Sudac-K, A Cultivar for Narrow Row Cultivation in the Sudan Gezira

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ABSTRACT

At the Gezira Research Station, Wad Medani, Sudan, a field study was initiated in 1996 to determine the response of morphologically contrasting upland cotton cultivars to different row widths and within-row spacing. Sudac-K is a newly synthesized okra-leaf type, resistant to whitefly (Bemisia tabaci Genn.) and is claimed to produce less sticky cotton than the normal-leaf type, Barac (67) B, which is hairy and bushy, forming a closed canopy that favours whitefly infestations. In this study, a relatively narrow row (60-cm) was tested against the conventional check (80-cm). Single-seeding at within-row spacing of 15 and 10 cm were compared against the conventional hill-dropping (3 plants/hill) at within-row spacing of 45 and 30 cm. Data accumulated over two seasons showed that Sudac-K had a lower LAI than Barac (67)B throughout the growing season. The two cultivars, averaged over all other treatments, did not differ significantly in seed cotton yield. However, Sudac-K responded favourably to the 60-cm rows. Yields from single-seeding was significantly higher than that from hill-dropping at the same plant population. The okra-leaf trait, as an average of row widths and within-row spacing, caused a significant reduction in the numbers of whiteflies and consequently in the degree of stickiness. Thus the expected superiority of Sudac-K can manifest itself in several ways: increased yield under high planting density, improved marketability of less sticky cotton and reduced insecticides expenditures.

Introduction

Conventionally, cotton in the Sudan Gezira is hill-dropped every 50-cm in 80 cm rows. Plant population density of 75,000 plant ha^{-1} is achieved by thinning to 3 plants hill^{-1}, 4-6 weeks after planting (Fadda and Kordofani, 1961). Most of the spacing experiments in the past utilized various within-row spacings and hill arrangements while keeping row width constant. Early attempts to reduce row width and to alter planting arrangement so as to obtain higher plant populations were met with practical problems, such as inadequate pest and weed control, lack of suitable machinery and cultivars sensitive to crowding. At present, aerial insecticide spraying and pre-emergence herbicide use are becoming standard practices in the Gezira. Planting and harvesting machinery in cotton production is well developed elsewhere, but its use in the Sudan is still under experimentation. With these developments, the use of narrow-row culture becomes more practical from management standpoint, provided cultivars suitable for this system are available.

The newly synthesized okra-leaf type, Sudac-K, with its short branches and reduced leaf surface area seems to be the suitable candidate. The primary objective of releasing Sudac-K has been to control cotton stickiness by opening up the plant canopy and creating a less favourable environment for the development of whitefly (*Bemisia tabaci*) than the bushy type, Barac (67) B (Khalifa, 1980).

This study was conducted to determine the response of morphologically contrasting cotton cultivars to various population densities within a relatively narrower row than that conventionally used.

Material and Methods

A 3-factor experiment commenced in 1996-97 to study the response of Sudac-K to different row widths and within-row spacing. The experiments dealt with two varieties, Sudac-K and Barac (67) B, two row widths of 80 and 60 cm and 4 within-row spacing of 45, 30, 10, and 15 cm. Seeds were hill-dropped for 45 and 30 cm spacing, and single-planted for the 10 and 15 cm spacing. These spacing arrangements represent plant populations ranging from 72,000 to 167,000 plants ha^{-1}. The experiment was a randomized, split-split design with four replications, varieties being the main plot, row width the subplots and within-row spacing the sub-subplot.

Growth observations were recorded fortnightly throughout the season. Seed cotton yield was recorded for each pick. The intensity of light at various plant zones was measured at noon by placing a sunfleck ceptometer (GPK Products Inc.) in the lower zone (6th to 10th node), middle zone (11th to 15th node) and upper zone (16th to 21st node). CIRAD Sticky Cotton Thermodetector (SDL International LTD) measured stickiness in each pick.

Results and Discussion

Varietal differences

The morphological differences between the two varieties as reflected by the growth data collected are of importance. Special emphasis was placed on leaf area index (LAI), relative earliness and percentage of sunlight intercepted by the foliage of each cultivar.

The LAI, averaged over all treatments, throughout 1997-98 season are presented in Figure 1. There was no marked difference in LAI between the two cultivars in the early part of the season but then the difference in LAI was large and consistent with Barac (67)B having a greater LAI than Sudac-K at every sampling date. The maximum LAI for both cultivars was attained 16 weeks after germination. The difference in LAI between the two cultivars was due to difference in the leaf shape. Sudac-K, being an okra-leaf type, is characterized by deeply cleft and narrowly lobbed leaves with a greatly reduced leaf area (Andries *et al.*, 1969). The LAI of Barac (76)B was about 35% more than Sudac-K, in keeping with results reported by Khalifa (1984) and Elmahdi (1986). Despite this, there was no significant difference in seed cotton yield of the two cultivars (Fig. 2). The openness of the plant canopy in the Sudac-K might have allowed for better air exchange and light penetration to the lower plant zones. This, in turn, may have resulted in increased photosynthetic efficiency of the lower leaves and bracts, enabling the plants to compensate for the reduced leaf area (Andries *et al.*, 1969).

A relatively small leaf area due to okra-leaf trait has been purposely selected in Sudac-K to give better light penetration into the canopy and to create less favourable microclimate for whiteflies (Khalifa, 1984). Most of the leaves of Sudac-K intercept more sunlight than those of Barac (67) B, many leaves of which are completely or partly shaded (Table 1). An additional advantage of the okra leaf is that it facilitates effective penetration of sprayed insecticides, possibly reducing the number of sprays and allowing biological activities (Khalifa, 1984).

Sudac-K was ready for picking 2-3 weeks earlier than Barac (67) B. Its earliness was associated with a lower number of green bolls at final harvest and a higher percentage of the two first pick to the total seed cotton yield (Table 1). The influence of okra-leaf on earliness has been well-documented (Andries *et al.*, 1969). The okra-leaf opens up the plant canopy and allows greater light penetration and influences light-induced or light-regulated reactions that promoted early and rapid fruiting (Kohel, 1974).

Effect of row width

Buxton *et al.* (1977) found that there is no advantage to high population density of conventional cultivars in narrow rows. Niles (1970) stressed the need for developing cultivars specifically adapted to narrow rows and high populations. According to Ray (1970), cultivars adapted to narrow rows should be small, early, with short branches, and a leaf oriented to permit significant light penetration. The okra-leaf type, Sudac-K, with its small, fine leaves and compact plant body seems to fit this plant type. The seed cotton yield was significantly affected by row width, and there was an interaction with cultivars, Barac (67)B being unaffected and Sudac-K showing an increase in seed cotton yield by decreasing the row width from 80 cm to 60 cm (Fig. 2).

Effect of within-row spacing

The difference in seed cotton yield of hill-drop at 45-cm and 30-cm was not significant. Similarly, the difference in seed cotton yield of single planting at 15-cm and 10-cm intervals was not significant. However, single seeded plants significantly outyielded hill-dropped plants (Fig. 2).

No significant interactions were found between row width and within-row spacing, although it approached the significance level. The nearly significant interaction together with the fact that the two highest yields were achieved by single planting at 15 -cm and 10-cm spacing suggests that lessening the distance between rows and single-seeding while maintaining the same plant population might improve the uniformity of plant distribution and consequently reduce the competition among plants for the available resources. Conversely, the widely spaced hill-dropped plants apparently did not fully utilize available moisture and nutrients between hills.

Whitefly infestation and cotton stickiness

Since the primary objective of this experiment was to determine the response of Sudac-K to a relatively narrower row than conventionally used, it is important to examine its reaction to the build-up of cotton whitefly and associated levels of cotton stickiness under such conditions. Barac (67)B was more prone to whitefly infestation with more than twice the population on Sudac-K (Table 4). The whitefly populations seems to have a direct effect on the number of sticky spots, the higher the population the greater the degree of stickiness. The effect of the row width on the build-up of cotton whitefly was erratic and inconsistent, though there was an indication that higher number of sticky spots was detected on cotton picked early in the season from 80-cm rows. These results confirmed the findings of Khalifa (1984) who reported that Sudac-K supports low populations of whiteflies and hence produces less sticky cotton than the standard medium cotton cultivar Barac (67) B. He also observed that Sudac-K responded better to insecticide spraying, requiring fewer sprays without a reduction in yield.

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Table 1. Percentage of sunlight intercepted in various plant zones at the stage of maximum LAI.

Cultivar	Percentage of sunlight intercepted		
	lower zone	middle zone	upper zone
Sudac-K	38	61	87
Barac (67)B	22	44	64

Table 2. Influence of cultivar on earliness of cropping as indicated by cumulative percentage of cotton picked and the number of green bolls at harvest [1] .

Cultivar	Cumulative percentage of cotton picked				Green bolls at harvest
	Pick 1	Pick 2	Pick 3	Pick 4	(No. plant-1)
Sudac-K	10.8a	54.7a	78.3a	100	0.66a
Barac (67)B	8.1a	44.7b	67.1b	100	1.01b

[1]Means within each column followed by different letters were significant at *P=0.05*

Table 3. Average number of whiteflies (adults/100 leaves) and average number of sticky spots as affected by cultivar and row width in season 1997/98.

A. Average numbers of sticky spots:

Cultivar	Pick 1		Pick 2		Pick 3		Pick 4		Mean
	80 cm	60 cm	80 cm	60 cm	80 cm	60 cm	80 cm	60 cm	
Sudac-K	2	5	5	4	1	3	4	5	4
Barac (67)B	9	12	5	12	15	7	15	13	10

B. Average numbers of whiteflies/100 leaves:

	Sampling dates				Sampling dates				Mean
Cultivar	2 Oct	16 Oct	1 Nov.	14 Nov	2 Oct	16 Oct	1 Nov	14 Nov	
	80 cm				60 cm				
Sudac-K	44	31	80	67	39	49	92	78	60
Barac (67)B	116	83	190	106	124	93	200	99	113

Figure 1. Progressive development of leaf area index for Barac (67) B and Sudac-K.

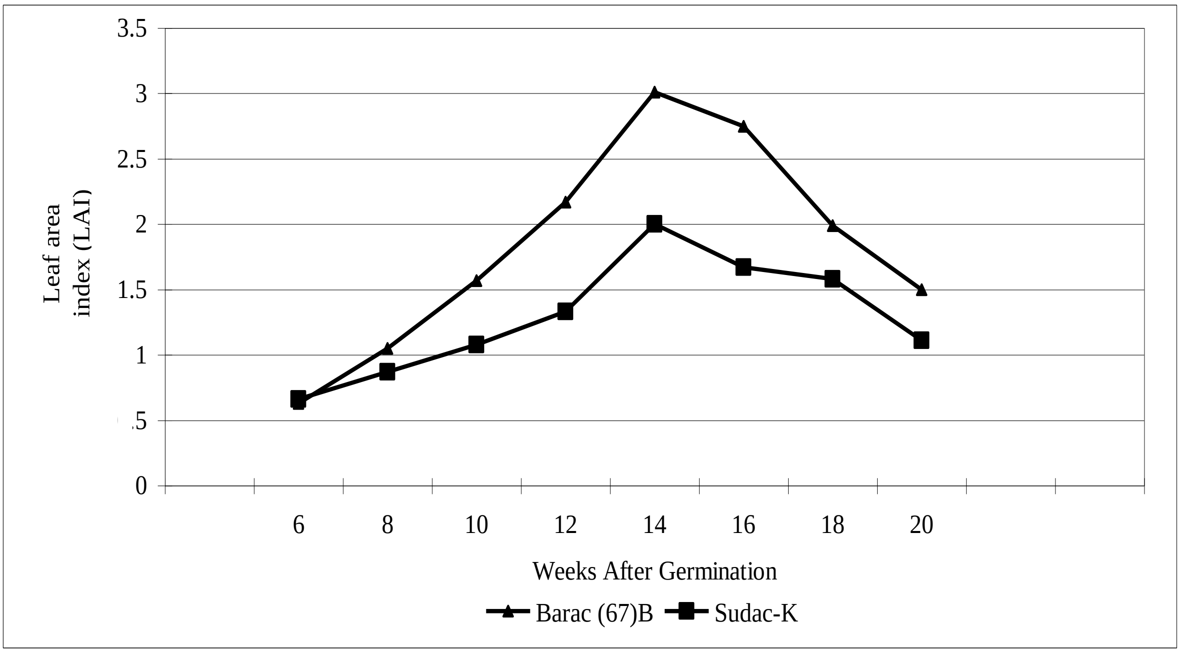

Figure 2. Seed cotton yield (kg/ha) of Sudac K and Barac (67) B in two years at different between and within row spacings.