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DESIGNING NEW SEED-COTTON FEEDER FOR RECIPROCATING-KNIFE GINSTAND

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ABSTRACT

A new designed extractor-feeder machine was built to replace both the inefficient belt and cylinder methods that are in use in feeding the ginstands with seed cotton. The seed cottons of seven varieties were fed by the new machine to the ginstand at different speeds (0.6, 0.7, 0.8, 0.9, and 1.0 rpm). The results obtained show that fixing the speed of the extractor feeder at 0.7 rpm (0.0022 m/s), resulted in increasing the ginstand capacity to about 35 %, 42.27 % and 68.5% higher than manual feeding, the cylinder and the belt methods, respectively. Meanwhile, this speed decreased the ginning time and non-lint content and improved the lint grade and fiber brightness. The extractor feeder machine did not affect the ginning outturn, fiber length parameters, fiber elongation, fiber strength, micronaire reading or seed cracking. Applying the new-design machine at 0.7 rpm speed to feed the reciprocating knife ginstand with seed cotton resulted in a satisfactory cotton ginning efficiency.

The results show that the inclined collection plates must have an angle greater than 48° in order to assure sliding of all varieties of seed cotton.

The ginstand capacity for all varieties at 0.7 rpm feeder speed was found to be a function of the 2.5% fiber span length, grade index, and ginning outturn. The following equation adequately describes this relationship:

$$P = -94916.5\ x_1^{-2.4} - 0.4\ x_2 - 0.9\ x_3^2 + 72.4\ x_3 - 1344.7$$

where: P : ginstand capacity (P_{mx}) in kg/h,

x_1 : 2.5% fiber span length (mm),

x_2 : grade index, and

x_3 : ginning outturn (%).

INTRODUCTION

The primary function of the feeder is to feed seed cotton to the ginstand uniformly at controllable rates (Bennett,1962). In USA, a lot of modifications for the ginstand feeders took place, in order to promote the feeder function to extract, clean and single lock the seed cotton directly before feeding it into the ginstand (Baker et al., 1994). Hand feeding gave the best ginning efficiency as compared to the belt or the cylinder methods used in the Egyptian ginnery at present (Eweida, 1997). Thus,

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this investigation was carried out to introduce a new efficient ginstand feeder with extracting capabilities.

The particular objectives of this study included investigation of the relevant factors as follows:

1- The optimum feed rate.
2- Optimum method for increasing the ginstand capacity.
3- Efficiency of cleaning and extracting the foreign matter embeded in the seed cotton.
4- The optimum speed of the drums.
5- The effect of feeding performance on the ginning efficiency and fiber and seed qualities.

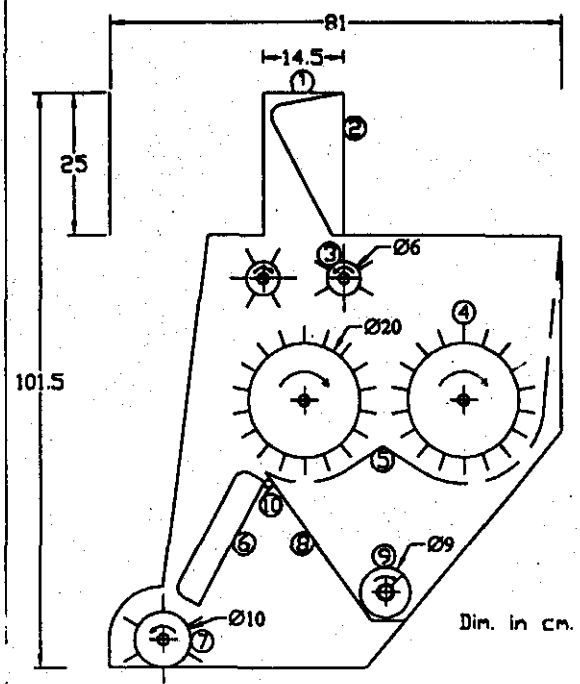
killough et al. (1930) concluded that cleaners, in general, improved the grade of seed cotton and had no appreciable effect on the staple length of the lint or the time required for ginning; but in most cases they slightly reduced the lint turnout. **Garner and Baker (1977)** reported that cleaning improved the ginstand efficiency by presenting cotton to it in small, uniform units (Baker et al., 1995). **Hossam El-Din (1978)** found that the feeding rate of seed cotton to ginstand significantly affected the ginning capacity, ginning time,lint grade, non-lint content, and lint color (Rd %) for Ashmuni variety. The highest value of fiber strength was obtained with low levels of feeding rate.**Youssef et al. (1978)** found that fast gin feeding rates decreased lint grade. **Eweida (1997)** found that feeding the ginstand with seed cotton by hand exhibited the highest ginstand capacity, and cracked seeds as compared to the belt or the cylinder method. Also, he mentioned that no significant differences were found in lint grade, lint color, fiber length parameters, non-lint content or micronaire reading due to the effect of the feeding method to the ginstand with seed cotton.

MATERIALS AND METHODS

An extractor–feeder was constructed at a private workshop in the Sharkeia Gov.. The view of the extractor – feeder is shown in fig.(1). The extractor – feeder had the following dimensions: effective length is 96 cm, width is 81 cm. and height is 104.5 cm.

A slide surface protractor was fabricated to measure the least angle of seed cotton sliding. Four cotton varieties, namely: Giza 70, Giza 76, Giza 86 and Giza 80 were involved in the study. For each cotton variety, a bulk sample of 0.25 kg of seed cotton with 10 replications was used to determine its slide angle. For measuring the angle of repose (internal friction) seed cotton was made to fill two rings (20 cm dia. X 5 cm thick.).The lower one was fixed to the inclined surface, while the upper was allowed to topple sliding when inclination is increased gradually.

The reciprocating knife ginstand of McCarthy, 40 inch roller-gin was used.



1-Seed cotton inlet.
2-Hopper.
3-Feed roll-driver.
4-Spiked cleaning cylinder.
5-Concave screen.
6-Feeder apron assembly.
7-Feeder discharge-cylinder.
8-Screw-conveyor trough.
9-Screw-conveyor.
10-Door hinge bolt.

Fig.(1): Cross-section of designed feeder.

The seed cotton of seven varieties was used in the current study, namely: Giza 80, 83, 85, 86, 88, 89, and 90. All the seed cotton bulk samples were obtained from Cotton Research Institute (CRI), Agriculture Research Center (ARC), Ministry of Agric..

Five extractor feeder speeds (0.6, 0.7, 0.8, 0.9, and 1.0 rpm, 6 cm dia., 0.00188, 0.0022, 0.00251, 0.00283, and 0.00314 m/s) were tested. Also, a control treatment (hand feeding) was done.

The ginning processes were carried out in the Cotton Ginning Research Division (CGRD), CRI, ARC. A bulk sample for each seed-cotton variety was taken at random and elaborately mixed. For each treatment. Three replications each of 5 kg of seed cotton were fed to the ginstand during ginning, the ginning time of each sample was measured by a stop watch and the ginned lint was weighed. A representative sample of lint was taken at random from each ginned lint to test for the ginning efficiency, lint grade and fiber properties at the Cotton Technology Research Division (CTRD), CRI, ARC. All fiber properties were carried out under standard atmospheric conditions of (65 % ± 2) relative humidity and (70° F ±2, 21.1°C ±1) temperature degree.

The characteristics of ginning efficiency i. e. ginstand capacity, ginning outturn and ginning time were determined and calculated according to the following equations as proposed by Chapman and Stedronsky (1959)..

$$1 - \text{Ginstand capacity (kg/h)} = \frac{\text{lint mass (kg)}}{\text{ginning time (min)}} \times 60$$

$$2 - \text{Ginning outturn} = \frac{\text{lint mass (kg)}}{\text{seed-cotton mass (kg)}} \times 100 \quad (\%)$$

$$3 - \text{Ginning time (h/Metric kentar)} = \frac{\text{ginning time (min)}}{\text{seed-cotton mass (kg)}} \times 2.625$$

where: Metric kentar = 157.5 kg.

The lint grades were determined by qualified lint classers. Fiber-length parameters were measured by the digital " fibrograph " and the uniformity ratio and the floating fiber index were calculated from the values obtained according to the following formula proposed by Prakash (1962):

$$\text{- Uniformity Ratio} = \frac{\text{50 \% span length}}{\text{2.5 \% span length}} \times 100$$

$$\text{- Floating Fiber Index} = \left[\left(\frac{\text{2.5 \% (in.)}}{\text{2 (50 \% (in.) - 0.075)}} \right) - 1 \right] \times 100$$

A Q-basic program was designed for calculating U.R. % and F.F.I % and print the value of 50%, 2.5 %, U.R % and F.F.I (50 %) in a table.

A sample of 100 seeds, taken at random for each treatment, was examined and repeated six times in order to get the average of cracked seed for each treatment.

The differences between means were tested according to Duncan's new multiple range test (Duncan 1955). Q- basic programs were designed for statistical analysis.

Multiple linear-regression analyses were preformed to develop individual relationships between ginstand capacity and feeder speed for each sample, ginstand capacity, 2.5% fiber span length, grade index, and ginning outturn.

RESULTS AND DISCUSSION

Ginstand capacity:

The results of the ginstand capacity showed that feeding the ginstand with seed cotton at 0.7 rpm (0.0022 m/s) exhibited the highest ginstand capacity. However, as the feeder speed increased over (0.7rpm) the ginstand capacity gradually decreased as a result of shockage, and as the feeder speed decreased under this speed (0.7rpm) the ginstand capacity gradually decreased as a result of decreasing in feeding rate. This result was true for all cotton varieties. Thus, the highest values of ginstand capacity ranged from 38.2 to 60.4 kg/h for the different cotton varieties, the least being for Giza 80, all values were at feeder speed of o.oo22 m/s. The range was from 35.2 to 43.2 kg/h for hand feeding. However, using the feeder gave an increase in rate of about 35 % over hand feeding (fig. 2).

Ginning time:

The results of the ginning time showed that feeding the ginstand with seed cotton at 0.7 rpm (0.0022 m/s) exhibited the lowest ginning time. However, as the feeder speed increased over or decreased under this speed, the ginning time gradually increased. The highest values were obtained when the seed cottons were hand fed (fig. 3).

Grade index and non-lint content:

The results of grade index showed no significant differences between the different speeds of the extractor feeder and hand feeding (control treatment), except in cases of feeding Giza 80 and Giza 90 seed cottons by hand, where the grade index decreased (fig.4-A). The results of non-lint content given showed no significant differences between the extractor feeder speeds and hand feeding except in cases of feeding Giza 80 and Giza 90 seed cottons by hand, where the non-lint content increased (fig.4-B).

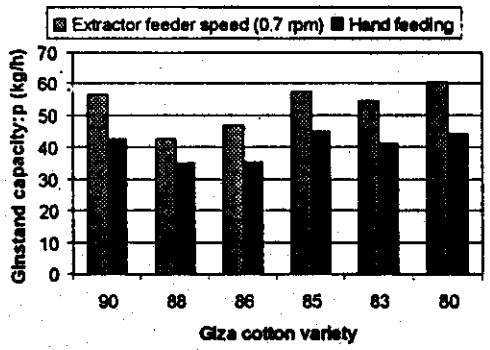


Fig.(2): Comparison between extractor feeder at speed (0.7rpm) and hand feeding in ginstand capacity for some Egyptian cotton varieties

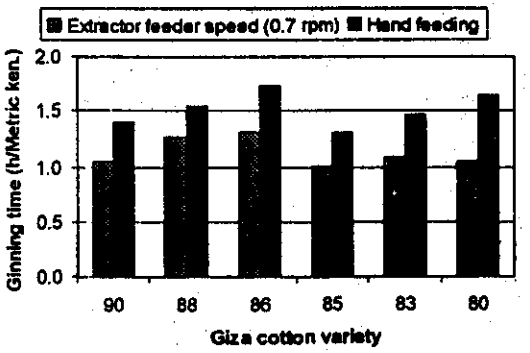


Fig.(3): Comparison between extractor feeder at speed (0.7rpm) and hand feeding in ginning time for some Egyptian cotton varieties.

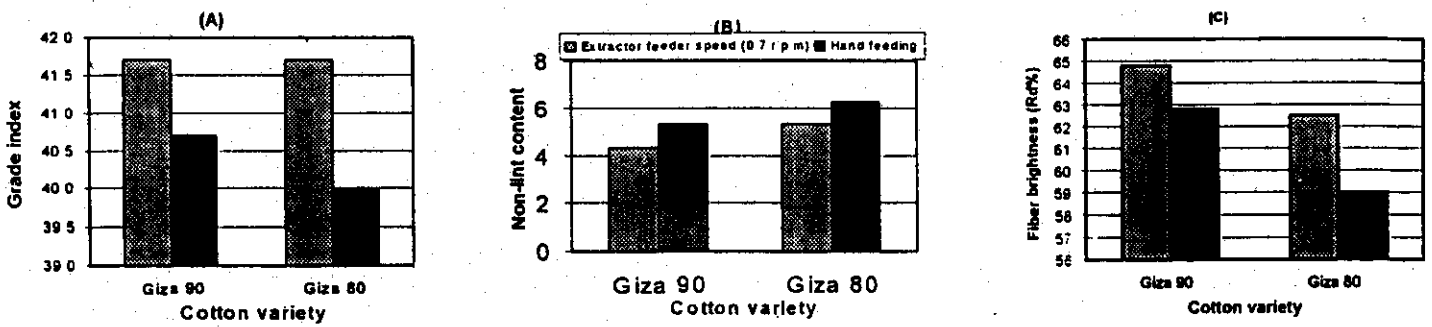


Fig.(4): Comparison between extractor feeder at speed (0.7rpm) and hand feeding in grade index, non-lint content, and fiber brightness for two Egyptian cotton varieties.

Fiber brightness:

The results of fiber brightness (Rd %) did not show any significant differences due to the effect of the speed of the extractor feeder, except the increases in fiber brightness of Giza 80 and Giza 90 varieties due to getting rid of a considerable proportion of foreign matter mixed with fibers. That led to decreased non-lint content and improving the grade and the fiber brightness. While foreign matter remaining mixed with the seed cotton, as in case of hand feeding, resulted in decreasing the fiber brightness (fig.4-C).

Ginning outturn, percentage of cracked seed, fiber yellowness, length parameters, strength, micronaire reading and fiber elongation:

The results of ginning outturn, percentage of cracked seed, fiber yellowness, fiber-length parameters (2.5% and 50% fiber span lengths, fiber uniformity ratio, and floating fiber index), fiber strength (determined by stelometer and pressley apparatuses), micronaire reading and fiber elongation as affected with feeding the ginstand with the seed cottons of seven varieties by the extractor feeder at different speeds did not show any significant differences due to different speeds of the extractor feeder.

Slide angle of seed cotton:

Table (1) shows slide angles of seed cotton. It is clear that the slide angle ranged from 40 to 48 degree. Giza 76 variety was the greatest as compared to other varieties involved in the study. The results show that the inclined collection plates must have angles greater than 48° in order to assure sliding of all varieties of seed cotton. The statistical analysis shows that deviations from the mean are highest in Giza 76. The lowest slide-angle was obtained by Giza 70 variety (the highest in fineness and the lowest in foreign matter). The results indicated that as the fineness of seed cotton increased, the slide angle decreased, while as the foreign matter increased, the slide angle increased. Fig. (5) shows the frequency curve, and fig. (6) shows the cumulative frequency.

Relationship between ginstand capacity, 2.5% fiber span length, grade index, and ginning outturn:

The ginstand capacity of each variety was found to be a function of the feeder speed (fig.7). The results indicated that:

1- There are differences between the varieties under study on the ginstand capacity due to the variations in staple length, ginning outturn, and grade.
2- Giza 80 gave the highest ginstand capacity because it has high ginning outturn, grade, and lowest in staple length.

The ginstand capacity for all varieties at 0.7 rpm (0.0022 m/s) feeder speed was found to be a function of the 2.5% fiber span length, grade, and ginning outturn (figs.8-9-10).

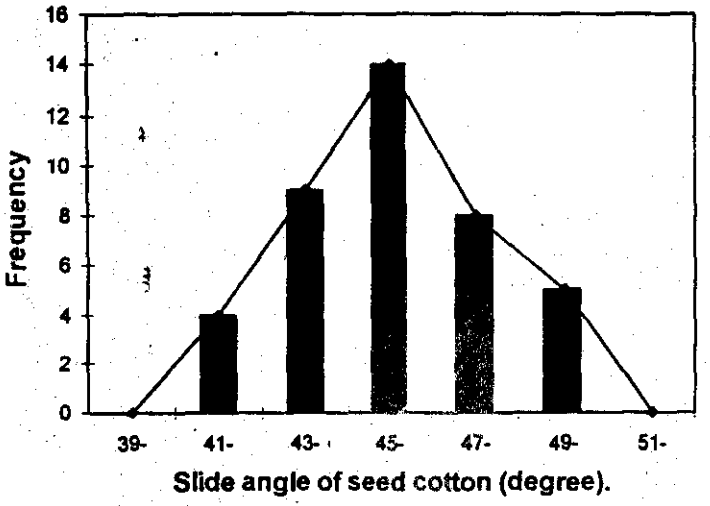


Fig.(5): The frequency histogram.

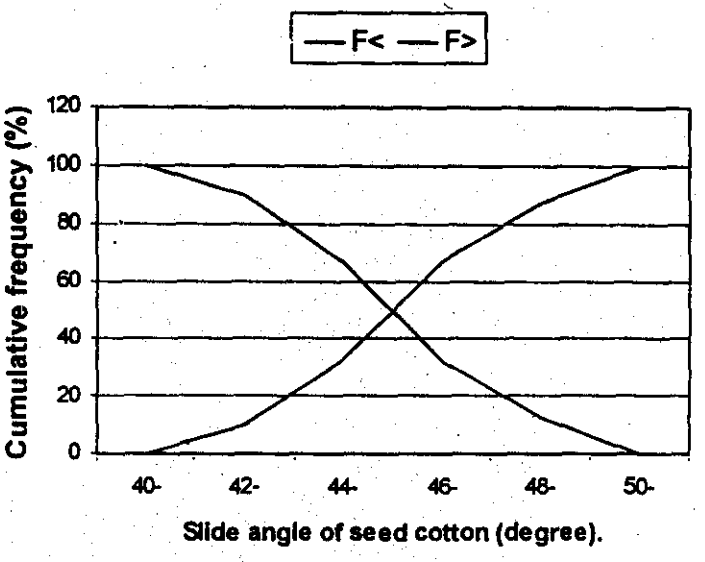


Fig.(6): The cumulative frequency.

Table 1: Slide angle of seed cotton varieties used in the present work.

Variety	Slide angle,degree			
	Range	Average	S.D.	C.V.
Giza 70	41-47	43.5	1.957	4.498
Giza 76	43-48	45.6	2.118	4.644
Giza 86	41-47	45.1	2.726	6.044
Giza 80	40-48	44.4	1.646	3.707

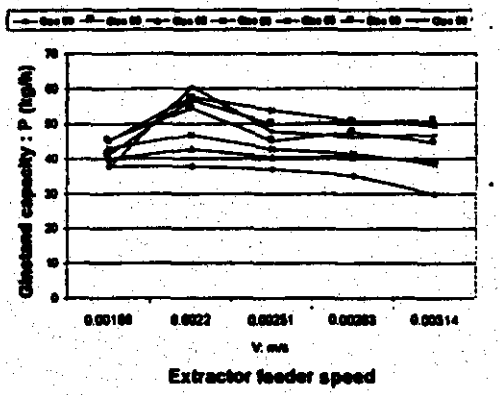


Fig.(7): Relationship between feeder speed and ginstand capacity for some Egyptian cotton varieties.

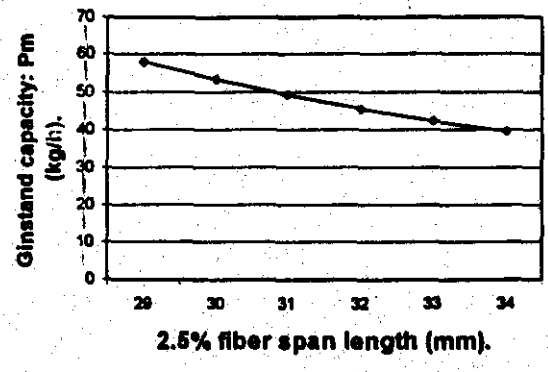


Fig.(8): Relationship between 2.5% fiber span length and ginstand capacity.

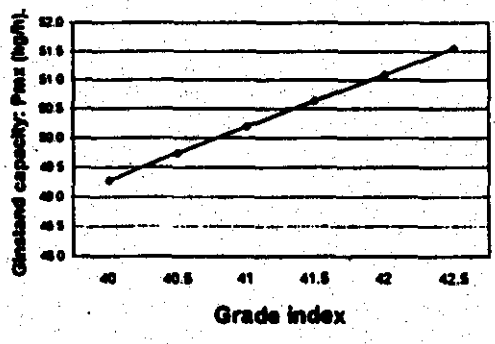


Fig.(9): Relationship between grade index and ginstand capacity.

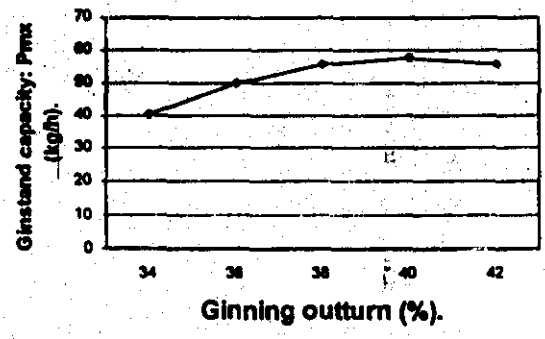


Fig.(10): Relationship between ginning outturn and ginstand capacity.

The scatter diagrams in Figs. (8-9-10) illustrated that as the 2.5% fiber span length increases, the ginstand capacity decreases. The latter factor tended to decrease less rapidly than increase in 2.5% fiber span length. When the grade index increased, the ginstand capacity increased. When the ginning outturn increased the ginstand capacity increased, to reach to its highest value at 40% ginning outturn. That is due to increase in the ability of roll in ginstand to catch locks of seed cotton. After that, the ginstand capacity decreased due to the increasing in ginning time as a result of increasing the ginning outturn. The following equation adequately describes the relationship between ginstand capacity (P in kg/h), 2.5% fiber span length (x_1 in mm), grade index (x_2), and ginning outturn (x_3 %):

$$P = -94916.5\, x_1^{-2.4} - 0.4\, x_2 - 0.9\, x_3^2 + 72.4\, x_3 - 1344.7$$

CONCLUSIONS

A new design extrator-feeder mechanism was developed for efficient ginstand. A slide swivel prototype was constructed to measure the angle between the horizontal base and the sliding surface of the seed cotton. Q-basic program was designed for calculating uniformity ratio (U.R. %) and floating fiber index (F.F.I %) and print values of 50 % and 2.5 % fiber span length, U.R. %, F.F.I (50 %). Statistical analysis, and multiple linear regression were preformed to develop individual relationships between ginstand capacity and feeder speed for all seed cotton varieties involved in this study, and ginstand capacity, and other factors.

The results obtained lead to the following conclusions:

1-Fixing the speed of the new designed extractor feeder at 0.7 rpm (0.0022 m/s) exhibited the best favorable results whatever was the cotton variety.

2-Using the extractor feeder at 0.7 rpm exhibited the lowest values of ginning time and non-lint content and the highest values of lint grade and fiber brightness.

3-The highest values of ginstand capacity ranged from 38.2 to 60.4 kg/h for the different cotton varieties, the least being for Giza 80, all values were at feeder speed of o.oo22 m/s. The range was from 35.2 to 43.2 kg/h for hand feeding.

4-The inclined collection plates must have angles greater than 48° in order to be sure that all varieties of seed cotton can slide over them.

5-The ginstand capacity (P in kg/h) for all varieties involved in this study at 0.7 rpm (0.002 m/s) feeder speed is a function of the 2.5% fiber span length (x_1 in mm), grade index (x_2), and ginning outturn (x_3 %). The following equation adequately describes this relationship:

$$P = -94916.5\, x_1^{-2.4} - 0.4\, x_2 - 0.9\, x_3^2 + 72.4\, x_3 - 1344.7$$

6-The new extractor feeder had no effect on the ginning outturn, fiber length parameters, elongation, cracked seeds, fiber yellowness, strength, and micronaire reading.

Thus, it could be concluded that using the new designed extractor feeder with the reciprocating knife ginstand of the Egyptian ginneries could give the best favourable characteristics at speed of 0.7 rpm (0.0022 m/s).

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الملخص العربى

تصميم مغذى قطن زهر جديد للحلاجة ترددية السكينة

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أجـرى هذا البحث لتصميم مغذى جديد للحلاجة ترددية السكينة أطلق علية أسم المغذى المستخلص Extractor-feeder ، يعمـل علـى فصـل المـواد الغريـبة ، وتفكيك كتل القطن الزهر إلى وحداتها من الفصوص ، بالأضافة إلى تغذية الحلاجة بالقطن.

صـممت بـرامج بلغـة البيسك لحساب وطباعة قيم طول تيلة ٢,٥% ، ٥٠% ، ونسبة الأنتظام ، ونسبة الشعيرات الطافية ، وكذلك لاجراء التحليل الأحصائى ، وتوفيق المنحنيات للعلاقة بين القدرة الأنتاجية للحلاجـة وسـرعة المغـذى ، وكذا القدرة الأنتاجية للحلاجة ، طول تيلة ٢,٥% ، ودليل الرتبة ، وصافى الحلج.

وقد أسفرت الدراسة عن النتائج التالية:

١- يجب أن تكون زاوية ميل أسطح تجميع القطن الزهر أكبر من ٤٨° للتأكد من أنزلاق القطن الزهر.

٢- أمكن بضبط سرعة المغذى على ٠,٧ لفة/ دقيقة الحصول على أفضل النتائج المرغوبة بالنسبة لجميع الأصناف تحت الدراسة.

٣- أدى ضبط سرعة المغذى على ٠,٧ لفة/ دقيقة (٠,٠٠٢٢ م/ث) إلى الحصول على أقل القيم بالنسبة لزمن الحلج ونسبة المواد الغريبة ، وأعلى القيم بالنسبة لرتبة التيلة ولون الشعر.

٤- تراوحت أعلى قيم لأنتاجية الحلاجة من ٣٨,٢ إلى ٦٠,٤ كج/س عند سرعه المغذى ٠,٠٠٢٢ م/ث لأصناف القطن المختلفة ، وكان أقلها لصنف جيزة ٨٩ ، وأعلاها لصنف جيزة ٨٠. تراوحت أنتاجية الحلاجة من ٣٥,٢ إلى ٤٣,٢ كج/س عند التغذية اليدوية.

٥- أرتفعت القدرة الأنتاجية للحلاجة بمايزيد على ٤٢% بالمقارنة بطريقة الدرفيل ، و٦٨% بطريقة السير ، و ٣٥ % عن الطريقة اليدوية.

٦- ربطت أنتاجية الحلاجة (P - kg/h) عند ٠,٧ لفة/ دقيقة لكل الأصناف المستخدمة فى هذة الدراسة بعلاقة مع طول تيلة ٢,٥% (x_1 - mm) ، ودليل الرتبة (x_2) ، وصافى الحلج (% - x_3) ، على الهيئة التالية:

$$P = -94916.5\ x_1^{-2.4} - 0.4\ x_2 - 0.9\ x_3^2 + 72.4\ x_3 - 1344.7$$

٧- لم يؤد أستخدام المغذى الجديد إلى التأثير على أى من صفات صافى الحلج وقياسات طول التيلة ومتانتها ودرجة الأستطالة وقراءة الميكرونير ونسبة البذور المكسورة.

لهذا يمكن القول أنه بأستخدام المغذى الجديد بعد ضبطه على سرعة التغذية ٠,٧ لفة/ د زادت القدرة الأنتاجية للحلاجة بنسبة ٣٥% عن التغذية اليدوية ، بالأضافة إلى تحسن بعض صفات الحلج الهامة.

١- أستاذ الهندسة الزراعية المتفرغ - كلية الزراعة - جامعة عين شمس.
٢- أستاذ الحلج المتفرغ - قسم بحوث حلج القطن - معهد بحوث القطن - مركز البحوث الزراعية.
٣- مدرس الهندسة الزراعية - كلية الزراعة - جامعة عين شمس.
٤-باحث مساعد - قسم بحوث حلج القطن - معهد بحوث القطن - مركز البحوث الزراعية.