

The Spin ability of Genetically Modified Acala Cotton Compared with Traditional Acala Cotton

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ABSTRACT

The present study aimed to determine the spinnability of genetically modified Bt cotton compared with the traditional cotton, Acala, (Hamid variety) under certain conditions. The procedure applied was to produce the most local commercial counts (8, 12, 16, 20, 26 and 30Ne) from the two types of cotton on rotor open end spinning machine. The machine was adjusted to the same technical variables which parallel the commercial production settings for both types of cotton. The spinning machine was fed with slivers after the second passage of drawing with the

Linear density (0.1Ne) for the two types of cotton. The feed speed, delivery speed and the draft were changed with the count change. Laboratory tests and data analysis to the produced yarns have been performed. The change in yarn properties with progressive change in count has been reported. Analysis of the results for the Bt cotton and Acala cotton showed that the difference between the two types of yarns strength, R.K.M, was not significant in all the produced counts except count (8Ne) in which the Acala yarns were better in strength. At the same time the Acala yarns elongation except count (30Ne) was significantly better than the Bt yarns elongation. Also the results showed that Bt cotton, can be operated successfully with the same manufacturing conditions as the Acala cotton. Count (30Ne) was the count limit for both types of cotton since the strength has dropped.

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INTRODUCTION

Genetically modified plants expressing *Bacillus thuringiensis* (Bt) is an insect-resistant transgenic crop designed to combat the bollworm. Bt cotton was created by genetically altering the cotton genome to express a microbial protein from the bacterium *Bacillus thuringiensis* (Kranthi, 2012). Cotton is a long duration crop and is attacked by large number of insect pests throughout its growth and development. In Sudan, cotton has been grown for centuries. The cotton plant is indigenous and a number of its wild relatives (members of the genus *Gossypium*) existed in various parts of the country. Commercial growing of the crop started in 1867. However, the big jump was in 1926, which marked the official start of functioning of the Gezira Scheme. Sudan cotton suffered mainly from low yields due to stickiness (Fadlalla, 1998). For this, people preferred new varieties of cotton so as to increase yield and improve quality to meet the recent demand of consumers (Abdelatif and Babiker, 2012). The Bt cotton was the new raw material in Sudan. In the year 2012 the area that were planted with Bt cotton by the Sudanese-Brazilian Partnership in Blue Nile was approximately 17,000 feddans and expected to rise up to 70,000 feddans next seasons (Sharief, 2012). For the textile industry the great challenge was the fiber quality properties. The effect of the different transgenic methods on fiber properties such as strength, length, fiber fineness, fiber maturity ratio, fiber uniformity and micronaire value, have been investigated by several research workers and compared it with the conventional cotton varieties fiber properties (Hagedorn, 1998) and (Shirong, 2004). It is clear that there is hardly any technology that can be 100% safe to everything, and since the introduction of Bt cotton a lot of attention was given to its advantages and disadvantages from an agricultural point of view, and little was reported from the industrial side in the discussions. There is little technical information about its performance in industry and its yarn properties. So in this study the aim is to focus on the new raw material, Bt cotton, and investigate its industrial behavior, in terms of yarn properties and compare it with one type of Sudanese conventional cotton, Acala, because of its similar fiber properties with Bt cotton.

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This is to provide technical information about the performance of the Bt cotton in industry and to define practically the spinnability of the newly introduced Bt cotton compared with the traditional Acala cotton. This is to give guide lines that may be needed in the Sudanese market.

MATERIALS AND METHODS

In order to conduct the experiment in real production conditions Sur Textile Factory in Hassahissa was the choice. In the present study, two types of fibers, Bt cotton (3.2 mic, 26.6 mm) and Acala cotton (Hamid variety) (4.2 mic, 26.7 mm) were used to produce yarns on open end spinning machine using Rieter machine type. The Bt cotton was supplied by the Sudanese Brazilian company which grew the Bt cotton as a commercial crop in Damazeen in season 2012. The traditional cotton, Acala, was supplied by the factory. The Bt cotton came in four lots which were all mixed in the blow room. The Acala cotton came in two lots. The different lots were sampled and tested for fiber properties in the laboratories of the Agricultural Research Corporation (ARC) and the fiber properties averages were used in machine settings calculations. The specifications of the cotton which were used in the study are shown in Table (1).

Table 1: Fiber specification

Cotton	UHM mm	UI%	Micronaire value	HVI mm	Elongation %	Rd	b+	Stickiness
Bt average	26.6	78.2	3.2	27.6	6.1	74.2	9.5	0
Acala average	26.7	78.1	4.2	27.1	6.3	73.8	8.8	0

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Preparation:

The two types of cotton were introduced into opening and cleaning machines line. Then it was fed to the carding machine using chute feeding machine and condensing fibers in sliver with the linear density 0.1 Ne.

The card sliver was passed through two successive drawing passages using the Rieter type draw- frame, the total draft was (6) for the two drawing passages. The spinning machine was fed with slivers after the second passage of drawing with the linear density 0.1Ne for both types of cotton.

Spinning:

This experiment was done using suitable manufacturing condition aiming to have good yarn quality and properties. Each count had the same condition and machine setting for both type of cotton. In the rotor open end spinning section, sixteen cans (7Kg in weight) were used, eight for each side of the machine, one

used for Bt cotton and the other for Acala cotton. The rotor spinning machine parameters used were as follows:

1. The rotor speed (68500 rpm).
2. The opening roller speed (7700 rpm).
3. The rotor diameter (35 mm).
4. The winding angle (34°)
5. The twist factor (4.5)

The counts produced were (8, 12, 16, 20, 26 and 30Ne).

The draft, feed speed, delivery speed and twist number were gradually changed in steps so as to produce the desired range of counts, as shown in Table (2)

Table 2: Machine setting parameters for both cottons

Count (Ne)	8	12	16	20	26	30
Delivery (m/min)	136.6	111.5	96.6	86.4	75.8	70.5
Feed (m/min)	1.82	1.03	0.67	0.5	0.32	0.26
Draft	75	108.3	144.2	172.8	236.8	271.1
Twist (t/m)	501.4	614.2	709.2	793	904.1	971.1

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RESULTS AND DISCUSSION

The yarn properties tests were conducted in Sur Textile Factory laboratory in Hassahisa and in Gezira University Faculty of Textile laboratory. The results for Bt yarns and Acala yarns are reported in Table (3).

Table 3: Bt yarns and Acala yarns results

Cotton type	Bt						Acala					
	8	12	16	20	26	30	8	12	16	20	26	30
Nominal Count Ne	8	12	16	20	26	30	8	12	16	20	26	30
Average Count Ne	7.7	11.5	16.2	19.6	25	29.7	7.9	11.5	15.4	19.6	25.7	29.5
Count CV%	1.5	0.8	2.1	1.3	0.2	1.7	0.4	1.3	1.9	2.4	1.1	0.7
Strength (g)	763	608	457	409	313.8	251.4	849	632	513	397	292.2	254.4
Strength CV%	4.1	4.5	4.5	2.7	3.5	7.2	3.6	7.8	6.9	7.3	6.8	5.2
R.K.M (km)	10	11.9	12.5	13.6	13.3	12.6	11.4	12.3	13.4	13.2	12.7	12.7
Elongation %	7.1	6.9	5.6	5.7	5.6	5.5	9.0	8.0	6.5	6.5	5.9	5.4
Elongation CV%	7.0	6.5	5.3	5.6	3.8	7.5	2.7	3.0	7.9	3.7	9.3	5.1

Twist (tpi)	10.1	137	16.6	19.1	21.8	24.1	11.6	13.4	16.5	19.5	22.1	24.9
Twist CV%	1.3	2.2	4.0	4.7	3.3	3.4	3.3	5.4	3.2	5.2	3.1	3.1
Yarn CV%	14.1	15.2	15.1	14.7	13.9	15.9	15.9	15.6	14.5	15.6	17	17
U%	11.1	11.9	11.9	11.6	11.4	12.5	12.6	12.3	11.5	12.3	13.4	13.4
Thin place	2	10	5	6	7	17	10	4	21	16	37	63
Thick place	42	37	24	32	87	50	72	53	29	61	83	79
Neps per (g)	2	1	2	9	24	37	2	2	21	47	28	85
Hairiness	9.8	10.3	8.7	8.3	8.1	7.2	7.9	9.7	8.3	7.2	8.2	7.6

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Yarn strength:

To compare the different types of cotton while taking the yarn count in consideration, its best to use the yarn tenacity or R.K.M values. This is shown in Figure (1) where the two types of cottons showed an increase in yarn strength as the yarn becomes finer, but this up to a certain limit, then the strength appears to reduce with further increase in yarn count Ne. The Bt cotton peak was in count 20Ne and the Acala cotton peak was in count 16Ne. This could be due to the different micronaire values for Bt cotton (3.2) and Acala cotton (4.2) which make them suitable for the two different yarn counts respectively. Count 30Ne for Bt cotton can be suggested to be the count limit under this experimental condition since the strength of the yarn dropped clearly in this count. The Acala cotton count limit suggested to be in count 26Ne as the strength value dropped and maintained the same value at count 30Ne and cannot be expected to be improved further in performance in this experiment condition. This is also supported by the deterioration of the other yarn properties when reached count 30Ne which will be described later. However, the statistical analysis of variance for the R.K.M showed that the difference between the Bt cotton and Acala cotton strength in all counts was not significant except in count 8Ne in which the strength of Acala cotton was better than Bt cotton. This could also be attributed to the same reason as before and it could be said that for the

spinning conditions as in this study the Acala cotton was more suitable for the coarse count 8Ne compared with the Bt cotton and the spinning limit for both cottons can be considered to be count 30Ne.

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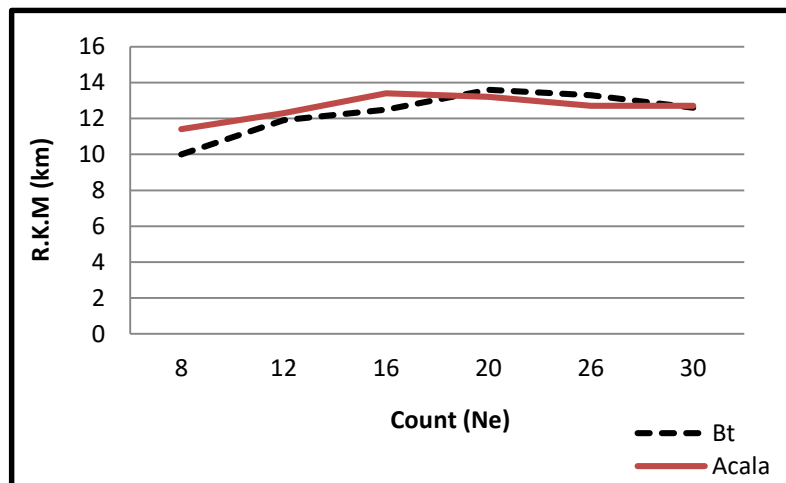


Figure 1. Yarn R.K.M vs count

Yarn elongation:

From Figure (2) the Acala yarns elongation was higher than Bt yarns elongation and there was a significant difference between the two types of cotton from count 8Ne to 26Ne. This may be explained by the higher elongation of the Acala cotton fiber which showed in Table (1). However, there is a general trend showing a decrease in elongation for both cottons as the count became finer. At count 30Ne the two types of yarns have almost the same elongation and consequently there is no significant test applied. This may well be reflected in the performance of Acala cotton yarns in later processes compared with Bt cotton yarns.

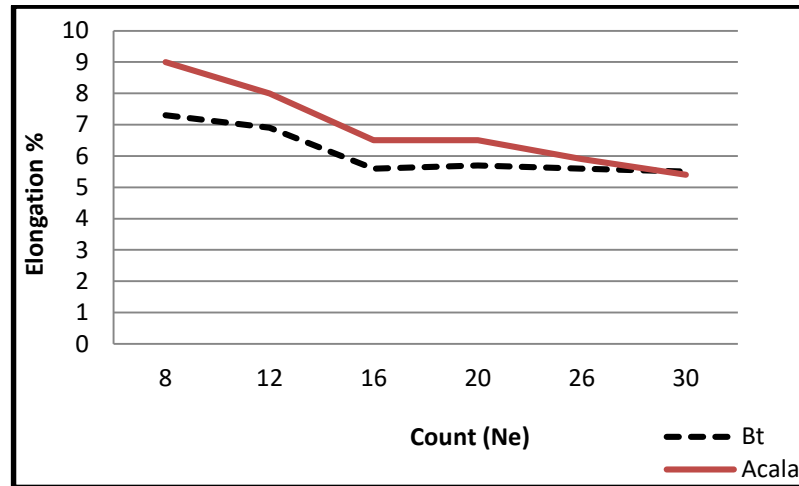


Figure 2. Yarn elongation vs count

Yarn evenness:

It is difficult to produce fine yarn with small irregularity than for coarse yarn due to the reduced fiber in cross-section (Furter, 2009). Fine yarns with a low number of fibers in the cross-section have a higher unevenness than coarse yarns. In this study the yarn unevenness does not have a clear trend as shown in Figure (3). The curve general trend was the Acala yarn unevenness appear to be worse than the Bt cotton in most of counts. This may be explained by the fiber fineness. Count 30Ne reported the highest values of irregularity for the Bt cotton and counts 26 and 30Ne reported the highest irregularity for Acala cotton. The statistical analysis of variance of yarn unevenness showed that there was a significant difference between Bt cotton and Acala cotton in CV% in all counts except 16 Ne.

However when looking back at the R.K.M results it was observed that Acala cotton gave the highest strength value at count 16Ne and at the same time it had the lowest unevenness among all Acala yarns counts.

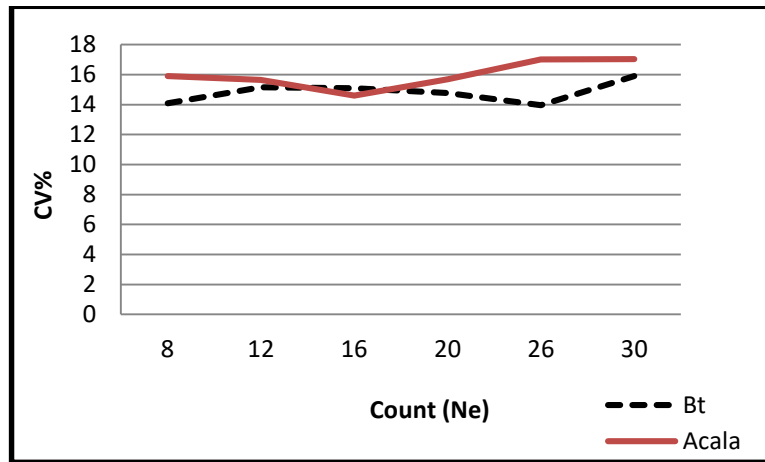


Figure 3. Yarn unevenness vs count

Yarn thin places:

Figure (4) shows that the thin places generally increased with increased count Ne for both types of cotton. The increase was more profound for the Acala type. The Bt yarns cross-section consisted of more number of fiber than Acala yarns, so the Acala yarns have the higher numbers of thin places, and this was reflected in higher unevenness in Acala yarns as explained before and higher neps and thick places as will be explained in the following sections.

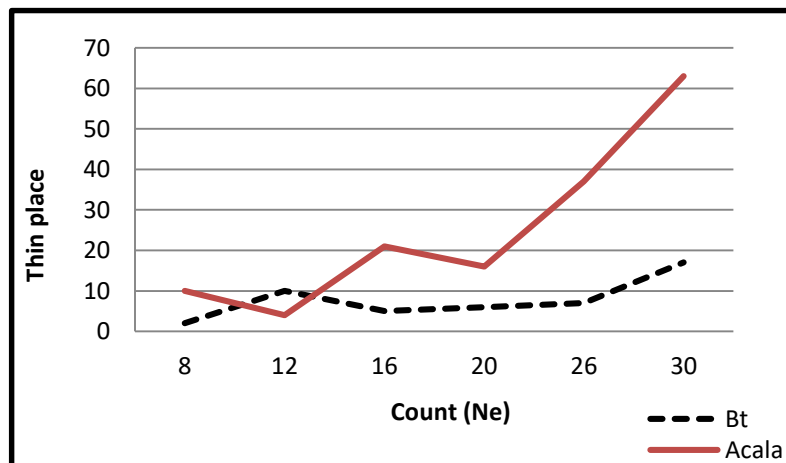


Figure 4. yarn thin places vs count

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Yarn thick places

Figure (5) shows that the two types of cotton have the same general trend. Furthermore, the lowest thick places and lowest unevenness for Acala yarn was in count 16Ne, this was translated into the highest strength for count 16Ne. In general the Acala yarn thick places were more than Bt yarns in all counts, this is attributed to the number of fibers in the yarn cross-section, thick and thin places increases with a decreasing number of fiber in the cross-section. Count 26Ne for both Acala and Bt yarns have the highest number of thick places.

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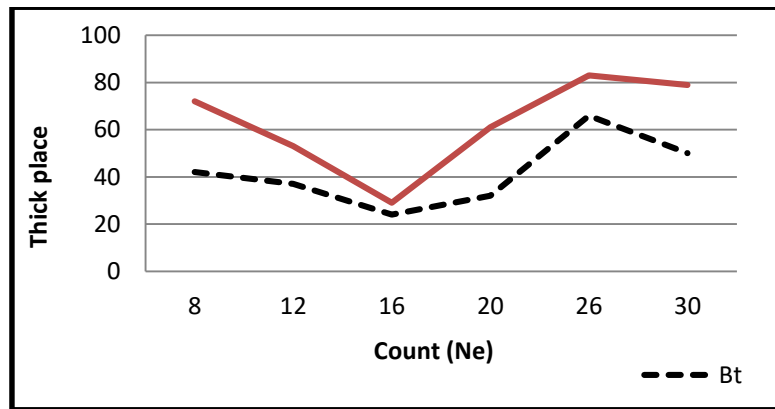


Figure 5. yarn thick places vs count

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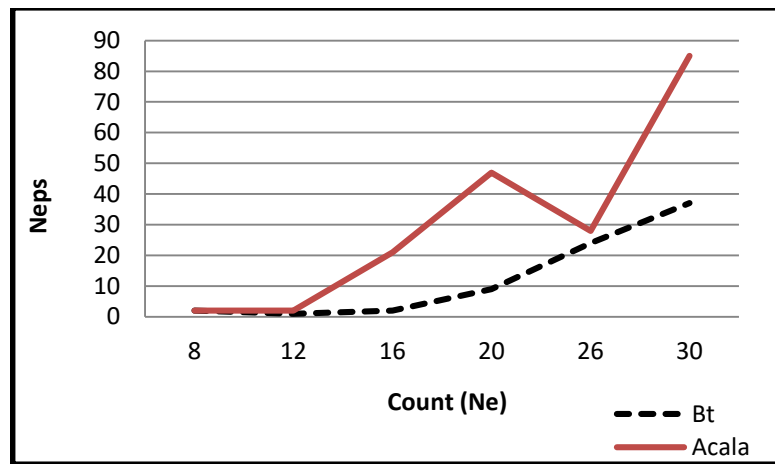


Figure 6. yarn neps vs count

Yarn twist:

In fact the twist supports the yarn strength to a certain limit according to the fiber length. In this study the influence of twist in the Bt cotton appeared in count 20Ne, which has the highest strength, whereas the highest strength of the Acala cotton influenced by twist appeared in count 16Ne. This could be attributed to the difference of the micronaire values of the two cottons. The twist curves in Figure (7) show the correspondence of the two types twist in all counts except 8Ne and there was no significant difference in twist between all counts.

Practically the twist factor applied to both types of yarns was constant equal to (4.5) even though the Acala yarns contained slightly more twist than Bt yarns. This can be retained to the different fiber fineness and its friction inside the rotor.

This result was supported by Palamutcu and Kadoglu (2008), who reported that lower twist loss is

Yarn neps:

Figure (6) shows the occurrence of neps with the different yarn counts for both types of cotton. The Bt yarns curve tends to increase with further increase in count. The first three Bt yarn counts gave almost the same number of neps, then neps number gradually increased as the yarn became finer. With Acala yarns the curve also tends to increase with further increase in count except count 26Ne which has less number of neps than count 20Ne. However, at the same time this count has the highest number of thick places among all the yarns. Therefore it could be suggested that this count neps size were small and cause short thick places in the yarn. The higher number of neps of Acala yarns is reflected in the high unevenness when compared with the Bt cotton.

expected with coarser and shorter fibers. Salhotra (1981) also reported that longer fibers resulted in more twist loss. However, the statistical analysis of variance showed that there was no significant difference in twist between all counts. Consequently, it could be said that the performance of the Bt cotton is not different from the Acala cotton in the present condition.

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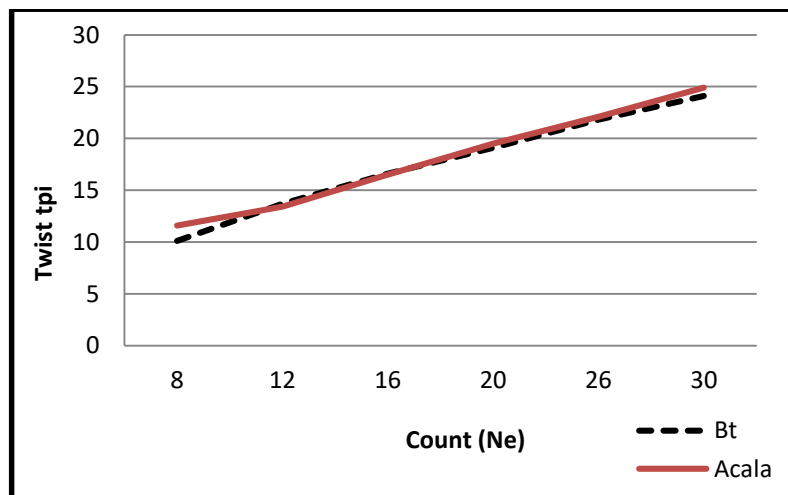


Figure 7. yarn twist vs count

Yarn hairiness:

Figure (8) shows the hairiness curves generally decreased with the increased count Ne. Since coarser counts yarn contains more fiber ends in cross-section it can be appreciated that hairiness and fly generation will increase with the coarse counts, and decrease with fine counts (Lawrence, 2010). This may be related to the high twist in fine yarns which reduces the number of protruding fibers and therefore reduces the hairiness in fine counts. Bt yarns have the higher level of hairiness than Acala yarns and this may be due to the fineness of Bt fiber. This may be as a result of the high acceptable twist in Acala yarns as the Acala yarns gain more twist from the machine than Bt yarns. At count 26Ne the two types of yarns were almost the same in hairiness. The statistical analysis of variance showed that there was a significant difference between the Bt yarns and Acala yarns in hairiness in count 8Ne and 12Ne. But the difference with the other counts was not significant.

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Figure 8. yarn hairiness vs coun

CONCLUSION

The study revealed that the Bt cotton can be used successfully as a suitable raw material in rotor open end spinning mills. The produced yarns from the Bt cotton fiber with the specific characteristics that were used in this study have the same strength as the Acala cotton yarns in almost all the counts that were produced. However, the Acala yarns were significantly better in elongation than Bt and therefore may be more preferred in later textile processes.

The twist in the two types of yarns was the same in all counts. Therefore, it can be concluded that when operating the Bt cotton with the same manufacturing condition as the traditional cotton Acala, the same results may be obtained.

The results obtained revealed that the Bt cotton yarns have good yarn evenness properties compared with Acala cotton yarns for all counts and under the different conditions as indicated. Further more, it was found that the count limits for Bt cotton and Acala cotton was (30Ne). The strength started to drop and high number of thin places, thick places, neps and unevenness were reported in this count.

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The findings in this study were compatible with the commercial range of counts. As the suitable counts that can be produced from the Bt cotton with the same fiber properties as in this study were; (12, 16, 20 and 26Ne) and (8, 12, 16, 20, and 26Ne) from Acala cotton. All these counts were within the commercial range.

Finally the industrial behavior of the Bt cotton qualify it to be used as an ideal raw material for certain counts with good yarn properties, and it can be operated successfully at similar manufacturing conditions as the traditional Acala cotton.

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المقدرة الغزلية لقطن الأكالالا المحور وراثياً مقارنة بقطن الأكالالا التقليدي

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الملخص

هدفت هذه الدراسة لتوضيح المقدرة الغزلية للقطن المحور وراثياً مع توفير المعلومات الفنية عن ادائه ومقارنته مع القطن التقليدي الاكالالا تحت ظروف تصنيعية محددة. الطريقة التي اتبعت لتحقيق متطلبات الدراسة كانت إنتاج مدى من النمر المختلفة من الخيوط السميكة والمتوسطة لتغطي المدى التجاري للنمر من (8 Ne) إلى (30 Ne) لكل من القطن المحور والاكالا وذلك في ماكينة غزل الطرف المفتوح. تم ضبط الماكينة لكل من نوعي القطن بنفس الضبطات الفنية والتي كانت أقرب ما يمكن للضبطات المستخدمة في الإنتاج التجاري. تمت تغذية ماكينة غزل الطرف المفتوح بشريط نمر (0.1Ne) بعد مروره بمرحلي سحب لكل من نوعي القطن. سرعة التغذية، وسرعة الانتاج، والسحب كانت تتغير في قيمتها تبعاً لتغير النمر. كما تم اجراء الفحص العملي وتحليل البيانات للخيوط المنتجة. تم تسجيل كل التغيرات في الخواص مع تغير النمر. تحليل النتائج لكل من القطن المحور وراثياً وقطن الاكالالا التقليدي أوضح أنه لا توجد أي فروقات معنوية بين متانة النوعين من الخيوط في كل النمر المنتجة ما عدا النمر السميكة (8 Ne) حيث كانت متانة الاكالالا التقليدي أفضل. في ذات الوقت كانت استطالة الاكالالا (ما عدا (30 Ne) أفضل من استطالة القطن المحور وراثياً. كذلك أوضحت النتائج أن القطن المحور وراثياً يمكن تشغيله بنفس الضبطات الفنية التي تستخدم لقطن الاكالالا التقليدي. الحد الاقصى للنمر كان (30 Ne) عندما سجلت هذه النمر تدهوراً في متانة الخيوط لنوعي القطن .