Impact of Roller Gin Type and Seed-Cotton Level on Ginning Efficiency and Fiber Properties

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Received on:6/3/2010 *Accepted:12/4/2010*

ABSTRACT

This study was carried out at Plant Production Department, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt, during 2008/2009 season to compare three different roller ginning stands with five seed-cotton levels and investigate their effect on ginning efficiency, lint grade and fiber properties. Five seed-cotton levels; namely, Good to Fully Good (G/FG), G + ¼, Good (G), G – ¼ and Fully Good Fair to Good (FGF/G) were used, belonged to one commercial Egyptian extra long staple cotton variety; namely, Giza 88. Three roller ginning stands were used in this study; i.e., McCarthy, Turkey single roller and Indian double roller. The obtained results clarified that the Indian double roller gin stand surpassed the other two gin stands and gave the highest gin stand capacity (kg/inch/hr), ginning out-turn (%) and lint grade. Concerning fiber properties, Indian double roller gin stand produced the lowest values of fiber elongation, maturity, reflectance degree percentages, degree of yellowness, uniformity index and the shortest mean length fibers.

Likewise, the highest mean values of gin stand capacity, ginning out-turn, lint grade, micronaire value, fiber elongation (%) and reflectance degree (Rd %) were obtained from the highest seed-cotton level, Good to Fully Good (G/FG).

Key words: seed-cotton level; double and single roller gin; fiber properties.

INTRODUCTION

Cotton is a natural fiber used primarily as a raw material for textiles. Cotton's strength, absorbency and capability to wash and dye make it the fiber king adaptable to a considerable variety of textile products. Egyptian cotton, despite of the up and down of the cultivated area, will continue its leadership role as the best natural fiber of choice around the world.

Ginning is the first important process, to which cotton is subjected on its way from the field to the textile mill, before it is spun into yarn and converted into fabrics. The gin stand is the heart of the ginning plant (Wright and Moore, 1977).

In Egypt, cultivated cotton varieties are long (LS) Giza 86 and Giza 90 and extra long staple (ELS) Giza 45 and Giza 88 cottons, so that it must be ginned by the roller gin stands.

Ginning in Egypt is 100% roller. The average age of the gin plants is 100 years. Most were installed in 1905. There are 64 gins in Egypt. In the early sixties, these gins were nationalized by the government, which consolidated the 64 gins into five national companies; namely, Arabia, Misr, Delta, Nile and Al Wadi Ginning companies.

The main objective of the ginning processes is separating fibers from seeds, and the perfect ginning operation would be performed with or without the slightest injury to either seed fiber.

Roller ginning produces a superior fiber with fewer raw-fiber neps and less fiber breakage (Hughs and Lalor, 1989). Roller ginned fiber, also, has excellent spinning potential. Roller gins are used primarily for ginning extra long staple cotton (Baker and Griffin, 1984). The roller gin uses a laminated canvas/rubber roller with a fixed and a reciprocating knife, to pinch and pull fibers from the seed (Alberson and Stredonsky, 1964). Roller ginned cotton, generally, has more dust, longer mean length, less short fiber and fewer neps than saw ginned cotton Cocke *et al.*,(1977a and b). Saw ginning is a more efficient method for short staple, fuzzy seed cultivars than roller ginning. The increased opening action of saw ginning allows less trash to be retained, but increases short fiber content and neps (Kveton, 1986).

The cotton roller ginning process is defined as the mechanical separation of cotton fibers from their seeds by means of one or more rollers, to which fibers adhere, while, the seeds are impeded and struck off or pulled loose. The roller is the major component of Double Roller (DR) gin. The gin roller length varies from 1025 to 1148 mm with a diameter varying from 178 to 180 mm suitable for operation. The roller consists of 78 to 80 washer disks, each washer disk is 180 mm in diameter and 1 mm thick and has 18 Chrome Composite Leather-Clad (CCLC) flaps stitched and bonded together (Gurdeep and Lyer, 2004). HVI color grade, staple length, uniformity and fiber value were improved when using the roller gin stands. Roller ginning improved fiber length, length uniformity and nep count, when compared to saw ginning, (Hughs and Lalor, 1990). (Armijo and Gillum 2007) showed that roller ginning upland cotton, when compared to

saw ginning, produced upland fiber that was more than one staple length longer, had fewer short fiber and neps and higher turn-out. (Armijo and Gillum 2009) found that the grade, length and value of fiber from the roller gin stands were better than fiber from the saw gin stands

The gin stand capacity and lint grades are more affected by the roller gin types. Recently, in Egypt, the ginning companies use different types of roller gin stands.

The objective of this study was to investigate the effect of the roller gin stand and seed-cotton levels on ginning efficiency, lint grades and fiber properties of Egyptian cotton variety, Giza 88.

MATERIALS AND METHODS

The type of roller gin stand is very important in Egyptian ginning industry because it is more effective on gin stand capacity, fiber properties and lint grades Therefore, the main goals of this research was to investigate the effect of kind of the roller gin stand and seed-cotton levels on ginning efficiency, lint grades and fiber properties of the extra long Egyptian cotton variety, Giza 88.

This study was carried out at Plant Production Department, Faculty of Agriculture (Saba Basha), Alexandria University, Egypt, during 2008/2009 season by using five seed-cotton levels, as follows: Good to Fully Good (G/FG), G + ¼, Good (G), G – ¼ and Fully Good Fair to Good (FGF/G) from one commercial Egyptian cotton variety; namely, Giza 88 as extra long staple (over 1 3/8 inch). A seed-cotton sample of 15 kilograms was drawn from each seed-cotton level, representing the original stock of the Arabia ginning Mill, Damanhour, Al-Beherah Governorate. Each sample was divided into three sub- samples (5 kilograms each) and ginned by three kinds of roller gins; i.e., the double roller gin (DR), a roll covered with the chrome composite leather-clad (CCLC), the conventional single roller gin (SR), a roll covered with natural leather (McCarthy roller gin) and single roller gin, covered with the chrome composite leather-clad (CCLC) Turkey Roller Gin.

Statistical procedures:

This work was conducted in a completely randomized design, with three replicates, and analyzed as a factorial experiment, according to the procedure of (Snedecor and Cochran 1967). The data was analyzed, using the SAS program. To estimate the significant differences among studied treatments, the least significant difference (L.S.D.) was calculated at 0.05 level of probability.

Studied characters:

1. Ginning efficiency parameters:

These parameters were calculated, according to the following equations, proposed by Chapman and (Stedronsky 1959):

1.1. Gin stand capacity (G.S.C.): as the lint weight in kg per inch per hour, as follows:

$$\text{Gin stand capacity (G.S.C)} = \frac{60 * \text{weight of ginned lint (kg)}}{\text{Time (min)} * \text{Length of roller (inch)}} = \text{(kg/inch/hr)}$$

1.2. Ginning time (G.T.):

$$\text{Ginning time (G.T.)} = \frac{\text{Ginning time (minute)} * 157.5}{\text{Seed-cotton weight (Kg)} * 60} = \text{(Kentar/hr)}$$

1.3. Ginning out-turn (G.O.T.): as a percentage, as follows:

$$\text{Ginning out-turn (G.O.T.)} = \frac{\text{Lint weight (kg)}}{\text{Seed-cotton weight (kg)}} * 100 = (\%)$$

2. Lint grade:

was determined by a three export classers, at (CATGO), Alexandria.

For statistical analysis, the grades were converted to code numbers, as shown in the following Table (Sallouma, 1970):

3. Fiber properties by H.V.I. :

The High Volume Instrument (HVI) premier HFT 9000 system that was used to determine the fiber properties, according the U.S.D.A. mode at the laboratory of the Modern Nile Cotton Company, Alexandria, Egypt. Samples were preconditioned for 24 hours, at least under the standard conditions of 65% ± 2% relative humidity and 20 ± 1 °C temperature before testing.

RESULTE AND DISCUSSION

1. Ginning efficiency parameters:

1.1. Gin Stand Capacity (kg/inch/hr):

With regard to data, shown in Table (1), it could be noticed that there were significant differences among the three gin stands in this trait. The highest mean value of gin stand capacity (1.28 kg/inch/hr) was recorded by the Indian double roller gin stand. On the other side, the lowest mean value (0.85 kg/inch/hr) was obtained by the McCarthy roller gin stand. These results could be attributed to the double ginning zone in the Indian double roller gin stand in the separate more cotton fibers from cotton seeds.

Grade	Abbreviation	Code
Fully good	FG	33
Good/fully good	G/FG	29
Good	G	25
Fully good fair/good	FGF/G	21
Fully good fair	FGF	17
Good fair/fully good fair	GF/FGF	13
Good fair	GF	9
Fully fair/good fair	FF/GF	5
Fully fair	FF	1

$^{1}/_{16}$ grade is represented by one mark.

For the seed-cotton level effect, it was obvious that, when the seed-cotton levels increased, the gin stand capacity would increase and vise versa. The highest gin stand capacity (1.23 and 1.20 kg/inch/hr) were recorded from the highest seed-cotton levels (G/FG and G + ¼), respectively .On the other hand, the lowest mean value of the same character (0.84 kg/inch/hr) was obtained from the lowest seed-cotton level (FGF/G). These results could be explained on the basis that the high seed-cotton level contained a high percentage of healthy fluffy locks and a low percentage of dust, trash and infected locks and vise versa.

1.2 Ginning time (kentar/hr):

Concerning data shown in Table (1), it could be concluded that the lowest ginning time per kentar (1.18 hr/kentar) was recorded by using the double roller Indian gin stand, and the highest mean value of the same character (1.75 hr/kentar) was recorded by using the McCarthy gin stand.

The lowest seed-cotton level (FGF/G) recorded the highest mean value of ginning time per kentar (1.72 hr/kentar), compared with the other seed-cotton levels studied. These results might be due to the fluffy untwisted locks of the high level, compared with the compact locks and high trash content in the low seed-cotton level.

1.3. Ginning Out-turn (%):

Data in Table (1) showed significant differences were noticed in the ginning out-turn due to gin stand type. However, insignificant difference was noticed between the McCarthy and Indian gin stand in this property. Meanwhile, the highest mean values (37.32 % and 37.24 %) were obtained, using the McCarthy and Indian gin stand types.

Furthermore, data presented in the same table revealed that the ginning out-turn was significantly affected by seed-cotton levels. It could be concluded that the ginning out-turn, correspondingly, decreased as the seed-cotton level decreased. It is obvious that the best ginning out-turn (37.91%) was recorded by using the highest seed-cotton level, Good to Fully Good (G/FG).

A highly significant interaction was found between gin stand type (A) and seed-cotton level (B) for gin stand capacity, ginning time and ginning out-turn and was insignificant for lint grade.

2. Lint Grade:

It could be noticed from Table (1) that the lint grade was significantly increased, using the Indian double roller gin stand, followed by the McCarthy and Turkey gin type.

These results could be due to the double seed grid in the Indian double roller gin stand, which separated the most trash content from seed-cotton before ginning.

Generally, it could be noticed that lint grade was considerably decreased by decreasing the seed-cotton level. It is obvious that the best lint grade (31.05) was obtained from ginning the highest seed-cotton level, Good to Fully Good (G/FG).

3. Interaction effect:

The interactions between gin stand type (A) and seed-cotton level (B), for the studied traits, were shown in Table (3).

The highest mean values of the gin stand capacity (1.53 and 1.46 kg/inch/hr) were recorded by the highest seed-cotton levels (G/FG) and (G + ¼), respectively, when ginned by the Indian gin stand. Meanwhile, the lowest mean values (0.77, 0.76 and 0.74) were obtained from the medium and lowest seed-cotton levels (G), (G – ¼) and FGF/G, respectively, ginned at the McCarthy gin stand.

Table 1: Effect of gin type and seed-cotton level and their interaction on gin stand capacity, ginning time, ginning out-turn and lint grade

Treatments	Gin stand capacity (kg/inch/hr)	Ginning time (Kentar/hr)	Ginning out-turn (%)	Lint grade
Gin Stand Types (A)				
McCarthy (SR)	0.85 c	1.75 a	37.32 a	25.96 ab
Turkey (SR)	1.05 b	1.37 b	36.30 b	25.76 b
Indian (DR)	1.28 a	1.18 c	37.24 a	26.43 a
L.S.D. (0.05)	**0.05**	**0.07**	**0.43**	**0.64**
Seed-cotton Levels (B)				
G/FG	1.23 a	1.24 c	37.91 a	31.05 a
G+1/4	1.20 a	1.25 c	36.95 b	27.66 b
G	0.97 c	1.51 b	36.54 b	26.44 c
G-1/4	1.06 b	1.44 b	36.59 b	23.44 d
FGF/G	0.84 d	1.72 a	36.78 b	21.66 e
L.S.D. (0.05)	**0.06**	**0.09**	**0.55**	**0.82**
Interaction				
A * B	**	**	**	NS

N.S. Not significant.
** Significant at 0.01 level of probability.
Mean values designated by the same letter are not significantly different.

Table 2a: Effect of gin type and seed-cotton level and their interaction on fiber properties by H.V.I Instrument

Treatments	UHML (mm)	Mean length (mm)	Uniformity index (%)	Micronaire value	Fiber strength (g/tex)
Gin Stand Types (A)					
McCarthy (SR)	35.53 a	30.58 a	86.06 a	3.78 a	45.92 a
Turkey (SR)	35.27 a	30.00 b	85.15 ab	3.76 a	44.85 a
Indian (DR)	35.24 a	29.66 b	84.14 b	3.65 a	45.40 a
L.S.D. (0.05)	**NS**	**0.47**	**1.54**	**NS**	**NS**
Seed-cotton Levels (B)					
G/FG	35.24 ab	29.91 bc	84.86 ab	4.05 a	45.87 a
G+1/4	35.56 a	30.36 ab	85.47 ab	4.04 a	45.61 a
G	35.02 b	29.50 c	84.22 b	3.64 b	45.21 a
G-1/4	35.27 ab	29.85 bc	84.65 ab	3.47 b	45.07 a
FGF/G	35.64 a	30.78 a	86.37 a	3.44 b	45.20 a
L.S.D. (0.05)	**0.4**	**0.61**	**1.99**	**0.19**	**NS**
Interaction					
A * B	NS	NS	NS	NS	NS

N.S. Not significant.
Mean values designated by the same letter are not significantly different.

Table 2b: Effect of gin type and seed-cotton level and their interaction on fiber properties by H.V.I Instrument

Treatments	Fiber elongation (%)	Maturity (%)	Rd (%)	+ b	Short fiber (w)
Gin Stand Types (A)					
McCarthy (SR)	6.25 a	85 a	67.71 a	11.50 a	4.54 b
Turkey (SR)	6.22 a	86 a	67.70 a	11.66 a	4.98 a
Indian (DR)	5.95 b	83 b	67.22 b	11.23 b	5.25 a
L.S.D. (0.05)	**0.13**	**0.01**	**0.19**	**0.17**	**0.36**
Seed-cotton Levels (B)					
G/FG	6.27 a	86 a	67.81 a	11.31 b	5.04 ab
G+1/4	6.24 a	87 a	67.40 b	11.35 b	4.73 bc
G	6.01 b	84 b	67.61 ab	11.51 ab	5.37 a
G-1/4	6.00 b	83 b	67.50 b	11.70 a	5.10 ab
FGF/G	6.18 a	83 b	67.41 b	11.44 b	4.38 c
L.S.D. (0.05)	**0.16**	**1**	**0.25**	**0.21**	**0.46**
Interaction					
A * B	NS	NS	*	NS	NS

N.S. Not significant.
* Significant at 0.05 level of probability
Mean values designated by the same letter are not significantly different.

Looking forward to data in the same table, it could be stated that the longest ginning times (1.98, 1.92 and 1.88 kantar/hr) were attained from the lowest and medium seed-cotton levels (FGF/G, G – ¼ and G), respectively, ginned by McCarthy gin stand. However, the lowest mean values of ginning time (0.96, 1.00 and 1.09 kantar/hr) were attained by the highest seed-cotton levels (G/FG), G + ¼ and G – ¼, respectively, ginned at the Indian gin stand.

Generally, the highest gin stand capacity kg/inch/hr was considered a resultant of the highest seed-cotton level and the lowest ginning time.

It is worthy to mention that the greatest mean value for ginning out-turn resulted from the highest seed-cotton level (G/FG) ginned at any of the three gin stand types, beside the lowest levels (FGF/G) with McCarthy and Indian types and G level, ginned by Indian gin type. On the other hand, the lowest mean values, 35.28, 36.23 and 35.29 % for the same character, were obtained by ginning the seed-cotton level (FGF/G, G – ¼ and G, respectively, at Turkey gin stand.

Concerning data shown in Table (3), it could be noticed that the highest mean values for reflectance degree, Rd % (68.43 and 68.00%), were recorded by

Table 3: Effect of interaction between gin type (A) and seed-cotton level (B) on some fiber properties by H.V.I Instrument

Treatments		Gin stand capacity (kg/inch/hr)	Ginning time (Kantar/hr)	Ginning out-turn (%)	Rd (%)
Gin stand types (A)	Seed-cotton levels (B)				
McCarthy (SR)	G/FG	1.04	1.43	38.06	68.43
	G+1/4	0.95	1.53	37.26	67.40
	G	0.77	1.88	36.92	67.53
	G-1/4	0.76	1.92	36.79	67.60
	FGF/G	0.74	1.98	37.56	67.60
Turkey (SR)	G/FG	1.12	1.34	38.22	67.66
	G+1/4	1.17	1.21	36.46	67.70
	G	1.01	1.37	35.29	68.00
	G-1/4	1.09	1.30	36.23	67.60
	FGF/G	0.86	1.60	35.28	67.53
Indian (DR)	G/FG	1.53	0.96	37.45	67.33
	G+1/4	1.46	1.00	37.14	67.10
	G	1.13	1.29	37.40	67.30
	G-1/4	1.33	1.09	36.75	67.30
	FGF/G	0.93	1.59	37.49	67.10
L.S.D. (0.05)		0.11	0.16	0.96	0.44

The three studied types of roller gins are shown in Figures (1, 2 and 3) as follows:

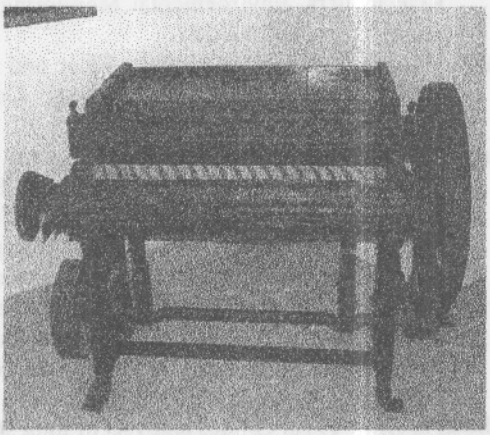

Fig. 1: McCarthy roller gin (SR)

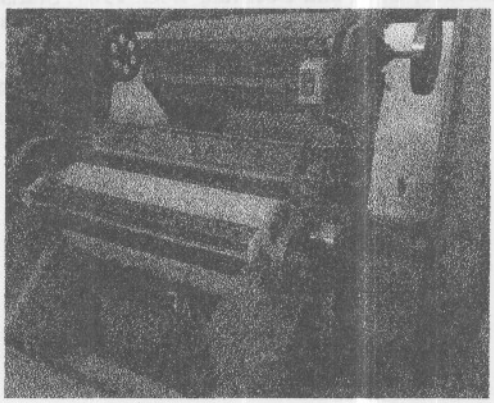

Fig. 2: Turkey roller gin (SR)

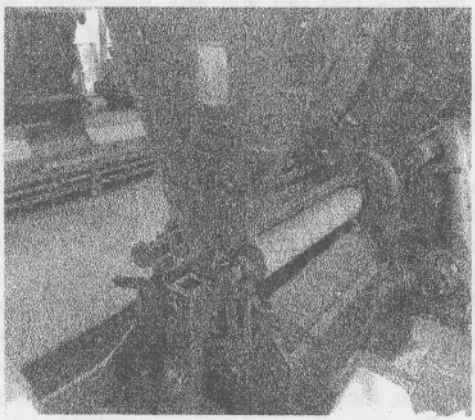

Fig. 3: Indian double roller gin (DR)

using the highest seed-cotton level (G/FG), ginned at McCarthy gin type and Good level, ginned by Turkey gin type. Otherwise, the smallest mean values were obtained from the lowest seed-cotton level (FGF/G), ginned at the Indian gin stand, G and G + ¼ ginned by McCarthy, and any seed-cotton types ginned with the Indian type. These results could be explained on the basis that, as the seed-cotton level increased, the maturity of seed-cotton locks and cotton fibers increased and, also, the non-lint content; i.e., tight locks and trash decreased and gave the highest degree of fiber lightness and vise versa.

4. Fiber properties by H.V.I. *Instrument*:

Regarding Table (2a), no significant differences were noticed due to the gin stand type, concerning the Upper Half Mean Length (U.H.M.L.), Micronaire reading and fiber bundle strength (g/tex). However, the McCarthy gin type recorded

the highest mean values (30.58 mm and 86.06 %) for the fiber mean length and uniformity index, respectively.

It is worthy to mention that the highest mean values (35.64 mm, 30.78 mm and 86.37 %) for Upper Half Mean Length (U.H.M.L.), mean length and uniformity index, respectively, were obtained when, the lowest seed-cotton level Fully Good Fair to Good (FGF/G), were ginned Meanwhile, the lowest mean values for the same traits were recorded when the seed-cotton level, Good (G), was ginned. These results might be due to the increase of amount of trash (non-lint content) as a factor to determine the seed-cotton level and it would be removed after ginning process, compared with other factors for determining the seed-cotton level.

Also, the highest mean values of micronaire reading (4.05 and 4.04), respectively, were attained when the highest seed-cotton level, Good to Fully Good (G/FG) and Good, were ginned. This result could be due to the increasing of fiber maturity for high seed-cotton levels.

Both McCarthy and Turkey gin stands produced the highest fiber elongation (6.25 and 6.22 %), maturity (%) (85 and 86), reflectance degree (67.71 and 67.70 %) and degree of yellowness (11.50 and 11.66), respectively. On the other hand, Turkey and Indian gin stands produced the heaviest short fiber weight (4.98 and 5.25), respectively.

With respect to the seed-cotton level effect, data in Table (2 b) clarified that the highest mean values of fiber elongation (%), maturity (%) and reflectance degree (Rd %) were attained from the highest seed-cotton level, Good to Fully Good (G/FG). Whereas, the highest values for degree of yellowness (+b) and short fiber were the highest from (G – ¼) and Good (G), respectively. Meanwhile, the lowest mean values for these traits, except for elongation (%), were recorded by ginning the lowest seed-cotton levels, Fully Good Fair to Good (FGF/G).These results could be due to high content of mature locks and fibers and low content of trash (non-lint content) and short fibers of the highest seed-cotton levels.

The interaction between the two studied factors (A x B), gin stand type and seed-cotton level, was insignificant for all H.V.I fiber properties, except for the fiber reflectance degree (Rd %), as shown in Table (2 b). The highest reflectance degree (68.43 and 68 %) was obtained from the highest seed-cotton level (G/FG), ginned by the conventional McCarthy, and G, ginned by Turkey gin stands.

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الملخص العربى

تأثير نوع الحلاجة الإسطوانية ومستوى القطن الزهر على كفاءة الحليج وخواص الألياف

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قسم الإنتاج النباتى – كلية الزراعة سابا باشا – جامعة الإسكندرية

أجريت هذه الدراسة بقسم الانتاج النباتى- كلية الزراعة – سابا باشا ، جامعة الإسكندرية – مصر ، فى موسم ٢٠٠٨/٢٠٠٩ لمقارنة ثلاثة أنواع مختلفة من الحليج الإسطوانى مع مستويات من القطن الزهر على كفاءة الحليج ورتبة القطن الشعر وخواص الألياف . استخدم خمسة مستويات من القطن الزهر، وهى: (جود/فولى جود و جود + ¼ وجود وجود – ¼ و فولى جود فير/جود) لصنف القطن "جيزة ٨٨ " طويل ممتازExtra Long . واستخدم ثلاثة أنواع من الحلاجات الإسطوانية وهى: (حلاجة مكارثى McCarthy Gin stand و الحلاجة ذات الشوبك التركى Turkey Gin stand والحلاجة الهندية مزدوجة الشوبك Indian Double Roller Gin stand). وتشير أهم النتائج المتحصل عليها إلى أن الحلاجة الهندية مزدوجة الشوبك تفوقت على النوعين الأخرين وأعطت أعلى إنتاجية (كجم/بوصة/ساعة) وأعلى تصافى للحليج (%) Ginning out-turn واحسن رتبة للشعر Lint grade . وبخصوص صفات الألياف، سجلت الحلاجة الهندية مزدوجة الشوبك اقل القيم من الإستطالة والنضج ونسبة إنعكاس الضوء (%) Rd ودرجة الإصفرار b+ ومعامل الإنتظامية (%) UI ومتوسط الطول للألياف.

وقد تم الحصول على أعلى النتائج أيضاً لكل من صفة إنتاجية الحلاجة وتصافى الحليج ورتبة الشعر وقراءة الميكرونير وإستطالة الألياف ونسبة انعكاس الضوء (%) Rd من اعلى مستوى قطن زهر (G/FG) Good to Fully Good .