The Progress of Recent Breeding Work on Cotton in Ceylon

D. V. ARIYANAYAGAM, Botanist and Senior Research Officer and R. T. WIJEWANTHA, Research Officer, Department of Agriculture, Ceylon

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Introduction

THE HISTORY of cotton cultivation in Ceylon and the advances in the improvement of this crop up to the year 1952 have been reported by Chandraratna (1) and Fernando (2). The programme of cotton improvement initiated by these workers was continued at the Hambantota Cotton Research Station. The present paper deals with the progress made in the next four years.

The strain *BP 79*, selected in Ceylon from the variety known by the same name introduced from Uganda in 1940, was recommended for cultivation in Ceylon in 1944. The release of this variety gave a fillip to cotton cultivation in this country and the acreage under the crop increased by leaps and bounds. Arrangements were made for the purchase of the entire production in Ceylon by the Wellawatta Spinning and Weaving Mills at fixed prices. The standard requirements of the Mills were Ugandas capable of spinning a minimum of 40 counts and having a staple length of 11/8 in. The mills were satisfied with the variety *BP 79* in respect of these requirements, but after some time they complained that it was neppy.

Neppiness is the term used to describe the presence of small knots or neps of fibre on the yarn. There are two common types of nep, viz.: " tangled nep " caused by a small knot of immature fibres and " seed coat nep " also caused by a small knot of fibre, often immature, but attached to a fragment of seed coat. These fragments come from the chalazal end of the seed, where a point of weakness—caused by the larger inter-cellular spaces in the sub-epidermal layers—appears to exist (3 & 4). The neppiness in *BP 79* is mainly of the latter type.

Other introduced varieties of medium-staple cottons were tested against *BP 79* and it was found that some of them were better yielders. It was therefore considered desirable to initiate a breeding programme, to include both selection and hybridization, in order to envolve a better strain than *BP 79*. This programme gave due recognition to all the desirable characters which are deemed necessary in a good variety of cotton. Special care was taken to reduce neppiness.

Straight Selection

One of the main objectives in the selection work being improvement of quality, the pureline method of selection was adopted. A careful watch, however, was kept on such characters as ginning percentage, halo length, lint index and yield at every stage of selection.

1. Selection in 5143C, 5143C × 5143 and Co.4. Selection on three of the Upland medium-staple varieties viz.: *543 × Cambodia, 5143 Cambodia × 5143 & Co. 4* was commenced in *maha* 1949/50. The first two varieties were introduced to Ceylon from S. Africa in 1940. *Co. 4* was introduced from India in 1941. Up to the time of commencement of selection, these varieties were acclimatized and the purity maintained in the Hambantota District.

Picking cotton — Variety B. P. 79

A large number of single plant selections were made in the purity blocks in each of these varieties in *maha* 1949/50 and selfed seed was collected. On the basis of the number of fruiting branches, number of bolls, and ginning percentage the number of selections was reduced to :—

5 1 4 3 C	..	129 selections
5 1 4 3 C × 5 1 4 3	..	142 „
Co. 4	..	91 „

These selections were grown in progeny rows in *maha,* 1950/51 and on the basis of number of bolls, yield and halo length, the following were selected for further testing :—

5 1 4 3 C	..	50 selections
5 1 4 3 C × 5 1 4 3	..	47 „
Co. 4	..	25 „

Further progress in selection could not be achieved in *maha* 1951/52 on account of adverse weather conditions. It was only possible to maintain most of them.

In *maha* 1952/53, the selections in each variety were set down in separate replicated yield trials. The randomised block design was used with single row plots 50 ft. long. Control plots of the parent variety (i.e., selfed seed from the maintenance of purity block of each variety) were set down at regular 5-row intervals. Further selection was based, in addition to yield, on the standards given below. The number of selections retained is also shown in the table below.

The lint from these selections was sent to the Shirley Institute, Manchester, for small-scale spinning test and a summary of the remarks made by the Institute is given below—

" Selections from the variety *5143C* gave yarns weaker and of poorer appearance than those from the variety *Co. 4,* although the yarns from the *5143C* selections did not contain quite so much nep as those from *Co. 4* selections. There was a wide range of spinning quality in the samples from the *5143C* × *5143* selections. The strength of the yarns spun from the *Co. 4* selections was on the whole satisfactory. In the yarns of fair and moderate appearance (*Co. 4*) there was a considerable amount of nep, most of which appeared to be seed coat fragments ".

The new strains thus obtained in each variety were tested in three separate yield trials with *BP 79* as control in *maha* 1953/54. The results did not reach

Variety	*Halo Length*	*Ginning%*	*Lint Index*	*No. of Selections retained*
5143 C ..	30·0mm & over ..	30·8% & over ..	0·14 & over ..	8
5143 C × 5143 ..	31·4 „ ..	29·2% „ ..	0·17 „ ..	7
Co. 4 ..	30·0 „ ..	27·8% „ ..	0·14 „ ..	5

the level of significance on account of adverse weather conditions during the growing period. All the strains selected from the three varieties were carried over and set down in a combined replicated yield trial against the parent varieties and *BP 79* in *maha* 1954/55. The results are given in Table I. The selections marked with asterisks significantly out-yielded their respective parent varieties at the 1 per cent. point. Thirteen out of the 20 selections tested yielded significantly higher than *BP 79*.

Large-scale spinning tests were carried out with the best selection in each of the varieties and with *BP 79* at the Shirley Institute. The report from the Institute is reproduced in Table II.

Table I

Selections	*Yield in cwt./ acre*	*% of BP 79*
5143C		
S 1—44	11·40	163·5
S 2—36	12·66	181·6
S 3—14	11·27	163·1
*S 4—39	17·55	251·7
S 5—43	11·87	170·3
*S 6—06	19·88	285·2
S 7—19	11·68	167·5
S 8—02	13·95	200·1
Parent Variety (5143C)	10·45	149·8
5143C × *5143*		
*S 10—18	15·35	220·2
S 11—44	9·88	141·7
S 12—34	11·41	163·7
S 13—35	11·94	171·3
S 14—21	10·42	149·4
S 15—05	9·55	137·0
S 16—20	10·53	151·0
Parent Variety (5143C × 5143)	8·30	119·0
Co. 4		
S 19—18	12·27	176·0
S 20—17	9·02	129·4
S 21—14	12·30	176·4
S 22—03	7·86	112·7
S 23—05	10·42	148·4
Parent Variety (Co. 4)	8·77	125·8
BP 79	6·97	100·0
Standard Error ..		14·2
Significant Difference (P = 0·01)		52·4

Significant at the 1% point.

Table II

Variety	*Fibre Tests*						*Yarn Tests Twist Factor = 3·75*				
	Effective Length (32nds in)	*% Short Fibre*	*Maturity Ratio**	*Fibre Wt. per cm **		*Analyser % Trash*	*50s Count Corrected Lea Count × Strength Product*	*Yarn Appearance †*	*50s Count Corrected Lea Count × Strength Product*	*Yarn Appearance †*	*Highest Standard Count ‡*
				Mean	*Standard*						
BP 79	39	34	0·925	150	162	3·39	1804	7	1577	7	38
5143C × 5143	39	35	0·865	193	223	0·91	1650	6	1328	5	35
5143C	42	35	0·860	149	173	0·96	1918	5	1705	4	44
Co. 4	36	34	0·795	173	218	1·52	1568	6	1294	6	27

* N = % Normal fibers ; D = % Dead fibres ; Maturity ratio = $\frac{N-D}{200} + 0{\cdot}70$; Standard fibre weight = Mean fibre weight ÷ Maturity Ratio.

† Yarn appearance classification.

‡ Highest Standard Count = Count in which yarn would be expected to give a count ÷ Strength Product of 2,000 carded, 2.250 combed. This is not necessarily the highest Spinnable Count.

1. Very Good. 2. Good. 3. Fairly Good. 4. Fair. 5. Moderate. 6. Poor. 7. Very Poor.

5143C selection No. S6-06 was the longest and spun the strongest yarns. *5143C* × *5143* selection No. S 10–18 was similar in length to *BP 79* but considerably coarser. It spun rather weaker yarns. *Co. 4* selection No. S 21–14 was the shortest sample; the yarns from this sample were the weakest. The yarns from the *BP 79* sample were very poor in appearance largely owing to seed coat nep. None of the samples gave yarns free from nep, but those from *5143C* were the best in this respect.

While the spinning tests were being carried out at the Shirley Institute, the usual laboratory tests were performed with all the selections, and the highest yielding strains of each variety which conformed to the following standards were retained :—

Lint Index	0·17 and over
Ginning%	30·0 ,,
Halo Length	30mm. ,,

These strains which consisted of three from *5143C* 3 from *5143C* × *5143* and two from *Co. 4* were tested in a final yield trial with the parent varieties as controls in *maha* 1955/56.

The results confirmed those of the previous season. The selection S 6-06, S 10-18 and S 19-18 were the highest yielders in the varieties *5143C*, *5143C* × *5143* and *Co. 4* respectively. The best selection in *5143C* outyielded all other selections. Ginning tests carried out with these selections gave the following figures :—

Variety	*Ginning Percentage*
5143C	33·8
5143C × 5143	33·8
Co. 4	30·5
BP 79	28·7

2. **Selection in Mwanza 561, Mwanza Local, BP 52, Co. 2 & Co. 3.** Selection work was also commenced in the above five Upland medium-staple varieties in *maha* 1951/52. The *Mwanza* varieties were introduced from Tanganyika in 1940, *BP 52* from Uganda in the same year, and *Co. 2* and *Co. 3* from India in 1937 and 1941 respectively.

These varieties were also acclimatized in the Hambantota District before selection work was commenced. The selection procedure adopted was very similar to that described earlier. The number of strains retained at each stage of selection is given in the schedule below :—

	M 561	*ML*	*BP 52*	*Co. 2*	*Co. 3*
MAHA 51–52	22	32	11	3	18
,, 52–53	8	11	3	3	5
,, 53–54	8	11	3	2	5
,, 54–55	5	3	0	0	3

The selections in *BP 52* and *Co. 2* were rejected at the end of *maha 54/55* as they did not reach the required standards in respect of lint index, ginning percentage and halo length.

In *maha* 1955/56 separate yield trials were conducted with the selections in the three remaining varieties against the original unselected materials. The yield figures are given in Table III.

Table III

Selections	*Yield in Cwt./ Acre*	*% of Parent Variety*
M 561		
Selection No. S—12 ..	6·06	106·9
S—15 ..	6·62	116·8
S—16 ..	7·42	130·9
S—17 ..	8·13	143·4
S—18 ..	5·43	95·8
Parent Variety (M 561)	5·67	100·0
M. L.		
Selection No. S—27 ..	7·19	113·7
S—28 ..	8·06	127·5
S—31 ..	7·59	120·1
Parent Variety (M. L.)	6·32	100·0
Co. 3		
Selection No. S—6 ..	9·63	110·7
S—7 ..	7·38	84·8
S—10 ..	8·48	97·5
Parent Variety (Co. 3)	8·70	100·0

Lint from the best selections in these varieties have been sent to the Shirley Institute for comprehensive spinning tests.

It is useful, at this stage, to consider the methods adopted in breeding for reduction of "seed coat neps". The removal of the chalazal cap during ginning (which causes the seed coat neps in the yarns) leaves a bare spot on the seed which can be easily seen on examination of the ginned seed. It is therefore possible to estimate the proneness of any variety to seed coat nep by determining the percentage of seeds showing chalazal cap removal in ginning (3). This technique is, now, proving useful in breeding work against seed coat neppiness. Investigations made at the Shirley Institute have shown that the relation between percent damaged seed and yarn appearance was generally close (5). Apart from the percentage of seeds damaged, the number of seed coat neps in the sample will also depend on the number of seeds per unit weight of lint. Breeding for high lint index is therefore a step in the right direction towards reducing seed coat nep, for of two cottons with the same seed damage count the one with the higher lint index (fewer seeds per unit weight of lint) should produce the less neppy yarn (5).

High lint index has always been an important objective in the breeding work done in Ceylon. The estimation of seed damage count is being done at present.

Cross-pollinating Cotton by hand

Wirawila Cotton Station

Hybridization

An ambitious hybridization project in cotton was commenced in *maha* 1952/53 with 33 crosses. The aim of this project was to evolve superior strains with the following characters :—

1. High yield.
2. Staple length between $1\frac{1}{8}$-$1\frac{1}{4}$ in.
3. Ginning percentage over 30%.
4. Lint index over 0.17.
5. Lint free of nep.
6. Good spinning qualities.
7. High oil content of seed.

This programme consisted of crossing groups of unrelated varieties introduced from different countries. These groups were : *Mwanzas* from Tanganyika, *Co.* varieties from India, *Domain Sakel* from Sudan, *Cambodia* varieties from S. Africa and *BP* varieties from Uganda.

The crosses effected were—

5143 Cambodia × Mwanza Local
× Domain Sakel
× S. G. 29
× B. P. 52
× B. P. 79
× Mwanza 561

S. G. 29 × Mwanza 561
× Co. 2

Mwanza Local × B. P. 52
× Co. 2
× Domain Sakel

Co. 3 × B. P. 79
× Domain Sakel
× Mwanza Local
× Mwanza 561
× B. P. 52

Co. 2 × Domain Sakel
× Mwanza 561

Co. 4 × B. P. 52
× Mwanza Local
× Domain Sakel
× Mwanza 561

B. P. 79 × 5143 Cambodia
× Co. 4
× Mwanza Local
× 5143 Cambodia × 5143
× Mwanza 561
× Co. 2

5143 Cambodia × 5143
× Domain Sakel
× Mwanza Local
× Mwanza 561
× B. P. 52

Domain Sakel × Mwanza 561

The pedigree method of hybrid selection was adopted. Individual plant selection was commenced in the F2 generation of each cross and these were carried into progeny rows in F3. The questionable lines were eliminated ; and within the desired progeny rows two to three individual plants were selected and selfed. In the following season the selections, which were in the F4 generation, were grown in unreplicated compact family blocks. Sufficient uniformity was observed within the progeny rows and even between progeny rows within a family. However, promising progency rows were selected and as many flowers as possible were selfed within the selected progeny rows. Laboratory tests have been carried out on the selected rows. Sub-standard strains will be rejected and the balance will be tested in replicated yield trials in F5. The results so far indicate that suitable strains which combine most of the desired characters could be obtained.

Scheme of Seed Production

The procedure adopted regarding the maintenance of purity of *BP 79* and the multiplication of seed for issue to cultivators has been described in detail by Fernando (2). To state very briefly, the methods followed were Harland's Mass Pedigree System of maintenance and the subsequent multiplication in isolation under open-pollinated conditions at Wirawila Cotton Station. This scheme of seed production has not proved very satisfactory due to various reasons, chief among which are the generally low

yields obtained at Wirawila, and occasional crop failure due to unfavourable seasons.

A new scheme of seed production has now been envisaged. The purity maintenance will be in a two-acre block at the Tissa Paddy and Cotton Research Station. Multiplication of pure seed in the first stage will be at Wirawila Cotton Station and Bata-ata Agricultural Station in 20-acre blocks at each station. This ensures reasonable seed multiplication in the first stage, even in the event of crop failure at one station.

With a minimum average yield of 2 cwt./acre of seed cotton at these two stations, the seed produced will be sufficient to grow 400 acres of purity cotton at the maximum seed rate of 15 lb./acre. These 400 acres will be grown in the second stage of seed multiplication at Pelwehera, Maha Illuppallama and a selected village in the Hambantota District. The isolated Gonnoruwa cotton-growing village, where a fairly high standard of cultivation is practised and where yields more than the average are obtained, would be suitable for this purpose. The seed produced at these three centres should be sufficient to meet the Island's requirements of cotton seed.

Replacement of BP 79

The defects in *BP 79*, the cotton exclusively grown in Ceylon at present, have been mentioned earlier. In view of the superior strains now available, it was considered desirable to replace *BP 79* with one of the new selections. The *5143 Cambodia* selection S6-06 has proved to be superior to others at every stage of testing. It out-yielded all other selections ; the staple length of 42/32 in. was extremely satisfactory ; its ginning percentage was 33.8 ; it spun the strongest yarns and had the best yarn appearance, especially in respect of neppines. Sufficient quantity of lint for a commercial spinning test was available only at the end of the *maha* 1955/56 season. The commercial spinning test was carried out at the Wellawatte Spinning and Weaving Mills and the report is given below—

Cotton :—

Colour ..	.. White
Cleanliness	.. Fair
Feel ..	.. Smooth
Card Sliver	.. Clean
Card Web	.. A little Neppy

Yarn :—

Cleanliness	.. Clean
Evenness ..	.. Even
Neppiness	.. A little neppy

Losses :—

Blowroom	.. 4%
Card ..	.. 6%
Speed frame and ring	.. 3%

Count × Strength Product :—

40s Warp ..	.. 1811
50s Warp ..	.. 1655
60s Warp ..	.. 1508

The report is, on the whole, very satisfactory. The *5143 Cambodia* selection was as good as the best lint imported by the mills in respect of neppiness and pre-spinning losses. The test proved beyond doubt that this selection was far superior to *BP 79* in all respects. *BP 79* was used in the mills only for spinning 20S and 30S counts, whereas the new selection is capable of spinning 40S and 50S counts. This coupled with the higher ginning percentage of this selection, enhances its value and the growers could expect a higher price for the seed cotton of this variety.

It has, therefore, been decided to announce this selection as *HC 101* (Hambantota Cotton 101) and issue it for general cultivation in Ceylon. It is now in the first stage of multiplication and it is expected to completely replace *BP 79* in 1958.

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