IMPROVEMENT OF TRACTOR PERFORMANCE IN RESPECT OF INCREASING THRESHING EFFICIENCY OF FLAX CROP

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ABSTRACT

Up till now in Egypt, the tractor treading (trampling by tractor wheel) is still the common practice for threshing flax crop. Improving the efficiency of the pneumatic tractor tire can help to obtain a good yield and quality for flax fiber.

This research investigated the effect of some factors including working speed, moisture content and inflation pressure on tractor performance during threshing flax crop. A Nasr tractor 60 Hp (44.77 kW) was used at three forward speeds (2.85, 4.17, and 6.07 km/h), four wheel inflation pressure (80, 100, 120 and 140 kpa) and three levels of capsules moisture content (17.35, 14.62, and 11.25%)

The results revealed that, optimum values for the operation conditions were obtained at 4.17 km/h forward speed, 120 kpa wheel inflation pressure and 11.25% (d.b) capsules moisture content. At these levels, maximum tractor productivity of (7.22 ton/h), minimum slip of (4.24%), minimum energy consumption (2.08 kW.h/ton), minimum seed losses (4.35%), minimum stalk losses (13.95%) and maximum fiber percentage(17.04%).

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INTRODUCTION

Flax plant *(Linum Usitatissimum L)* is considered one of the most important economical crops due to, it is a source of heavy (idle) oil and special fibers used in different scopes of industry. So, the cultivated area in Egypt reach up to 70.000 Feddan yearly. Seeds and fibers losses are still a question had to be answered by improving the popular threshing methods depending on tractor traffic on a heap of plants. To accomplish, the improvement; tractor wheel pressure, plant moisture content and workable speed will be investigated.

ABD El-Maksoud (1975) stated that the primitive method of the flax threshing performed by knocking the plants on hard subject is still carried out by the majority of flax producers. A very limited number of large mechanical flax combines are used in the public sector farms, but these are expensive equipment that needs high technical operation and maintenance.

(Kepener et al. 1978). Mentioned that, threshing may be accomplished by: a) Impact of a fast moving member up on the material. b) Rubbing c) Squeezing pods. d) A combination of two or more of these action or e) some other methods of applying the required forces.

Vpadhyaya and Wulfsohn (1990) reported that as the inflation pressure decreased from 124 to 83 kpa while as, the contact area was increased and changed from ellipse-shape to rectangular shape with curved edges. **Wiley et al, (1992)** showed that inflation pressure and dynamic load are important factors that effect on the performance of tractor tires. **Tendon et al. (1988)** found that moisture content has a significant effect on threshing efficiency and invisible grain damage.

Gee Clough (1980) mentioned that, tire inflation pressure will of course have a strong effect on tire deflation as will tire side wall stiffness. Lyne et al. (1984) indicated that traction efficiency tended to decrease as inflation pressure increased, but minimally in some instance.

Hunt (1983) indicated that the rolling resistance is the force required to keep the equipment moving at a constant speed and is proportional to equipment weight.

Awatif et al. (1987 stated that at constant dynamic load, the motion resistance of the agriculture tire decreased with increasing inflation pressure.

Farmers do not usually attempt to change tractor ballast because the process is tedious and time consuming as cited by **Clark and Dahua (1995).**

El-Ashry et al. (2003) investigated and evaluated the comparative economic benefits of partial and complete mechanized flax threshing practices. They found that the complete mechanized system recorded the maximum values of criterion costs 254.08 L.E/ton because of the maximum straw losses 24.35% occurred under complete mechanized systems. That indicated cause the flax threshing still carried out manually or trampling by tractor wheel.

The main objective of this study was to evaluate the effect of some factors including working speed, inflation pressure and capsules moisture content on tractor performance and yield components quality during threshing flax crop by trampling tractor wheel.

MATERIAL AND METHODS

The experiments were carried out during 2005 season at Shobrameles village, El-Gharbia Governorate to investigate the effect of some processing parameters such as three working speeds (2.85, 4.17, and 6.07 km/h), four inflation pressure (80, 100, 120, and 140 kpa) and about three capsule moisture content (17.35, 14.62, and 11.25 %) on flax yield and its components quality.

To carry out this study, a Nasr DM34 tractor 62 Hp Diesel engine was used. Technical and specifications of the used tractor and its tire are tubulated in tables 1 and 2.

Table (1): Tractor specifications:

Item	**Characteristics**
Model	Nasr DM 34
Source of manufacture	Egypt
Drive mode	2WD
Engine	Diesel, 4 cylinders
Power Hp (kW)	62 at 2600 r.p.m (46.26)
Total weight, (kg)	2255
Dimensions, (mm.)	
Overall length	3450
Overall width	1900
Wheel base	2050
Tire size, (mm)	
Rear	14-30//
Front	6.5-20//
Axle load kN	
Rear	13.83
Front	8.29

Table (2) Technical data and specifications of the used rear tire characteristics:

Item	Characteristics
Size of tire	14 – 30\\
Source of manufacture	Egypt
Type of tire	Nisr-Nylon
Ply rating	8
Width of tire (mm)	357
Diameter of tire (mm)	1479
Height of lug, (mm)	60
Number of lugs	36

The used flax crop was of variety (Sakha1). The physical characteristics were estimated for both plants and seeds. As shown in the following table:

Table (3): The measured physical properties for flax crop (Sakha 1):

Physical characteristics	Average value
Plant height,(cm)	101.5
Technical length, (cm)	82.45
Stem diameter, (mm)	1.75
Number of capsules per plant	10.05
Capsule diameter (mm)	6.5
Seed yield (kg/fed.)	600
Straw yield (ton/fed.)	3.5

MATERIALS AND METHODS

The flax crop was harvested manually. The flax plants were left in the field for 3 to 4 days in small piles for natural drying and later gathered into large heaps in the threshing yard. Before any tests flax crop was sun dried for a few hours to extract the moisture that the plants were picked up during the night since the crop was not stored in an enclosed building. Sheets are stretched out to perform the deseeding operation on it by stocking the plants to form a hill and then let the tractor to pass around over the periphery of the stock, then separated and cleaned by winnowing unit as shown in fig. (1)

Before threshing, four levels of tire pressure were selected and measured by a simple tire pressure gauge; the values were 80, 100, 120, and 140 kpa. pressures were applied from the highest and gradually reduced to the lowest. Actual speed was determined by measuring both of the tractor trips time and length, by means of a stopwatch and a measuring tape. Then slip percent was estimated from both theoretical speed (forward speed without load), and actual speed (forward speed with load)

Slippage (%) = $(1 - V_{act.} / V_{th.}) \times 100$

Where:

V act. = actual speed

Vth. = theoretical speed

Fig. (1) Deseeding of flax crop by treading (trampling by wheel of tractor).

<u>Stalks losses:</u>

Stalks losses were calculated according to the following formula:

Stalks losses = (W sps. / W st.)x 100

Where:

W sps. = weight of spilt portion of stalks during threshing

W st. = total weight of stalks rather than capsules

<u>Threshing capacity:</u>

The threshing capacity is expressed as amount of crop which threshed in time (ton/h)

Threshing capacity = W tc / T

Where:

W tc = weight of total sample before threshing.

T = time of threshing process.

<u>Unthreshed seed losses:</u>

Unthreshed seed losses were calculated as follows:

Unthreshed seed losses = (Wus /Wts) x 100

Where:

W us = weight of unthreshed seed.

Wts = weight of total seed.

Threshing efficiency:

Threshing efficiency was calculated as follows:

Threshing efficiency = 100 – unthreshed seed losses

It was calculated according to the following equation

Threshing efficiency = 100 – (W2 / W1)

Where:

W 1 = the total weight of seeds in the samples.

W2 = the weight of unthreshed seeds in sample

Energy requirement:

The power consumed by the tractor was calculated using the measured fuel consumption during threshing operation under different variables of the study.

The following formula was used to estimate the tractor horse power according to **Embaby (1985).**

$$E.P = Fc(\frac{1}{60x60})P.FxLCVx\,427\,x\eta_{th}x\eta_{m}x\frac{1}{75}x\frac{1}{1.36}kW$$

Where:

Fc = the fuel consumption L/h.

P.F = the density of fuel, kg/L (for solar = 0.85).

L.C.V = the lower calorific value of fuel (k.cal/kg) average L.C.V of solar is 10000 k.cal/kg).

ηth = the thermal efficiency of the engine, consider to be about 40% for diesel engine).

427 = thermo-mechanical equivalent, kg.m/kcal.

ηm = the mechanical efficiency of the engine, consider to be 80% for diesel engine).

Power consumed = 3.16 Fc kW/h.

So, the energy requirement in (kW.h/fed.), was calculated as follows:

$$\left[\text{Energy requirment} = \frac{\text{the consumed power (kW)}}{\text{Actual field capacity (ton/h)}}.\right] kW.h/ton$$

RESULTS AND DISCUSSION

In order to evaluate the tractor performance during threshing flax crop by trampling using tractor wheels, the different criteria of threshing operation, such as quality properties of two yield components (straw and seeds) and other factors related to threshing capacity, energy requirements must be taken into consideration .

Slipage ratio:

The observation illustrated in Fig. (2) shows the effecte of working speeds, inflation pressure for rear wheel and average moisture content of capsules on slip ratio. The data revealed that at any average capsules moisture contents, the slip ratio increased as the tractor forward speed and tire inflation pressure increased. In other words, at 11.25% average moisture content of capsules, the results indicated that increased tractor trips speed from 2.85 to 6.07 km/h caused a corresponding increase in slippage from 2.2 to 2.88, from 3.7 to 4.03, from 4.15 to 4.9 and from 5.65 to 7.4% at wheel inflation pressure 80, 100, 120, and 140 kpa., respectively.

Seed losses:

The data illustrated in fig. (3) show, the effect of wheel inflation pressure, tractor speeds and moisture content of capsules on seed losses. These data revealed that at any moisture content of capsules, the seed losses decreased as the wheel inflation pressure and tractor speed increased. As an example at 11.25% moisture content of capsules, increasing inflation pressure from 80 to 140 kpa causes a decrease in the seed losses from 7.4 to 6.05 and from 6.48 to 4.1% and from 5.8 to 4 at tractor forward speed of 2.85, 4.17 and 6.07 km/h respectively. High wheel inflation pressure and tractor speed led to small seed losses , because it caused an increase in the wheel slippage, which led to an increase in the friction between the wheel and the capsules.

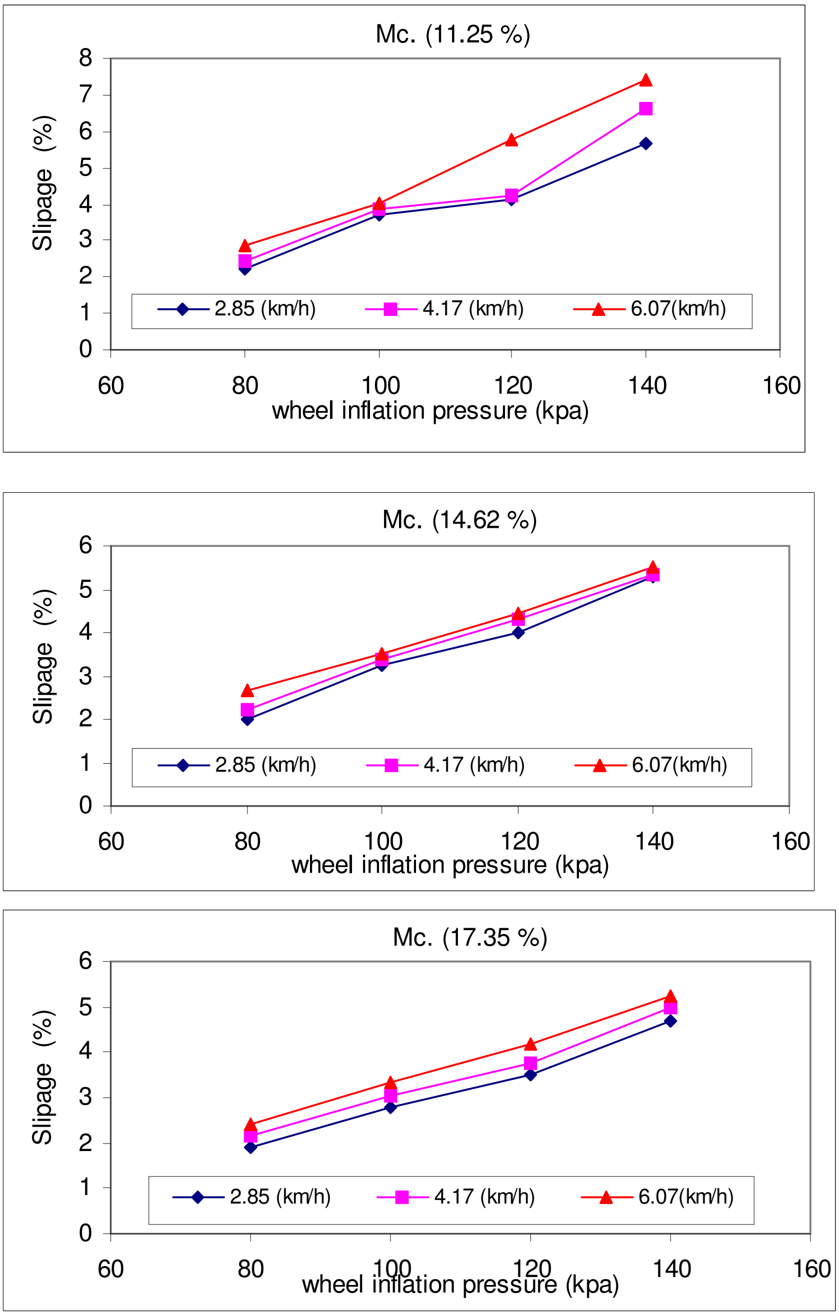

Fig. (2) Slippage ratio as affected by wheel inflation pressure and different tractor speed at different moisture content of capsules.

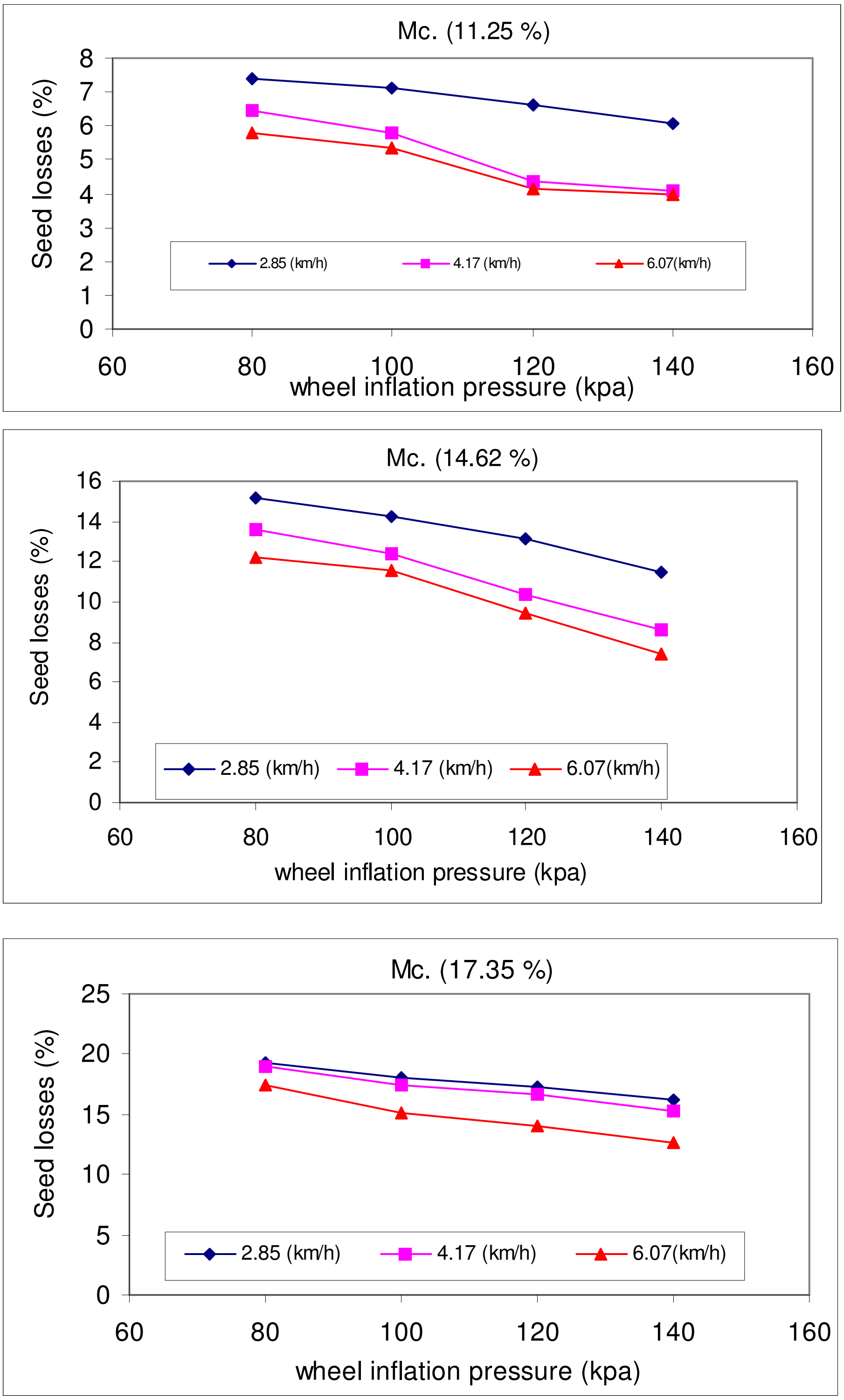

Fig. (3) Seed losses as affected by wheel inflation pressure and different tractor speed at different moisture content of capsules.

Also, the mentioned data indicated that for all wheel inflation pressure and tractor speeds the seed losses increased with increasing of capsules moisture content. This comes in agreement with **Khatab (1998) and El-Ashry et al, (2003)** . the minimum seed losses (4.16%) was recorded at 11.25% moisture content, 6.07 km/h tractor forward speed and 140 kpa wheel inflation pressure.

Stalk losses:

The data reported in fig. (4) show the effect of wheel inflation pressure, tractor speeds and moisture content of capsules, on stalk losses. The mentioned data revealed that at any moisture content of capsules, the stalk losses increased as the wheel inflation pressure and tractor speed increased. As an example at 11.25% moistu0r10e content of capsules, increasing wheel inflation pressure from 80 to 140 kpa, causes an increase in the stalk losses from 11.74 to 14.93% and from 12.7 to 15.35% and from 14.67 to 18.09% at tractor speed of 2.85, 4.17 and 6.07 km/h respectively. This can be accomplished during fiber extracting operation . The same mentioned data indicated that for all wheel inflation pressure and tractor speed the stalk losses increased with decreasing moisture content of capsules. This may be due to lower elasticity of stalks. It is found that at forward %speed 4.17 km/h decreasing moisture content of capsules from 17.35 to 11.25 increased the percentage of stalk losses from 6.15 to 12.7%, from 6..85 to 13.73%, from 7.05 to 14.95% and from 7.32 to 15.35% at inflation pressure of 80, 100, 120, and 140 kpa respectively.

Productivity

The observations reported in fig.(5) show the effect of wheel inflation pressure, tractor speed and average moisture content of capsules on the tractor threshing capacity.

The mentioned above data revealed that at any average moisture content of capsules, the threshing capacity of tractor increased as the wheel inflation pressure and tractor forward speed increasing. On the other hand, at 11.25% average moisture content of capsules, the results indicated that increasing tractor speed from 2.85 to 6.07 km/h cause a corresponding increase in threshing capacity from 6.05 to 7.82, from 6.14

to 8.05, from 6.45 to 8.22 and from 6.71 to 8.32 ton/h at wheel inflation pressure of 80, 100, 120 and 140 kpa respectively.

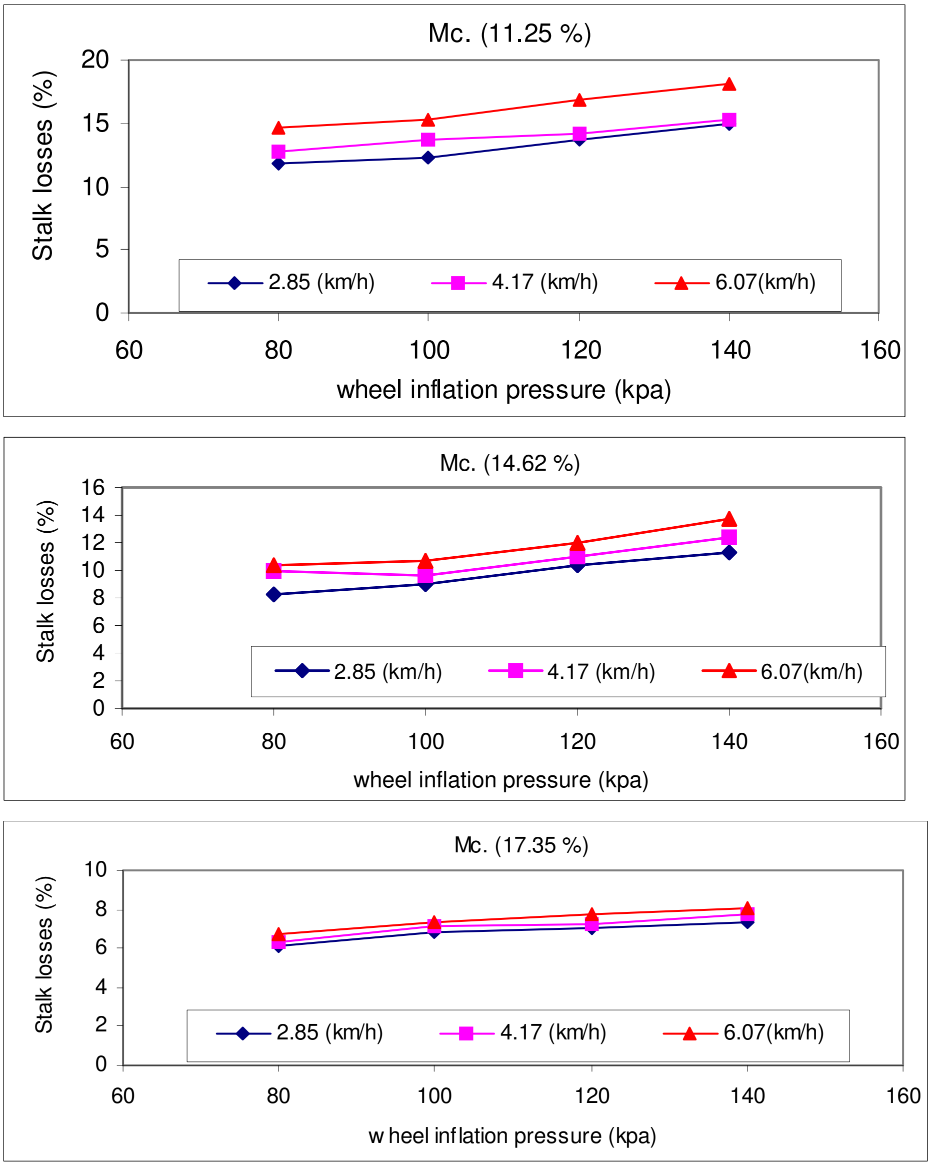

Fig. (4) Stalk losses as affected by wheel inflation pressure and different tractor speed at different moisture content of capsules.

Meanwhile, the data indicated that threshing capacity tends to decrease as average moisture content of capsules increased from 11.25 to 17.35%. This decrease in threshing capacity as average moisture content of capsules increased may be due to the high attachment strength of high moisture content seeds than for low moisture content of seeds

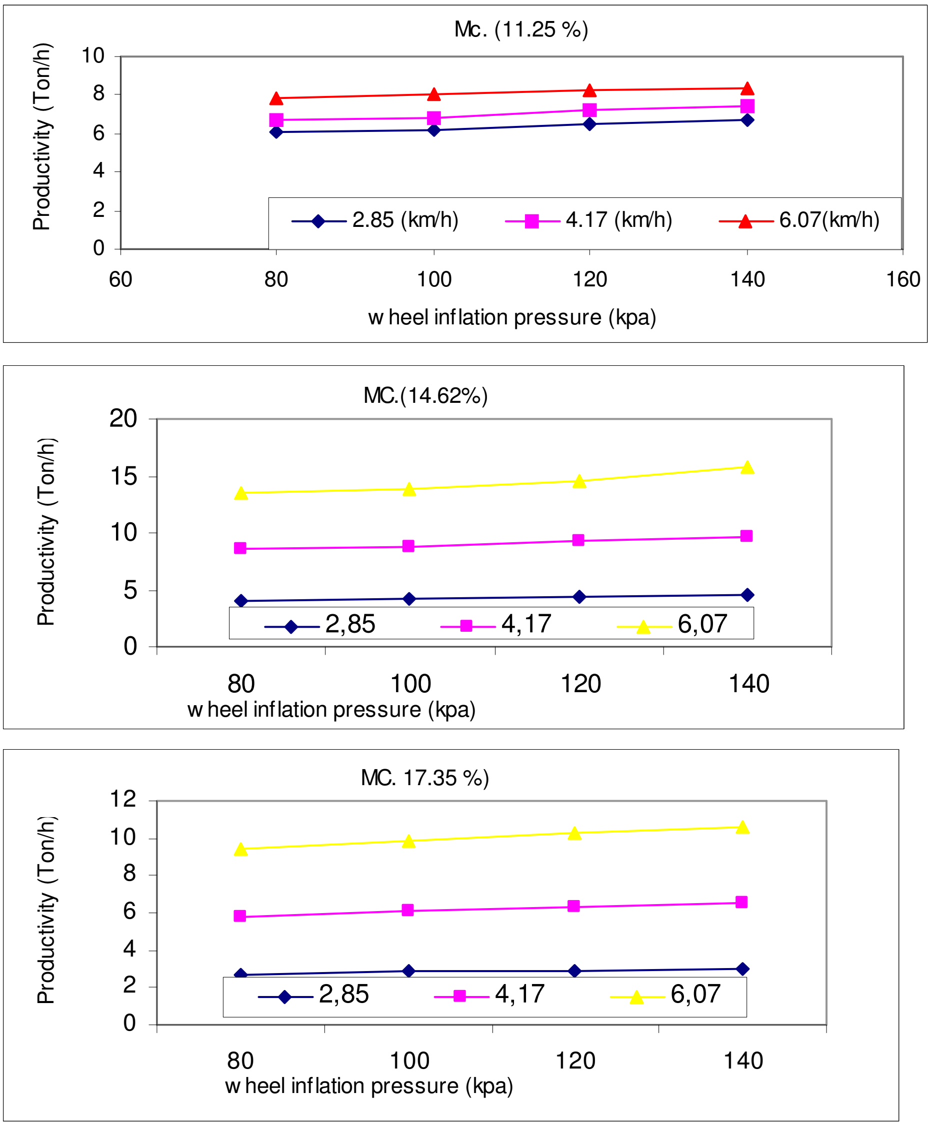

Fig. (5)Productivity as affected by wheel inflation pressure and different ractor speed at different moisture content of capsules**.**

Energy requirement:

The consumed energy illustrated in graphically in fig. (6) show energy requirements as affected by tractor speed and wheel inflation pressure. It is remarkable that the energy requirements for threshing of flax fiber by trampling using wheels of tractor decreased with increasing of tractor speed and wheel inflation pressure. On other words, at 11.25% moisture content of capsules, the results indicated that increasing the wheel inflation pressure from 80 to 140 kpa decreased the energy requirement from 2.54 to 1.88 , from 2.4 to 1.98 and from 2.13 to 1.87 kW.h/ton, at tractor forward speed of 2.85, 4.17 and 6.07 km/h respectively.

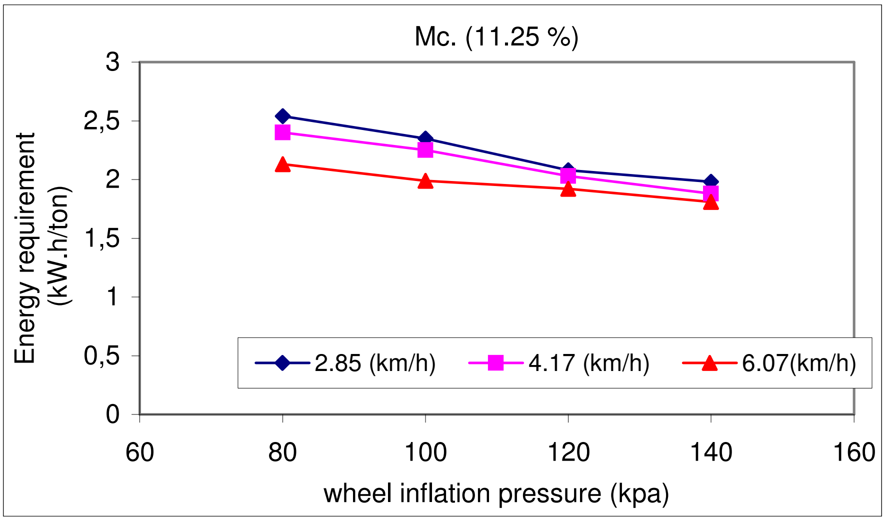

Fig. (6) Energy requirement as affected by wheel inflation pressure and different tractor speed at 11.25% capsule moisture content.

Fiber percentage:

The calculated data in fig. (7) revealed that, the lowest fiber percentage (14.42%) was achieved at wheel inflation pressure 140 kpa and tractor forward speed 6.07 km/h

The results showed that, increasing wheel inflation pressure from 80 to 140 kpa decreased fiber percentage by 11.73 % this may be attributed to the high rubbing force applied to the flax plants, which tended to increase losses and damage of branch zone.

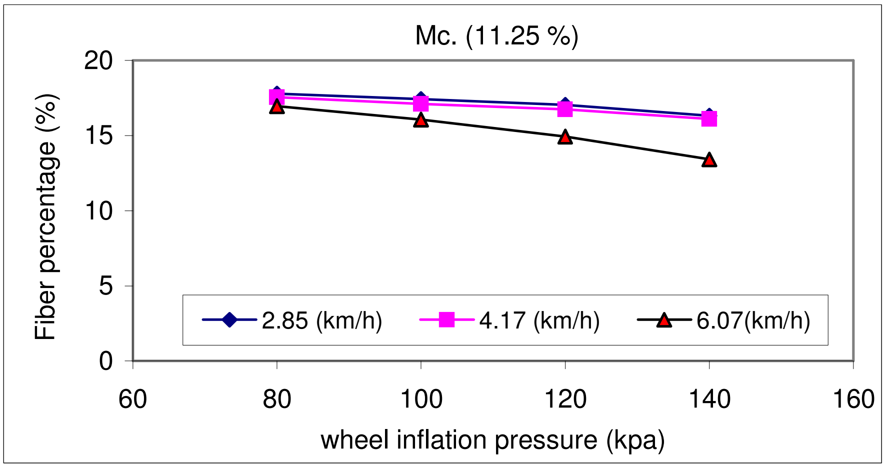

Fig. (7) Fiber percentage (%) as affected by wheel inflation pressure and different tractor speed at 11.25% capsule moisture content.

CONCLUSION

To obtain high fiber percentage and low losses (less unthreshed capsules and less total straw damage) the following conditions are recommended for the tractor during threshing flax crop by trampling wheel, inflation pressure 120 kpa, tractor forward speed 4.17 km/h with the above recommended conditions. The following optimum conditions were achieved: unthreshed seed 4.35%, straw losses 13.95% , tractor productively 7.22 ton/h ,consumed energy 2.08 kw.h/ton and fiber percentage 17.04% .

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المراجع العربية

نشـرة وزارة الزراعه المصرية (٢٠٠١) الدقى – الجيزة – مصر

الملخص العربى

تحسين أداء الجرار لزيادة كفاءة دراس محصول الكتان

د.عبده شوقى العشري*   د. عمر عبد الطيف عمر**   د. إبتسام حسن موسى**

يُعتبر الكتان من أهم محاصيل الألياف فى مصر ويحتل المرتبه الثانيه على مستوى العالم كما يُزرع فى مصر بغرض الحصول على الألياف والبذور ويلى القطن من حيث المساحه االمنزرعه.وتُعتبر عملية هدير محصول الكتان من اهم العملبات التى تؤثر بشكل كبير على ؛نتاجية المحصول وجودة الألياف والبذور.

ونظراً لآن ألات الدراس الموجوده حالياً لا تتناسب محصول الكتان ومن ثم فإن عملية هدير المحصول تتم عن طريق عجل الجرار ثم التذريه بإستخدام آلة تذريه ميكانيكيه. (العشرى وآخرون ٢٠٠٣).ورغم أنها الطريقة الشائعة حتى الآن ولكن ليست الأفضل نظراً لتأثيرها عاى خواص العيدان مما يُحدث تلف فى المحصول وفقد فى الألياف. وبناءً عليه تمت هذه الدراسه لإختيار نظام تشغيل جيد للجرار أثناء عملية الدراس بغرض الحصول على محصول عالى الجودة سواءً من الألياف أوالبذور.

ولذلك كان الهدف الرئيسى لهذا البحث دراسة التأثير لبعض العوامل المُؤثره على أداء الجرار الزراعى أثناء عملية الدراس وجودة الألياف وحساب الطاقه اللازمه لعملية الدراس. وهذه العوامل تشمل:

مستوى الرطوبه والسرعه الأماميه و وضغط الهواء قى عجل الجرار وشملت العوامل :

ثلاث مستويات رطوبه ١٧,٣٥ – ١٤,٦٢ – ١١,٢٥.

ثلاث سرعات تشغيل أماميه للجرار: ٢,٨٥ – ٤,١٧ – ٦,٠٧ كم/ س.

أربعة ضغوط هواء داخل الإطارات الخلفيه للجرار : ٨٠ – ١٠٠ – ١٢٠ – ١٤٠ كيلو بسكال.

أظهرت نتائج الدراسه المُتحصل عليها أن العوامل المثلى لتشغيل الجرار كان بإستخدام سرعه أماميه قدرها (٤,١٧ كم/س) وضغط الهواء داخل الإطارات الخلفيه (١٢٠كيلو بسكال) ومحتوى رطوبى للكبسولات (١١,٢٥%) حيث أعطى الجرار تحت هذه الظروف أعلى إنتاجيه (٧,٢٢ طن/س). وأقل إنزلاق(٤,٢٢%) وأقل طاقه مُستهلكه (٢,٠٨ كيلو وات.ساعه/طن) وأقل فاقد للبذور (٤,٣٥%) وأقل فاقد للقش (١٣,٩٥%) وأعلى نسبة ألياف (١٧,٠٤%).

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