1650 COMBAT OF COTTON STICKINESS CAUSED BY WHITEFLY (Bemisia tabaci Genn) THROUGH BREEDING RESISTANT CULTIVARS

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ABSTRACT

Sticky cotton causes disruptions in the whole spinning process contaminating the cards, the brush tables, the feed trays and the rotors in opened spinning, requiring frequent stoppages to clean the machines. Unfortunately, the reputation of being sticky cotton producing country punishes Sudan producers in the international market since stickiness discount is applied to all cotton produced in Sudan regardless to its level of contamination. A breeding program was initiated in Sudan to develop improved cotton (Gossypium Spp.) cultivars having resistance, genetic or cultural, to whitefly as a mean to reduce stickiness contamination. In addition to the breeding efforts, experimentation was initiated and carried out to determine the geographical and other issues relative to stickiness of Sudan cotton. These efforts resulted in the development of Sudac-K, a medium staple cultivar with Okra leaf shape, nectariless flowers and leaves, smooth leaves and stems and high levels of gossypol. Sudac-K with open plant canopy enhances efficient insecticide spraying, especially towards the end of the season. This resulted in spraying three to four times, and allow for biological control and high prices of cotton free of stickiness.

Cotton stickiness caused by whitefly Bemisia tabaci Genn caused serious production and marketing problems. Usually the cotton spinners only pay the regular price for lint where they are certain that it is clean and does not contain other impurities . Buyers offer discounts ranging from 5 to 30% for the suspected cotton .

In the past reports from the International Textile Manufactures Federation (ITMF) were showing that Sudan was continuously on the top of the list of countries producing sticky cotton .

However the 2005 ITMF report showed that the problem of stickiness in cotton produced by Sudan was greatly reduced . No doubt, Sudan continued to produce sticky cotton , but this does not mean that all the cotton it produces has the stickiness problem . Moreover , a part of the sticky cotton produced in Sudan could still be spun without significant problems .The reputation of being a sticky cotton producing country put Sudan under punishment in the international market since stickiness discounts are applied to all cotton produced in the country . The country suffers heavy losses because all cotton produced here is exported .

The main objective of the breeding program was to manipulate the morphological, physiological and biochemical characteristics of the susceptible plant to render it unfavorable for breeding by whitefly and to reduce the damage. The Okra leaf shape resulted in open plant canopy and resulted in high response to insecticide spraying. Nectariless flower and leaf confirm non-preference type of resistance to the insect. High gossypol confers antibiosis type of resistance. Sudan grows long, medium and short staple cottons. Insect pests especially whitefly, which has wide range of host plants, excretes honeydew which contaminates the seed cotton causing stickiness. This will lead to problems in ginning and spinning processes. The main control measures were the use of insecticide, cultural practices and the use of leaf defoliants. Multiple harvests have also been practiced

reducing more contamination as seed cotton will be exposed after maturity for a long time. It is essential for the producer and user to have reliable information on the stickiness grade of cotton together with the classical grade of cotton because the main constraint confronting the ginning and spinning which will be reflected on the cotton marketing.

MATERIALS AND METHODS: -

The material used in the program was genetic stocks imported from USA, carrying the characters Okra leaf shape, nectariless flower and leaf, high gossypol content and glabrous plant body. These characters have been transferred singly and in combination to commercial cultivars of G. hirsutum using the backcross method followed by pedigree selection. A line containing okra leaf shape, nectariless flower and leaf, smooth stem and leaf and high gossypol content was rendered pure breeding. This line was tested with four standard commercial cultivars for whitefly build up. The experiment was randomized complete block with four replications. Sowing date was first week of August, sub-plot size was 110sq.m, and spacing was 80cm between ridges and 50cm between plants. Plants were thinned to three per hill. Watering, weeding and fertilizer application was carried out according to the Gezira Research Farm Standards. Whitefly counts were carried out at weekly intervals (adults per 100 leaves selected at random). Seed cotton was collected, ginned and lint was used to determine stickiness grades (Ali and Khalifa, 1980). According to the total sugars (mg / 100g), the following grades were set up: (0) free, (1) light, (2) medium, (3) heavy and (4) very heavy stickiness. Analysis of variance was conducted on the transformed data (Table 1).

Another RCB with four replications was conducted in the GRF with the same sub- plot size, to find out the response to insecticide spraying in the advance selection Sudac-K and the standard medium staple cultivar Barac (67) B. The mean number of whitefly adults on random 100 leaves was recorded before spraying (5 counts) and then after pre- spraying and post- spraying. Data was transformed and analysis of the variance was conducted and actual means in parentheses (Table 2). The response of the insecticide spraying was again tested for Sudac-K and Barac (67) B. In this, case the plot size in the RCB experiment was half a hector and carried out in two locations GRF and Rahad Corporation for two seasons. Seed cotton was collected at random from sub- plots, ginned and the lint was analyzed for the sugar content and stickiness grades were found (Table 2). A replicated trial was carried out in two locations, Turabi (north Gezira) and Hag Abdalla (South Gezira) using long staple and medium staple cultivars (Table 3), in order to find out the variation of cotton stickiness with lots of harvest and location within the same field. The locations include south, north, east west and centre. Seed cotton was collected from the different sub plots, ginned and the lint was tested for stickiness grades (Table 4).

Finally, comprehensive regional and replicated trials were carried out in different production locations to evaluate the yield and quality of the cultivar Sudac-K and the standard commercial cultivar Barac (67) B. Seeds of Sudac-K were multiplied and distributed to the farmers (Table 6a and 6b). Table 7 shows fibre characteristics of Sudac-K compared with Barac (67) B.

RESULTS AND DISCUSSION: -

The results indicated that the selected line subsequently released as Sudac-K with Okra leaves, glabrous plant, nectariless flower and high gossypol content showed significantly fewer whitefly adults per 100 leaves compared with the other control in each of the three years tested (Table 1).

Sipple and Khalifa (1983), using some commercial cultivars and some lines not having such characters in a replicated trial, subsequently showed that there was a significant positive correlation between hair density and low number of whitefly per 100 leaves, scales and pupae per unit area. It was also found that parasitization in Sudac-K was 30% greater compared to the standard cultivar. The whitefly build up did not exceed 200-300 adults per 100 leaves, while in the control cultivar more than 1000 adults pre 100 leaves were evident (Fig 1). These figures also support the Sudac-K with the above characters conferred resistance to the whitefly build up. There was also reduction in scales and larvae. This was mainly due to unfavorable conditions in the lower part of the plant canopy, with higher temperature and less humidity. The high gossypol content rendered the cell sap unpalatable to the insect and this may confer antibiosis type of resistance, which will lead to insect starvation and in some cases the eventual death of the feeding juvenile or adult stage. As to the different morphologic characters, this may confer a non-preference type of resistance. These suggestions are supported by the reduction of whitefly population.

Table 2 shows clearly the insecticides applied to the cultivar Sudac-K were more effective than when applied to the standard cultivar with normal leaves. This resulted from the open plant canopy in Sudac-K. The Okra leaf allowed for better penetration of the insecticide even to the bottom of the plant canopy, especially at the end of the growing season, when the standard cultivar exhibited almost complete canopy closure. Another finding was the standard cultivar required 7-8 sprays per season, while Sudac-K required about 3-4 sprays (Fig 1).

Long and extra long staple cultivars together with the medium cultivars showed significant variation number of harvests and location. The medium staple cultivars have more quantities to honeydew compared with the other cultivars (Table 3). This is mainly because the medium staple cultivars are more hairy, thus harboring more whitefly and their boll maturation period coincides with the peak of whitefly build up. There was also significant difference between two locations, Hag Abdalla being in the south, the most productive region and having more host plants for whitefly reproduction produced more sticky cotton in both type of cultivars.

Even within the same field, there was variation in harvested sticky cotton. The southern part of the field was the most affected part due to prevailing north wind driving the whitefly to the southern part of the field. The east and west margins showed relatively higher concentration of honeydew compared with the centre (Table 4).

The last harvest showed higher contamination of honeydew, thus having higher grades of stickiness. This was expected because the whitefly usually hides in the lower shady part of the plant during the last sprays.

After ginning commercial seed cotton, in Sudan, the resulting lint is mixed and baled. Therefore, it was expected that there was variation of honeydew dispersion within the same bale, if there were differences within fields and locations on the plants. It was found that on the average if the bales sampled that the upper part of the bale showed higher concentration of honeydew compared with other parts of the bale (Table 5). However, in case of medium staple cotton, the process of mixing clean lint with sticky lint is evident, as the right and front positions of the bale showed higher grades of sticky cotton. Therefore, there was heterogeneity in the lint stickiness grade in the medium staple cotton. This is mainly due to the missing of seed cotton during the hand harvest. It was recommended that sticky and non-sticky cotton should be bulked separately. It was also recommended that

25-30 bales should be selected at random from a lot of 320 bales, for testing. It is also recommended that both stickiness grades should be marked with the quality grade to avoid any arbitration.

Sudac-K was included in the routine comprehensive trials conducted every season including the standard cultivars and the newly advance selected lines. The results in all theses trials showed that Sudac-K did not show significant difference in yield, but there was 10% less in yield compared with the standard commercial cultivar Barac (67) B. Table 6a and 6b shows the result of the comprehensive trial conducted at the GRF to compare Sudac-K and the standard commercial cultivars Barac (67) B. The lower yield of Sudac-K will be compensated by higher prices due to lower grades of stickiness and less number of sprays. Sudac-K has similar fibre characteristics as the standard cultivar (Table 7). Sudac-K seeds were multiplied and recommended for commercial production in whitefly-infested areas based on its host plant resistance to whitefly and the increased efficiency of insecticides spraying on the open canopy.

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Table 1: Average number of Whitefly adults per 100 leaves and grades of cotton stickiness in the different breeding lines for seasons 1978-1979/1979-80/1980-81) (data transformed to √x)

Breeding lines	1978-1979			1979-1980			1980-1981		
	Mean no. of whitefly adults	Stickiness grades	Total sugars (mg/100 gm)	Mean no. of whitefly adults	Stickiness grades	Total sugars (mg/100 gm)	Mean no. of whitefly adults	Stickiness grades)	Total sugars (mg/100 gm)
Okra-leaf shape	13.7^{a}	0-1	684	12.6^{a}	0-1	591	20.13^{a}	0-1	434
Hairy line	33.9^{d}	2-3	908	25.8^{c}	2-3	822	27.03^{d}	1-2	797
Barac 67(B)	29.9^{c}	2-3	904	20.2^{b}	1-2	789	25.73^{c}	1-2	625
Barakat	27.3^{b}	0-1	422	21.5^{b}	1-2	772	24.20^{b}	0-1	512
Huda	27.7^{b}	0-1	39	21.5^{b}	1-2	792	24.54^{b}	0-1	452

Stickiness grade (0) = free, (1) = light, (2) = medium, (3) = heavy, (4) =very heavy.

a, b, c and d indicate means having the same letter are not significantly different at .05 level of probability.

Table 2: Response of insecticide spraying of "Sudac-K" and "Barac (67) B", 1982/83: mean whitefly on 100 leaves: data transformed to √x: Actual means in parentheses.

Treatment	Average of 5 counts before spraying was commenced	Pre- sprayed counts; average of 8 counts (one before each of the 2nd to the 4th spray)	Post- pray count; average of 4 counts (one after each of the 1st to the 4th sprays)	General performance through the season (average of 20 counts from 11 Sep. 1982- 9 Jan. 1983)
Barac (67) B sprayed	13.76 (189.8)	22.27 (496.8)	11.8 (140.8)	18.3 (333.8)
Barac (67) B un-sprayed	14.5 (209.5)	53.37 (2851.0)	43.2 (1871.3)	0.8 (16668.7)
Sudac-K sprayed	8.00 (64.0)	15.35 (236.3)	6.6 (43.)	11.6 (136)
Sudac-K un-sprayed	6.88 (48.5)	24.88 (620.5)	23.5 (522.0)	20.6 (426)
S.E*		0.6635	0.8281	0.5822

* S.E = Standard error of the difference between two means. It is a measure of reliability at 5% level of probability between two means. Multiply the figure by 2 and compare with the menas.

Table3: Variation of cotton stickiness with harvest and locations within the same field, CV. "Barakat"

location	Cotton stickiness mg/100gm lint	Grade
South	602	1
North	473	0-1
East	521	0-1
West	577	0-1
Center/s	468	0-1
Center/n	455	0-1
Harvest I	468	0-1
Harvest II	427	0-1
Harvest III	539	0-1

S.E= 26

Table4: Variation of cotton stickiness with cultivar and location

Cultivar	Turabi (north Gezira)		Hag Abdulla (South Gezira)	
	Mg/ 100g lint	Stickiness Grade	Mg/ 100g lint	Stickiness Grade
Long staple:	476	0-1	727	1
Barakat	532	0-1	622	1
VSA	563	0-1	725	1
Huda	450	0-1	746	1
Maryould				
Medium staple	797	1	922	1
Barac (67) B	767	1	783	1
Barac (69) 2				
Mean	594		754	

S.E= 16

Table 5: Dispersion of honey-dew within the same bale, CVS. Barakat and Barac (67)B.

Position in bale	Total soluble sugars (mg/100gm lint)	
	Barakat	Barac (67) B
Top	753	839
Bottom	733	722
Right	694	902
Left	672	654
Front	656	933
Rear	636	688

Table 6a: Summary of the performance of Sudac-k vs Barac (67) B for 4 seasons, (GRF).

Fourth season	Third season	Second season	First season	
(ha/kg)Lint yield	(ha/kg)Lint yield	(ha/kg)Lint yield	(ha/kg)Lint yield	
(39.0)911	(39.5)815	(38.5)772	(39.1)692	**k-Sudac**
(2-40)953	(372) 886	(39.2)811	(40.0)745	**B(67)Barac**
34.5	39.2	42.3	36.3	**-/+ .E.S**

Table 6b: Summary of the performance of Sudac-k vs Barac (67) B in Rahad Agricultural Corporation for 2 seasons.

Season 2	**Season 1**	
(38.9)828	763 (38.5)763	Sudac-k
(40.0)944	8322225544 (39.4)823	Barac(67)B
(38.0)60.4	47.9	S.E.+/-
G.O.T	**Kg lint/ha**	
(39)	793	Sudac-k
(39)	886	Barac(67)B

Ginning out turn in percentage :T.O.G *

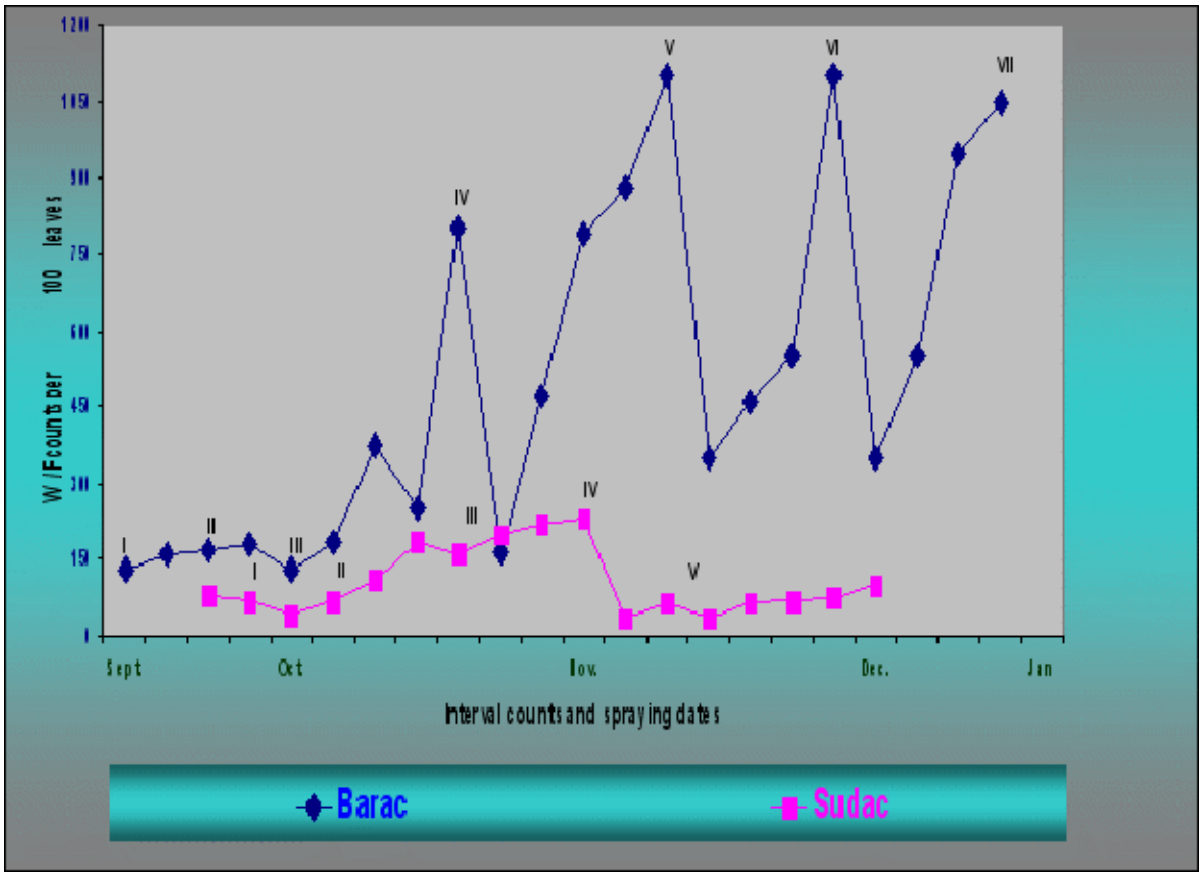
%10but there is significant ,level of probability %5These tables do not show significant differences in yield at .k-B over Sudac (67)increase in yield for Barac

B (67)k compared with Barac -Fiber and spinning characteristics of Sudac :7 Table

.and Rahad Agricultural Corporation (GRF)Average of trials

Cultivar	Fibrograph			Shirley-IIC		Stelometer	
	SL %2.5 311/1	R.U	V.M	Maturity ratio	tex/Fin M	tex/Strength g	Elongation
k-Sudac	36	49	4.7	0.93	198	22.0	6.5
B(67)Barac	37	49	4.3	0.90	185	21.0	6.6

Fig (1) : Response of spraying and whitefly build up in "Barac (67) B" and "Sudac - K" , Rahad Corporation – 2006/2007



**** Note : Latin figures indicate number of spray***

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