A high yielding quality hirsutum cotton variety for sustainable agriculture in the penninsular India under irrigated situations

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ABSTRACT

Indica, a hirsute variety yielding 3056 kg/ha of seed cotton per hectare with 35.41% of ginning out turn, mean fiber length of 35.37 mm, micronaire 3.5, bundle tenacity 24.43 g/k tex at 1/8 inch gauge, maturity ratio 0.65 with 6.8 mg/kg of wax and predicted spinning value was 2332 csp was developed for sustainable agriculture on low input agriculture under irrigated situation. The arrangements of the cells in the leaf of Indica were similar to that of the female parent with 14 vascular bundles as against 12 and 15 respectively in the female and male parents. The protein profile of the seeds of Indica differed significantly from that of the parents.

Introduction

Cotton has a classical history spreading over more than five thousand years in India. The research, development and commercialization of cotton have undergone an impressive metamorphosis after independence to meet the demand of the population. Unlike other cultivated crops cotton besides supporting the livelihood of several million people directly and indirectly has played a vital role in transforming the economy and evolution of human ethical, moral, cultural and commercial values.

India gets 14 to16 million bales of cotton every year from one fourth of the cultivated area under this crop in the world through diploid, tetraploid species of *Gossypium* and F_1 hybrids and meet the industrial annual requirement of 17.2 million bales. The contribution of hybrids to the national annual production is more than thirty percent. Although the productivity of cotton in India is increasing at annual growth rate of 3.7 percent further increase has to come from the enhanced productivity per unit area through high yielding varieties and hybrids (Sundaramurthy, 1992) as indiscriminate extension of area under cotton particularly during the main crop season may result in decline of the area under food crops in India having a population of more than 100 crores. The frequent failure and changes in the pattern of rainfall, miss management of the production centers and ecological succession of the insect pests in the agro system are responsible for the production losses in the cotton system (Sundaramurthy, 1996).

As cultivation of cotton under high inputs is not always profitable in a number of cotton growing regions, a hirsute variety with high productivity on low inputs better than hybrids with acceptable quality was evolved to suit the needs of small and marginal farmers for sustainable agriculture under assured irrigated situations.

Experimental procedure

Two short stature hirsute varieties were hybridized (Figure 1B). The F_1 seeds from a single boll were used for raising the progenies and pedigree method was employed for further selection of progenies with high single plant yield. The materials were advanced in the succeeding generations by selfing. On stabilization it was tested for three years in the villages by following the agronomy of 75 cm x 35 cm planting distance in the ridges and furrows system that is in vogue under irrigated situation and the fertilizer level of 60 kg of nitrogen, 30 kg of P_2O_5, and 30 kg of K_2O/ha. The fertilizers P_2O_5 and K_2O were applied at the time of sowing and the nitrogen was applied in two split applications. The seed cotton yield and other economic traits were recorded. Using the HIV instrument the quality of the fibers were assessed.

The protein profiles of seeds of the parents and Indica were prepared with the aid of the Shimdzu Protein analyzer by extracting the protein in the phosphate buffer from the seed embryo after removal of seed coat and the chlorophyll. The wax content of the fibers was assessed by the Soxhelt method using petroleum ether as solvent and quantified gravimetrically (Sundaramurthy and Appukuttan Menon, 1996). Following the normal methods a histological preparation was made of the leaf and a professional microtomist made sections and stained the tissues with differential stains.

Experimental procedure

Indica has short internodes and seeds were sown 4 to 5 cm apart with 13 to 16 boll bearing sympodial branches springing out of the main stem at about 80 to 90 degree angle to give open canopy with four to five buds and one or two monopodial branches in a few plants (Figure 1A). The growth of the plants of Indica reached to a height of 120 cm with the leaves having pubescent hairs on their under surface. The loss of buds during their growth facilitate further growth of the sympodial branch as against the cultivated ones in which the main stem used to grow further. This unique feature, besides opening up of the canopy, ensures good coverage of the pesticides on the bolls and also facilitates easy penetration of the light energy. Indica recorded an average productivity of 3056 kg/ha on the farmers fields with 35.41% of ginning out turn, mean fiber length of 35.37 mm, micronaire of 3.5, bundle tenacity of 24.43 g/tex at 1/8inch gauge, and maturity ratio of 0.65. This cotton has a short fiber index of 1.77 with the neps of 102/g and elongation of 6.30 mm with the predicted spinning value of 2332 csp yielding yarns of 60 s and this category of cotton forms about 6% of total cotton produced in India (Tables 1 and 2). As a component of mixing composed of similar cottons may yield the yarns of 80s. Indica was better than the popular F_1 and other hybrids that are ex-

tensively cultivated under high input regime (Figures 1C and 1D). The crop received only two to three applications of pesticides during its growth phases against the sap feeding insects and bollworms.

The histological investigations showed that the arrangement of the cells in the leaf of Indica *was* similar to that of the female parent with 14 vascular bundles as against 12 and 15 respectively in the female and male parents.

The protein profile of the seeds of the parents was differed both in number and in the RT value of each protein peaks (Table 3). The male had 19 proteins while the female parent had 20 as against 21 in the offspring Indica. It is evident from the results that 16 proteins in both the parents are with the same RT values (Figures 2A, 2B and 2C). However the male parent had differed from the female parent by having three proteins with the different RT values of 2.61, 2.75 and 15.81. The offspring Indica resulted from these parents was with 17 proteins that were similar to that of both the parents. In addition to these proteins Indica had additional four proteins with the RT values of 14.80, 20.85, 21.09 and 24.37 and these were not present in the male and the female parents.

The wax content of the fibers of Indica was 6.7 mg/g and this might be responsible for giving luster to the lint. The luster of the lint of Indica is almost similar to that of the Indian finest barbedense cotton variety Suvin. The presence of the wax on the fibers facilitates smooth flow in the mechanical processing of raw cotton and known to interfere with absorption of dyes and high speed wet processing operation. The amount of the wax present on the fibers of Indica is with in the range that has been reported to be present in other Indian cottons (Hector and Hodkinson, 1989).

The observed significant changes in the protein profile of Indica may be due to the action of genes. These changes may be attributed to the differing morphological characters such as the short sized internodes, open type of the plant canopy with ability for further growth of the bolls bearing sympodial branches if loss is occurred to the fruiting parts either due to insect bite or physiological stress. This unique phenomenon does not permit Indica to have additional growth of the main stem, a common feature with the most of the cultivated varieties and hybrids under these situations. The additional growth of the main stem under such situations is considered as one of the factors that go against the well being of the system, escalation of cost of cultivation and inefficiency of the conventional methods of insect control under irrigated and assured rain fall regions in the county. The observed high productivity and better quality of fibers as compared to many of the cultivated hybrids (Table 2) may also be attributed to the changes of the protein profile. Since syntheses of the proteins of the seeds are under governance of the genes, the pattern of seed proteins or other plant parts of a varieties, parents and F_1- hybrids may be used for identity and assessing the genetic purity instead of resorting to the time consuming grow out test (Sundaramurthy *et al.,* 1998) or complex expensive DNA finger printing for seeds for certification purposes.

Acknowledgements

The help rendered by Mr. A.P. Janakiraman, South Indian Textile Research Association, Coimbatore and Mrs. M. Bhasker and K. Thiyagarajan, Unit of Central Institute for Research on Cotton Technology, Coimbatore for analyzing the quality of fibers and wax is acknowledged with thanks. Thanks are also due to Dr. P.N. Gururajarao of Sugarcane Breeding Institute for the laboratory facilities and to the Department of Bio Chemistry, Tamil Nadu Agricultural University Coimbatore for the help while preparing the protein profiles of the seeds. The cooperation and help rendered by the farmers for assessing the performance in their fields are acknowledged with gratitude.

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Table 1. *Productivity and quality of the fiber of the variety Indica on the different soils.*

	Name of the villages and types of soils			
Traits	Pudupalayam (Deep red loam soils)	Karamadai (Shallow black soils)	Veerakeralam (Red loam soils)	Mean
Yield (kg/ha)	3056.00	2811.00	3302.00	3056.00
% Ginning	35.46	35.26	35.52	35.41
Length (mm)	35.80	35.92	34.20	35.37
Micronaire	3.50	3.30	3.70	3.50
Maturity	68.00	62.00	65.00	65.00
Strength g/tex	24.70	25.10	23.60	24.43
Uniformity	42.70	44.90	44.90	44.16
Elongation (mm)	7.10	5.90	5.20	6.30
Short fiber index	1.80	1.70	1.80	1.77
Wax (mg/g)	6.70	6.80	6.60	6.70
Neps	102.00	105.00	100.00	102.00
CSP	2320.00	2312.00	2274.00	2332.00
Color Rb	71.60	71.20	71.90	71.56
+b	8.90	11.90	9.40	10.06

Table 2. *Productivity of indica as compared with hybrids.*

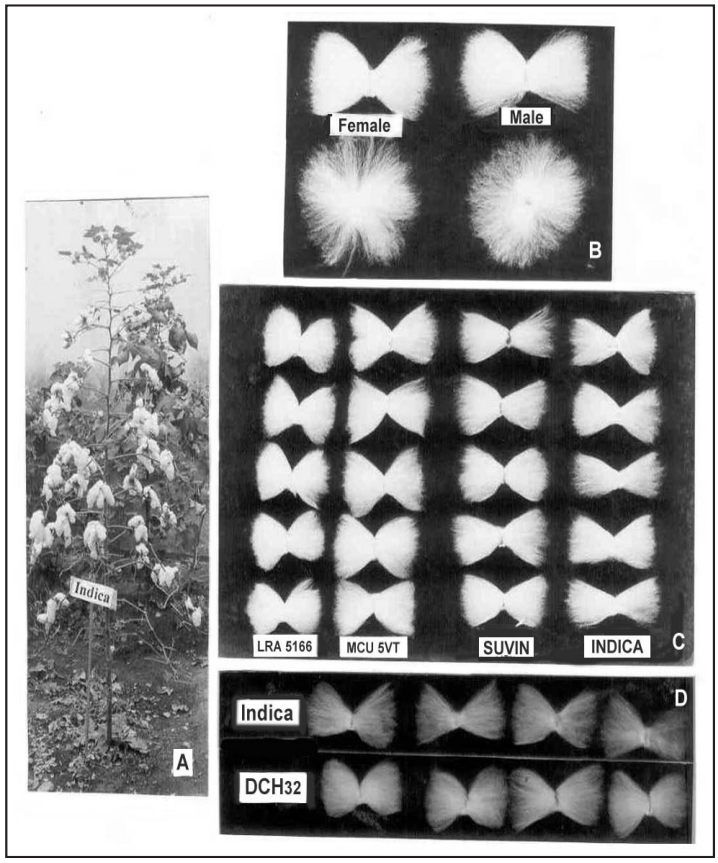
Indica vs. hybrids	Height (cm)	Yield (kg/ha)
Indica	120.0	3056
Interspcefic hybrids*		
SRUTHI	88.0	1401
CDHB2	95.7	1790
HB224	161.4	1481
DCH32	170.4	1230
TCHB213	187.9	1490

*Regression coefficient for the height of the plants and yield was not significant with r = -0.49 and slope = -2.06

Table 3. *Rt-values of the peaks of the seed proteins of the parents and indica.*

S.No	Female	Male	Indica
1	1.44	1.44	1.41
2	1.64	1,65	1.65
3	1.89	1.88	1.88
4	2.05	2.05	2.05
5	2.53	2.53	2.53
6	2.90	**2.61**	2.59
7	3.35	**2.75**	2.71
8	14.01	2.90	2.87
9	14.58	3.34	14.00
10	14.90	14.57	14.55
11	15.17	14.91	**14.80**
12	15.42	15.16	15.15
13	15.65	15.42	15.41
14	18.05	**15.81**	18.54
15	18.51	18.54	**20.85**
16	18.72	21.83	**21.09**
17	21.84	22.14	21.83
18	22.16	22.65	22.15
19	22.69	23.28	22.65
20	23.31	----	23.26
21			**24.37**

Figure 1.
The architecture of a plant of indica (A), seed cotton of the parents (B) and the popular varieties (C) and a hybrid (D).



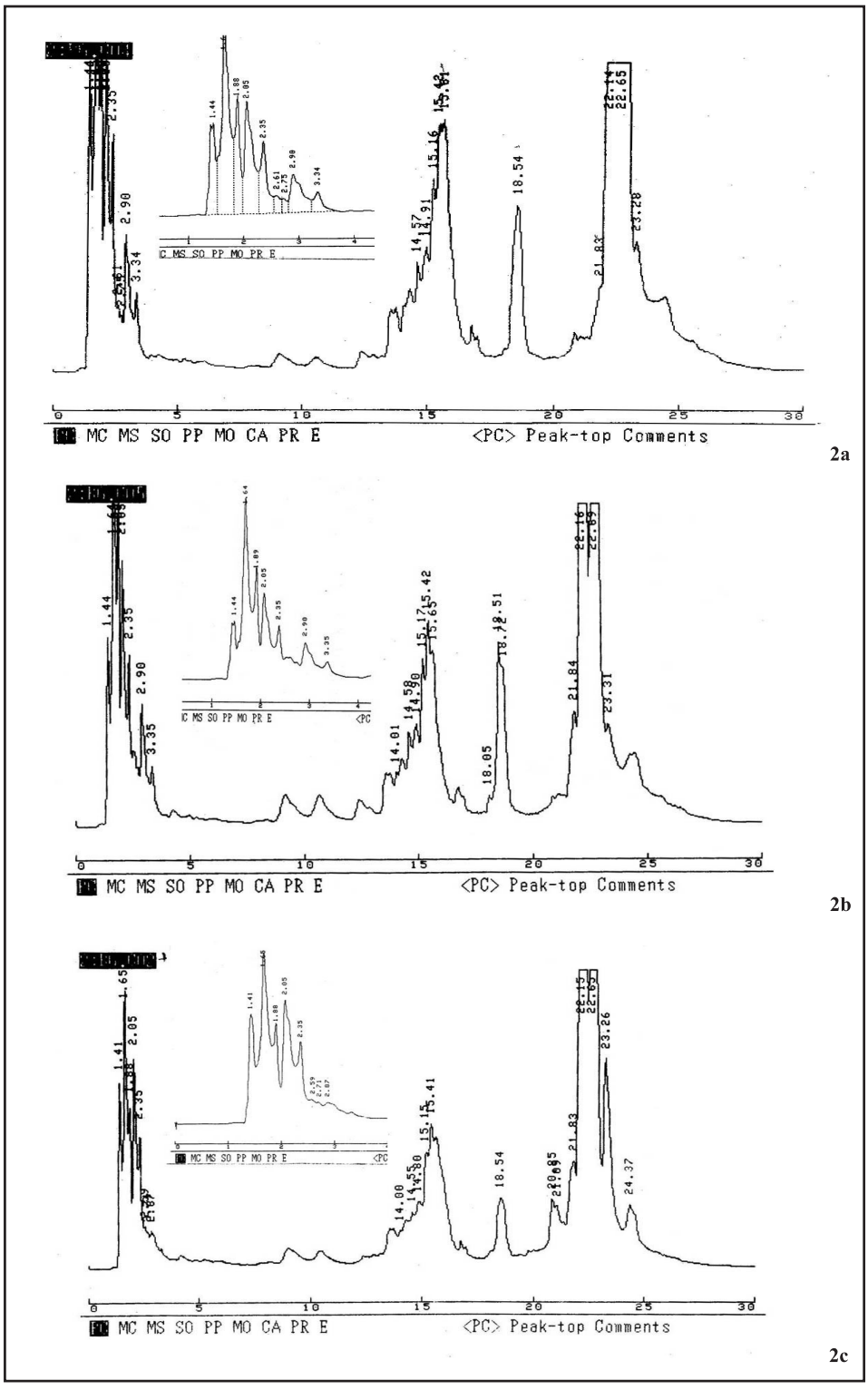


Figure 2. *Seed protein profile for a) the male parent, b) the female parent and c) indica.*