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DEVELOPMENT OF A SIMPLE MACHINE TO GIN EGYPTIAN COTTON FOR RESEARCH PURPOSES

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ABSTRACT: This research aims to develop and evaluate small and simple machine to gin Egyptian cotton in laboratory. This machine helped technicians scholars to study the effect of any treatments during the agriculture season on properties of cotton fibers and seeds. The studied parameters in this study were: four values of fly wheel weight, three values of clearance between two drums, three values of rotation at speed and four values of inclination angle of drums with horizontal axis. Evaluation parameters were: the fall rates of cotton flower and seeds, To evaluate the fibers Goodness of following tests were conducted Ginned (elongation, solidity and stiffness), energy requirement, machine efficiency and costs. The developed machine decreased the ratio of seeds damage and short fibers. Worth mentioning that this machine do not make any complicacy in fibers. Added to the ease of using for this machine with no cutting in fibers.

Key word: Developed machine, gin, seeds, fibers.

INTRODUCTION

Cotton is the most important fiber crop in the world as well as in Egypt. But this plant are exposed to many pests so, the country spend millions of pounds to increase the production by helping the technicians to control the pests. These pests can annihilate all crops if it is not controlled in other hand keep on good quality for fibers and seeds.

Anthony and Wesley (1979) determined the effects of individual processing machines and combinations on lint quality, and their electricity consumption. Of the 14 machine combinations investigated, the treatment that included 2 tower driers, a cylinder cleaner, stick machine, impact cleaner, gin stand and 2 stages of lint cleaning produced highest classer's grade classification, the lowest trash content and lint turnout from both the high and low moisture content seed cotton samples. Treatments which included only the gin stand and one lint cleaner produced classer's grades among the highest and lint trash contents among the lowest. Lint turnouts for these treatments ranked in the intermediate range. About 55-60% of the total energy required by max. machine processing was consumed by the fans and separators. The lower moisture cotton consumed 20 - 40% more electric energy/kg of seed cotton processed. Hughs et al. (1983) found that the total nonlint content of the cotton fiber, most quality factors measured for the cotton lint processed through the experimental gin-cleaner were generally as good if not better than the same quality factors for lint processed through standard cleaning equipment.

Anthony (1985) discussed the different features of a ginning machine, the controls and the maintenance which, along with the humidity of the cotton, have an effect in limiting the deterioration of cottonseed and cotton fiber quality (percentage of short fiber and presence of foreign material and seed husk debris). Results quoted are from tests at the Cotton Ginning Laboratory. Anthony (1989) reported that processing cotton at the gin to minimize machinery usage and maximize monetary returns requires a thorough understanding of the performance characteristics of individual machines. A database involving multiple moisture, trash, machine and cotton levels was developed for all routine and laboratory fiber properties before and after various gin processes. Ranges of these variables are representative of the min. and max. levels normally found in spindle-harvested cotton. The database is suitable for multiple regression analyses and development of prediction equations based on the performance characteristics of individual and combinations of machines.

Rafiq-Chaudhry (1997) found that about 85% of total cotton in the world is ginned on saw gins. Most countries have either large scale saw ginning or roller ginning, although small scale roller ginning does exist in some countries. Among the major cotton producing countries of the world, India and Turkey are the only countries where saw ginning and roller ginning are popular. Ginning is most expensive in Spain followed by Argentina, Zimbabwe, Australia and Colombia. Ginning is heavily subsidized in China (mainland).

Mangialardi and Anthony (2000) found that, cotton (Gossypium hirsutum L.) fibers are cleaned at gins with saw-type lint cleaners to improve the market value, but the aggressive saws sometimes harm the quality of the fiber. The cleaning efficiency of one saw-type lint cleaner averaged 54%, and the efficiencies of seed cotton cleaners used as lint cleaners ranged from 9 to 16%. There was a significant improvement in the classers' leaf grade designations when lint was cleaned with each of the seed cotton-type cleaners. Staple lengths tended to be shorter after cleaning with saw-type cleaners. A modified non-saw cleaner appears practical and could help preserve fiber quality at cotton gins. Patil et al. (2006) found that the foot operated gin and the Lilliput gin have a ginning output capacity of 311 and 2111 g lint/h, respectively. The 2.5% span length and uniformity ratio remained practically the same for hand ginning, foot operated gin and the Lilliput gin. So, the foot operated gin is much more suitable for farmers because it is economical and auxiliary power is not required for its operation. The Lilliput gin is the most popular amongst the cotton breeders, traders and seed industries.

Whitelock *et al.* (2007) stated that most gins use one or two cylinder cleaners and an air-type lint cleaner for lint cleaning. The trend in roller ginning today is toward aggressive seed-cotton cleaning and gentle lint cleaning to limit fiber damage.

The aim of present study is to develop and evaluate simple machine to gin Egyptian cotton in laboratory. To help technicians scholars to study the effect of any treatments during the agriculture season on properties of cotton fibers and seeds.

MATERIALS AND METHODS

The overall objective of the present investigation was to develop, construct, and quantify the performance of a gin machine having main construction advantages. Advantage of such construction is that: - it is used in the laboratory of the far situation researcher which can not deal directly with the central laboratory and, any researcher can test seeds and fibers for cotton easily and control in the growing rates of insects too; the change in the yield by using any treatments. added to that it is fabricated by local cheap material.

The gin developed machine was fabricated and calibrated in private local workshops at Sofia village, El-Sharkeia Governorate (Figures 1 and 2). The main Components of The developed Gin Machine Were as Follows:

Power source

The machine was supplied its power from electric motor (0.36 kW), whereas, the lowest of machine productivity.

Drums

Two cast iron drums for separated cotton fibers of seeds. The dimensions: length 700 mm, diameter of drum 12.5 mm and machine weight 65 kg.

Fly wheel

Made from iron with diameter 380 mm. This diameter is kept on the balanced of machine.

Transmission system

Two pulleys and belt to transport motion from motor, but with manual motion is by hand. The performance of the developed machine was compared with the ferris gin, which has the following specifications:

Ferris gin

Type (conventional), rotational speed (950 rpm.), model (India). (In Figure 3).

1- The motor base
2- Motor
3-Pulley (50mm)
4-Belt
5- Pulley (200mm)
6- Two gears
7- Two drums
8- Fly wheel
9-Feeding box
10- Out put box of cotton gin

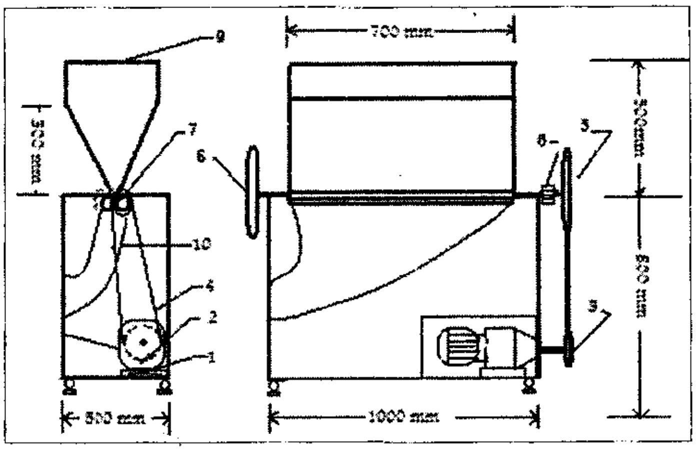

Fig. 1. Schematic diagram of the developed gin machine

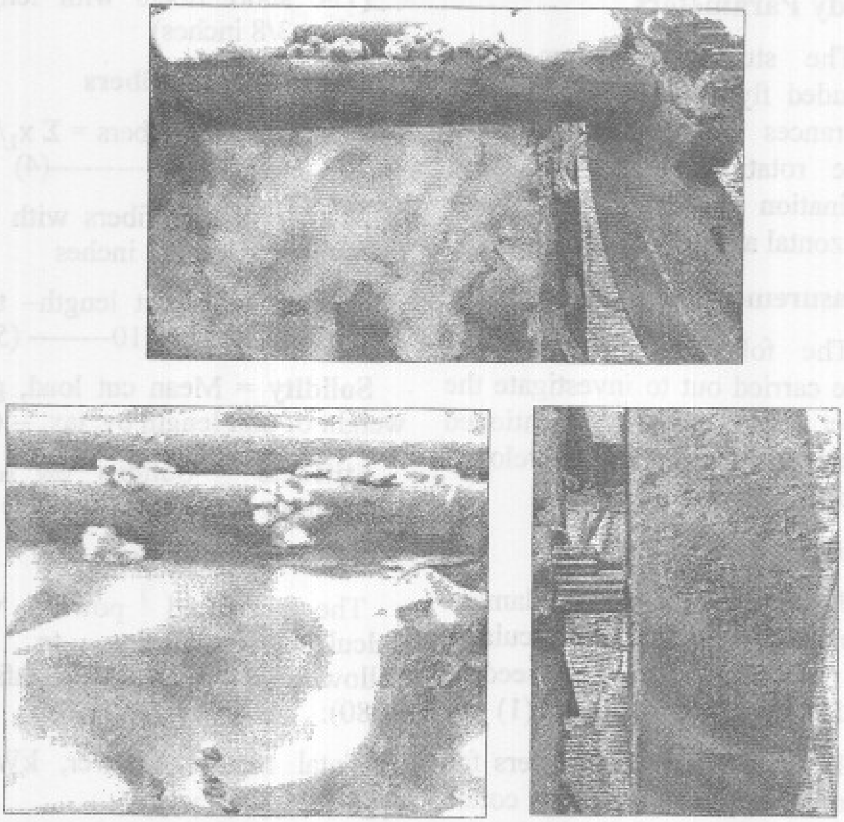

Fig. 2. Photographic views of the developed machine during gin process

Fig. 3. Photographic view of Ferris gin

Study Parameters

The study parameters were included fly wheel weights, three clearances between two drums, three rotation speeds and four inclination angles of drum with horizontal axis.

Measurements and Calculations

The following measurements were carried out to investigate the effect of previously mentioned parameters on the developed machine performance.

Seeds damage

The percentage of seed damage (broken and ungun) was calculated by number of damaged seeds / total seeds ×100 ------------ (1)

The ratio of cotton flowers fall = mean weight of flower cotton fall/ mean weight of feed rates ×100 ------ (2)

To evaluate the fibers Goodness of following tests were conducted Ginned

The mean short fibers

The mean short fibers = $\Sigma x_s/n$ -------------- (3)

Σx_s : summation of values, n: numbers of values.

(The short fibers with length less than 3/8 inches)

The mean long fibers

The mean long fibers = $\Sigma x_L/n$---------------------------------(4)

Σx_L: the long fibers with the length more than 3/8 inches

Elongation = cut length– true length / cut length × 10-------- (5)

Solidity = Mean cut load, gm/ weight of unit length by, tax. -- (6)

Stiffness = Solidity gm/ tax / Elongation-------------------- (7)

Energy Requirement

The required power was calculated according to the following formula (Gustafson, 1980):

Total required power, kW = $\sqrt{2}$ I V cos ɵ /1000 ------------ (8)

Where:

I = Line current strength in amperes;

V = potential difference (voltage) being equal to 220V.

cos ɵ = power factor (being equal 0. 486).

$\sqrt{2}$ = Coefficient current two phases (being equal 1.4)

The consumed energy, (kW. h/ton) = required power (kW)/ Machine productivity (ton/h).

While the human energy was calculated as the following equation:

Human energy $= P_{man} / q_{man}$ ---(9)

Where:

P_{man} = Manpower, kW;

q_{man} = Manual productivity, ton/h.

The manpower was computed by assuming that one normal labor supplies. 0.0748kW according to (Ezeike, 1987) cited by (Matouk *et al.*, 1999)

Machine Productivity

The machine productivity (Q) was calculated by using the following formula:

$Q = m/t$ -------- (10)

Where:

Q=Machine productivity, kg /h;

m= mass of input cotton, kg;

t= the time consummation for ginning, h.

Machine Efficiency

The machine efficiency (η) was calculated according to the following formula:

$\eta = (a / Q) \times 100$ ---------- (11)

a : The amount of input cotton, kg /h.

Whereas:

a= the mean weight of poll × the number of revolutions per minute/the number of revolutions per minute to gin one poll.--------- (12)

Q= Machine productivity,kg /h.

Operational Cost of the Unit

The total cost was determined by using the following equation (Awady, 1978).

$C = p/h\,(1/a + i + t/2 + r) + (Ec \times Ep) + m/144$ --------------- (13)

C = Operation hourly cost;

P = Price of machine;

h = Yearly working hours;

a = Life expectancy of the machine;

i = Interest rate/year;

t = Taxes;

Ec = Electricity energy;

r = Overheads and indirect cost ratio, consumption, (kW/h);

m = Monthly wage, LE;

Ep = Electricity price, (EL/kW.h);

144 = The estimated monthly working hours, h/month.

Operating cost (LE/ton) = Machine operation hourly cost (LE/h) / Machine capacity (ton/h) ----- (14)

RESULTS AND DISCUSSION

The Relation between Weight of Fly Wheel and Machine Productivity

Figure 4 shows that the relation between weights of fly wheel and machine productivity, the maximum value of gin by using human power source was 2.101 kg/h under using weight of fly wheel 8 kg. while the weight of fly wheel increased to 10 kg the rate of gin decreased by 7.5%. This can be explained as follows: When weight of fly wheel increased the rotational speed decreased but high weight of fly wheel is required to give force for pulling out the seeds from staples.

Effect of Feeding Rate and Clearance between Two Drums on Seeds Damage and Loss

Figures 5 and 6 show that the suitable clearance between two drums is 2 mm with feed rates 2 to 2.5 and 10 kg/h by using manual power source and electric power respectively. While the feed rate increased by 50%, the rates of seeds damage and loss increased by 19.7 % and 27.5% by using manual power source and electric power respectively. This is due to when clearance increase the number of seeds without gin increased.

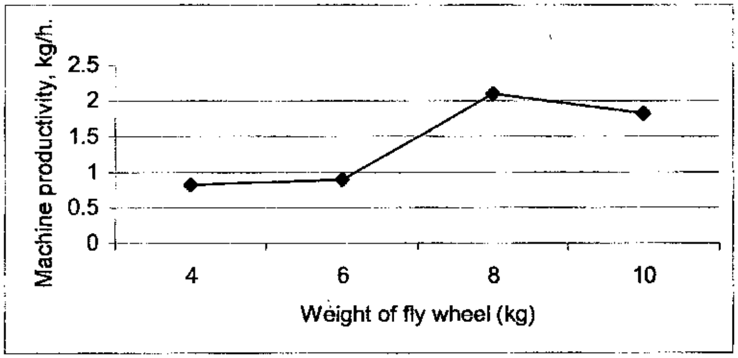

Fig. 4. The relation between weight of fly wheel and feeding rate on the machine productivity

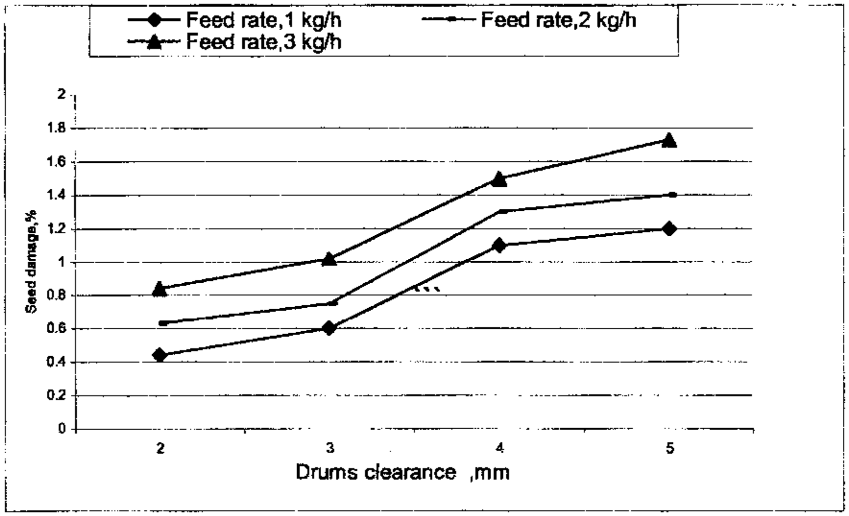

Fig. 5. The relation between feeding rate and drums clearance on the ratio of seeds damaged and loss by manual power source

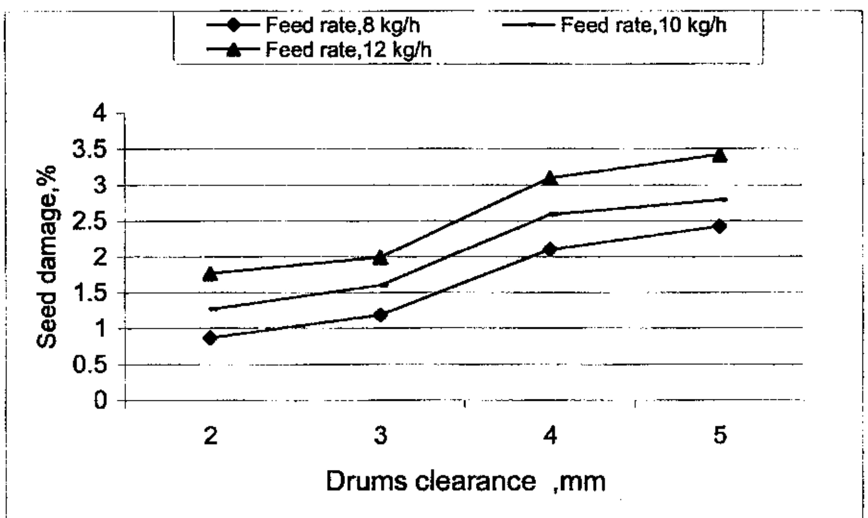

Fig. 6. The relation between feeding rate and drums clearance on the ratio of seeds damaged and loss by electric power source

Effect of Feeding Rate and Drums Rotational Speed on Seeds Damage

Figure 7 showed that, when rotational speed increased by 50% the number of seeds damage increased by 22.4%. The suitable value of rotational speed is 60 rpm which give the lowest value of seeds damaged by using electric power source.

The Relation between Inclination Angle of Drums on Horizontal Axis and the Fall Rates of Cotton Flower and Seeds

Figure 8. indicated that when inclination angle increased by 33.33%, the fall rates of cotton flower increase by 3.63% and the fall rate of seeds increased by 3.94% .in other hand the suitable inclination angle is 15 degree with manual power source because the inclination angle 20 degree increased the fall rates of flower cotton by 11.25% compared with inclination angle 15 degree but, on other hand decrease the difference between two angles with seeds fall to 2.3% .

The Tests Goodness of gunned fibers

The mean short and long fibers

By using the developed machine the mean length of short fibers was increased by 38.94%. Also, the mean length of long fibers was increased by 20.25% compared with gin Ferris. This result are shown in figure 9.

Effect of Gin Machine Type on Elongation, Solidity and Stiffness

Figure 10 shows that by using developed machine the values of elongation, solidity and stiffness increased by 25.17%, 16.66% and 10% respectively compared with gin Ferris.

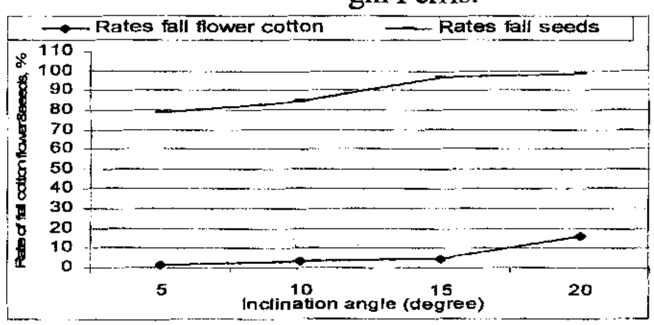

Fig. 7. The relation between feeding rate and drums rotational speed on seeds damage

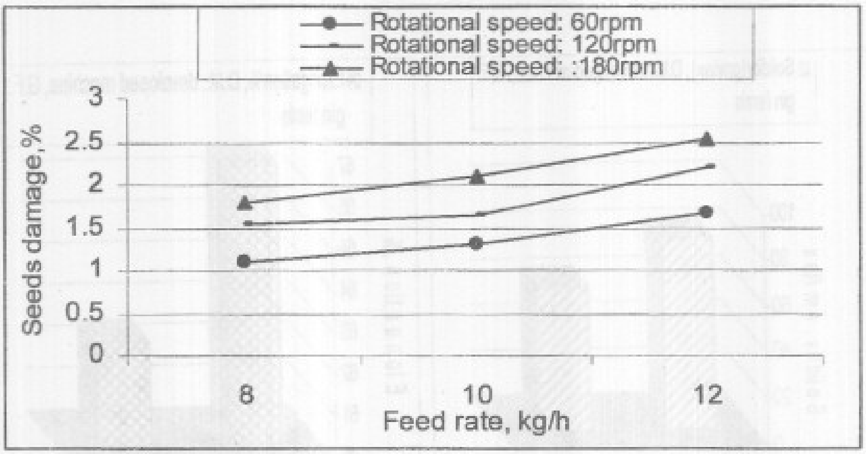

Fig .8. The relation between inclination angle of drums on horizontal axis and the fall rates of cotton flower and seeds

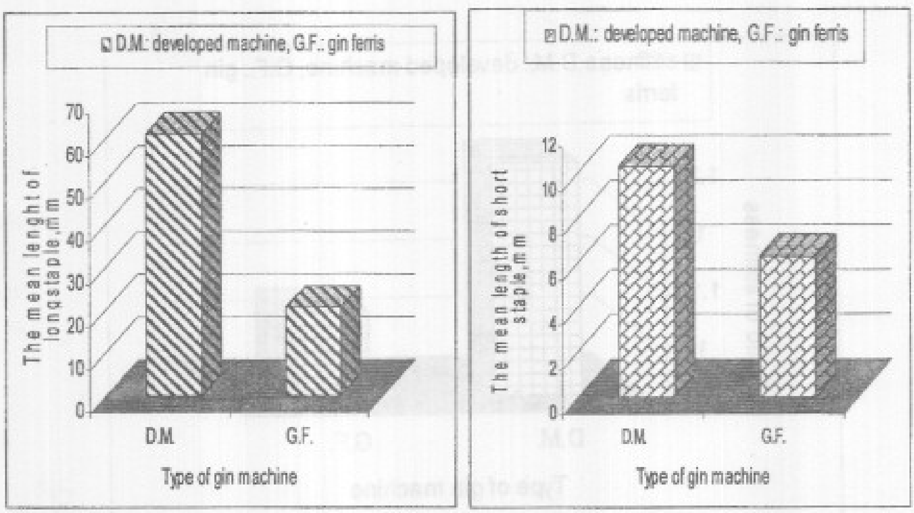

Fig. 9. The relation between type of gin machine and the length of staple

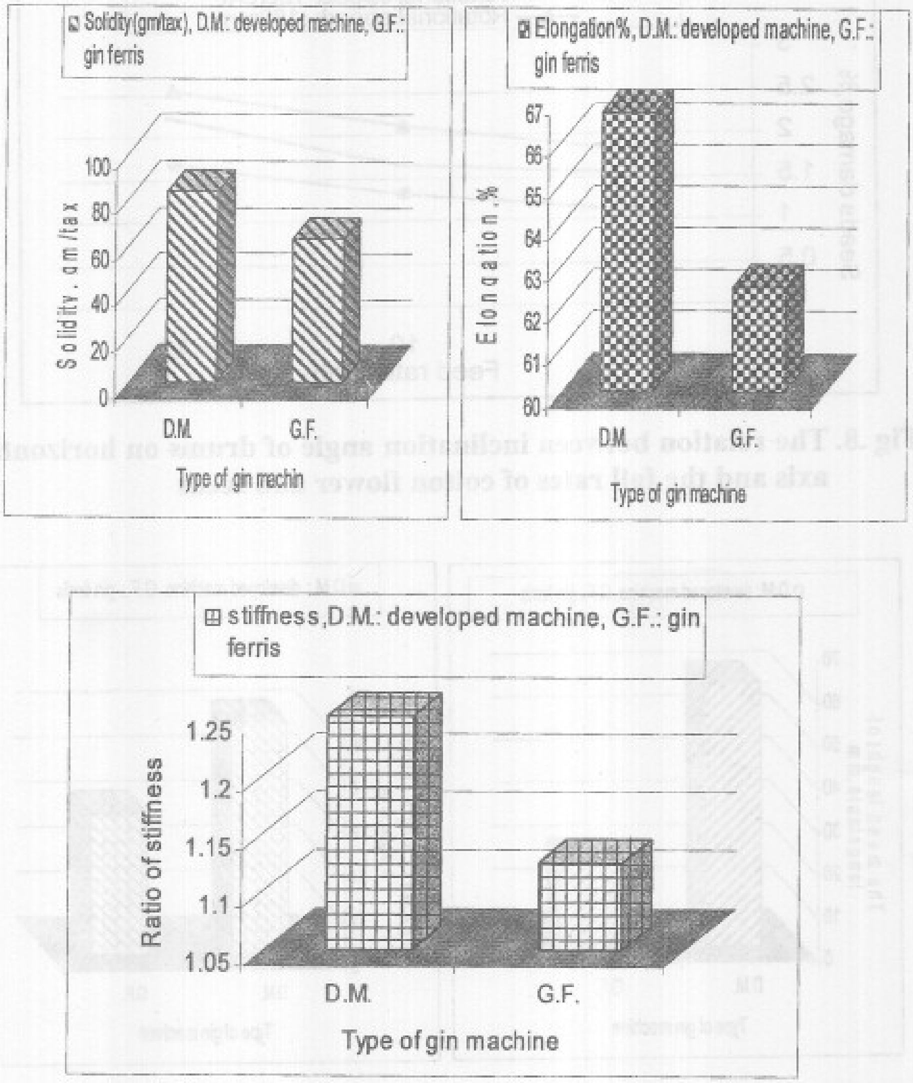

Fig. 10. The effect of machine types on elongation, solidity and stiffness rates

Machine Productivity

The maximum value of machine productivity was 2.204 kg/h by using manual power source and 10 kg/h by used electric power source (rotational speed 60 rpm).

Machine Efficiency

Figure 11 indicated that the maximum value of machine efficiency (74.86%) was noticed under used rotational speed of 60 rpm with feed rate of 10 kg/h.

Energy Consumed

The total consumed energy for product 10 to 11 kg/h was 176.38 kWh/ton with electric power source. But by using human energy it was 33.24 kWh/ton.

Production Costs

The hourly cost for the developed machine at feed rate of 10 to 11 kg/h and rotational speed of 60 rpm. was 8.97 LE/h. with electric power source. But, the total cost production 815.45 LE/ton.

Conclusion

Machine productivity, the maximum value of gin by using human power source was 2.101 kg/h under using weight of fly wheel 8 kg. The best clearance between two drums is 2 mm with feed rates 2 to 2.5 and 10 kg/h by using manual power source and electric power respectively. The optimum value of rotational speed is 60 rpm which give the lowest value of seeds damaged by using electric power source. The optimum inclination angle is 15 degree with manual power source.

The tests staple goodness after gin: the mean length of short fibers was increased by 38.94%. Too, the mean length of long fibers was increased by 20.25%, solidity and stiffness increased by 25.17% , 16.66% and 10% respectively compared with gin Ferris. The maximum value of machine productivity was 2.204 kg/h by using manual power source and 10 kg/h by used electric power source and machine efficiency, 74.86% (rotational speed 60 rpm). The total energy required to product 10 to 11 kg/h was 176.38 kWh/ton with electric power source and by using human energy it was 33.24 kWh/ton. The total cost production 815.45 LE/ton.

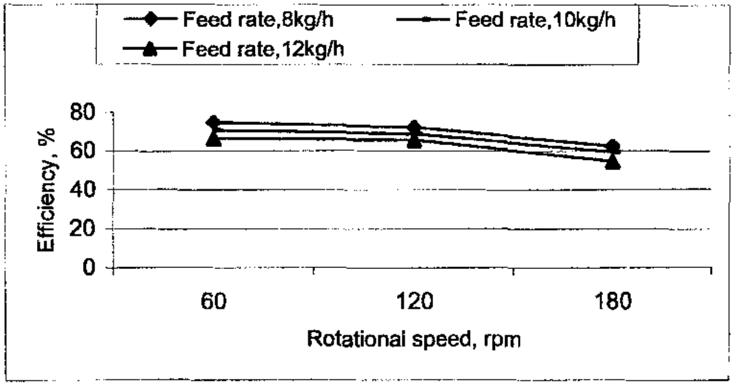

Fig. 11. The effect of drum rotational speed on machine efficiency

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تطويــر آلــة بسيطــة لحلــج القطــن المصــري للأغــراض البحثيــة

شرين فؤاد عبد الحميد محمد – سامي السعيد بدر – عاطف عزت اليماني

قسم ميكنة المحاصيل الحقلية والبستانية – معهد بحوث الهندسة الزراعية–

مركز البحوث الزراعية الدقي الجيزة – مصر

يعد محصول القطن من اهم المحاصيل الاستراتيجية للدخل القومي المصري فكان من أهم أولويات البحث العلمي ونظرا لبعد المعامل المركزية عن المحطات البحثية الاقليمية وإصابة نبات القطن بالعديد من الأفات خلال موسم النمو فيلجأ الباحثون لاستخدام المقاومة الحيوية للحفاظ على البيئة وتقليل التلوث كما يحاولون زيادة انتاجية الفدان باجراء معاملات مختلفة على النبات او التربة خلال موسم النمو.

و يهدف البحث إلى تطوير نظام آلى يمكن الباحث من سهولة اجراء عملية الحلج داخل المعمل وامكانية فصل البذور عن القطن الزهر بسهولة وباقل تلف ممكن للبذرة والتيلة وبالتالى امكانية اجراء اى اختبارات معملية على البذرة او التيلة نتيجة تعرضها لاى معاملة اثناء موسم الزراعة.

وكانت عوامل الدراسة

- وزن الحدافة ١٠،٨،٦،٤ كجم
- الخلوص بين الدرفلين ٣،٢،١ مم
- سرعة الدرفيل (rpm٦٠،١٢٠،١٨٠)
- زاوية ميل الدرفيلين على المستوى الافقى ٥، ٢٠،١٥،١٠ درجة
- معدل التلقيم ٣،٢،١ كجم باستخدام مصدر قدرة يدوى.
- معدل التلقيم ١٢،١٠،٨ كجم باستخدام مصدر قدرة كهربى.

وذلك للحصول على اقل تلف للبذرة والتيلة او مرورالبذرة مع التيلة بدون فصل.

عوامل التقييم

- النسبة المئوية لتلف البذور.
- اختبار جودة الألياف بعد عملية الحلج وتتضمن النسبة بين الشعيرات الطويلة والقصيرة، الاستطالة، المتانة، الصلابة.
- النسب المئوية لمعدلات سقوط البذرور ومعدلات سقوط القطن الزهربدون حلج لتحديد افضل زاوية ميل للدرافيل على المستوى الافقى.
- الطاقة المستهلكة - معدل الانتاجية - الكفاءة- التكاليف.

وقد بينت الدراسة ما يلى

١- بزيادة الخلوص بين الدرافيل يزداد تلف البذور او فقدها بمعدل ٢٢,٤% ايضا بذيادة معدل التلقيم يذداد تلف البذرة بمعدل ٢٧,٥%.

٢- افضل سرعة دورانية وخلوص للدرافيل لتعطى اقل تلف للبذرة وعدم تركها بدون فصل كانت ٦٠ لفة/دقيقة، ٢مم.

٣- وأفضل وزن للحدافة ٨ كجم.

٤- افضل معدل تلقيم يدوى وآلى كان ٢ ، ١٠ كجم على التوالى.