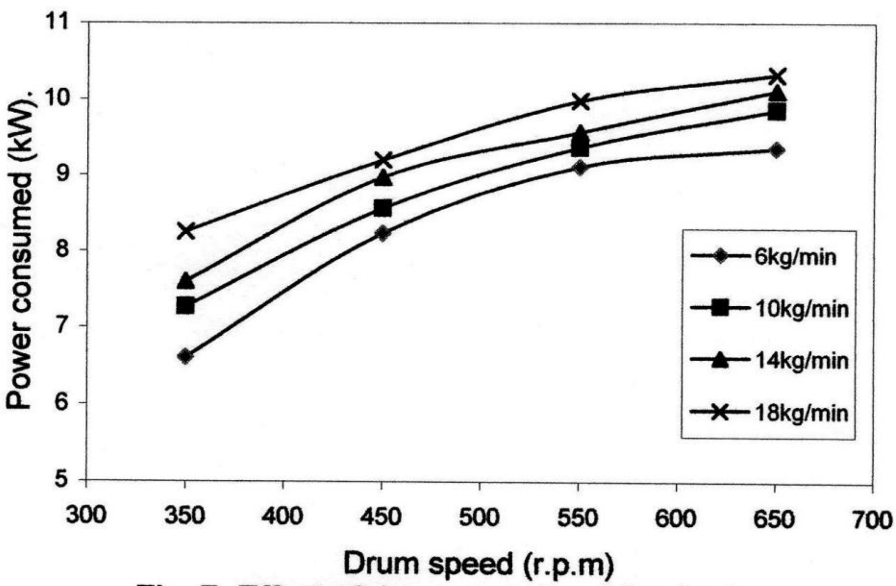

Fig. 7: Effect of drum speed and feed rate on power consumed ,kW.

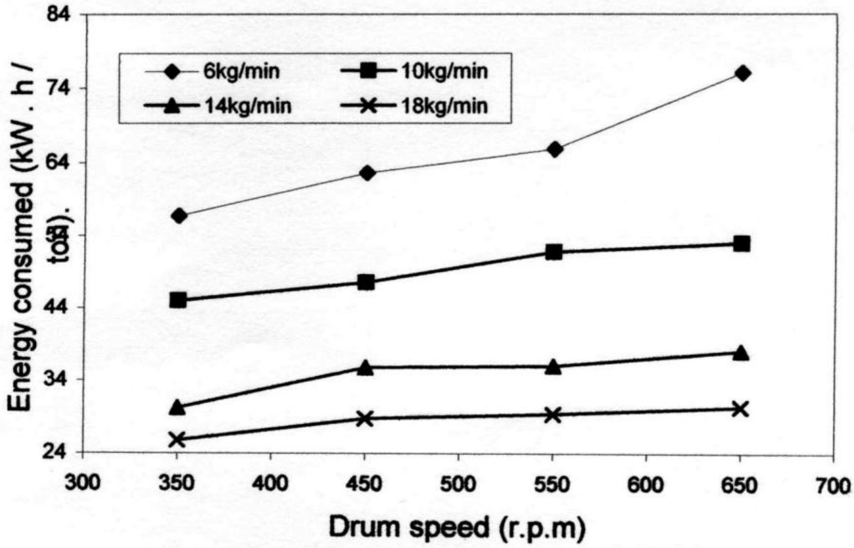

Fig. 8: Effect of drum speed and feed rate on energy requirements,(kW . h / ton).

CONCLUSION

The results of the present study revealed the following points.

1- The optimum condition for operating the threshing machine was at drum speed of 550 r.p.m, 14 kg / min feed rate with straw moisture contents 9.8 %, seed moisture contents 10.5 %, air speed in cleaning 6 m/s, slope of sieves at 3^0 with horizontal and vibrating screen speed at 350 rpm.

2– Threshing capacity increased from 1.8 to 4.43 kg / min by increases of drum speed from 350 to 550 r.p.m, while, it slightly increased when drum speed was 650 r.p.m, The threshing capacity increased with increasing feeding rates of threshed materials.

3- Total grain damage increased by increasing drum speed and decreased by increasing feed rate.

4– The threshing efficiency increased from 90 to 95.2 % by increasing feed rate from 6 to 14 kg / min with drum speed 550 r.p.m, while it decreased when feed rate was 18 kg /min at all drum speeds.

5- The un-threshed seed increased by increasing feed rate and decreased by increasing drum speed.

6- The seeds losses with straw decreasing by increased feed rate from 6 to 14 kg / min at all drum speeds, while increased when feed rate was 18 kg /min at all drum speeds.

7- The energy consumed increased by increased drum speed and decreased by increasing feed rate.

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الملخص العربي

أداء آلة دارس محلية الصنع في دارس وتذرية محصول البرسيم

د / رأفت على أحمد[1] د/ عبد الحميد السعيد[1] د / سمير حافظ الدسوقي[1]

البرسيم من أهم محاصيل العلف وهو المحصول الرئيسي في مصر لتغذية الحيوانات . ولذلك تتناول هذه الدراسة إمكانية استخدام آلة دارس القمح (محلية الصنع) في دارس البرسيم وزيادة عدد ساعات التشغيل وخفض تكاليف التشغيل في الساعة للآلة. وإنتاج حبوب ذات صفات جيدة. تحت ظروف التشغيل الآتية:

١ – سرعة درفيل الدراس ٣٥٠ ، ٤٥٠ ، ٥٥٠ ، ٦٥٠ لفة / الدقيقة.

٢ – معدل تغذية المحصول ٦ ، ١٠ ، ١٤ ، ١٨ كج / الدقيقة.

٣ – مع استخدام نسبة رطوبة (علي أساس رطب) للقش ٩.٨ % وللحبوب ١٠.٥ % ، وسرعة هواء التنظيف ٦ م / ث، وميل الغربال ٣٠° مع الأفقي وسرعة الغربال الترددية ٣٥٠ لفة / دقيقة

وتم دراسة المتغيرات علي: إنتاجية الآلة من الحبوب – ونسبة البذور الغير مدروسة – ونسبة البذور التالفة الكلية ـ ونسبة البذور المفقودة في التبن – وكفاءة الدراس – والقدرة المطلوبة .

أوضحت النتائج أن أفضل ظروف للتشغيل تحققت عند سرعة درفيل الدراس ٥٥٠ لفة / دقيقة ومعدل تغذية ١٤ كج / دقيقة ومحتوي رطوبي للقش ٩.٨ % و ١٠.٥ % للحبة وسرعة الهواء على غرابيل الفصل ٦ م / ث وسرعة الاهتزاز لغرابيل التنظيف ٣٥٠ لفة / د وزاوية ميل الغربال على الأفقى ٣٠° . حيث كانت إنتاجية الآلة ٤.٤٣ كج / د، وفوا قد البذور (بذور بدون دارس ٠.٩١ % - بذور تالفة ٣.٦ % - بذور مفقودة مع التبن ٠.٢٩ %)، وكفاءة الدراس ٩٥.٢ %، والطاقة المستهلكة ٣٥.٩٧ كيلووات . ساعة / طن.

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