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NATURAL CROSS-POLLINATION OF COTTON IN CENTRAL QUEENSLAND

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SUMMARY

The percentage of natural cross-pollination occurring in cotton in the Callide Valley was investigated at Biloela Research Station over a period of 2 years.

The level of crossing was 4·17% between plants within rows, 1·72% between adjacent rows, and 0·12% at a distance of 70 ft from the foreign pollen source. Enclosing plants in a bee-proof cage proved effective in almost eliminating cross-pollination.

I. INTRODUCTION

American upland cotton (*Gossypium hirsutum* L.) is a partially cross-pollinating species, the amount of out-crossing varying between countries and localities. The percentages of cross-pollination reported from different localities in the United States and in India, China, Russia and Egypt have been reviewed by Loden and Richmond (1951). In the United States it varied from 1 to 81% and in the other four countries from 2 to 35%. It is probable that the level of cross-pollination depends chiefly on the honey-bee population (Balls 1929; McGregor 1959).

A knowledge of the amount of natural cross-pollination occurring in cotton in Queensland is important for the following reasons:—

(1) The methods of plant breeding in use are dependent on a certain amount of natural crossing to maintain genetic variability in the breeding stocks (Harland 1949; Richmond 1951).

(2) If the percentage of natural crossing is too high, some controlled pollination of breeding lines must be done to maintain their identity.

(3) The possibility of producing hybrid cotton-seed is greater in an area of high natural crossing.

(4) The production of pure seed depends on adequate isolation if natural crossing occurs.

The first study on the amount of natural crossing occurring in cotton in Queensland was made in 1964-65 and 1965-66 at the Biloela Research Station, where most of the basic cotton-breeding work is conducted.

Initial results of this work are reported in this paper. The study is being continued at Biloela and at three other cotton-growing areas in Queensland.

The immediate aim of the experiments at Biloela was threefold:—

(1) To measure the amount of contamination in one cultivar planted adjacent to another and the extent of the contamination at varying distances from the foreign pollen source.

(2) To measure the amount of natural crossing occurring in a bee-proof cage, with the possibility of using such a cage for initial seed increase of introductions if crossing is negligible.

(3) To measure the amount of natural crossing occurring between contiguous plants within rows, a knowledge of this being of importance to the breeding programme.

II. MATERIALS AND METHODS

Two cultivars were used in the experiments, namely Deltapine Smoothleaf, the commercial cultivar in Central Queensland, and Empire Red Leaf, a marker stock carrying a dominant gene for the production of anthocyanin pigmentation in the leaves and stems.

Experiment 1.—To measure the amount and extent of contamination, the design of experiment I incorporated a plot of four rows of Empire Red Leaf marker bounded on each side by a large area of Deltapine Smoothleaf (see Figure 1).

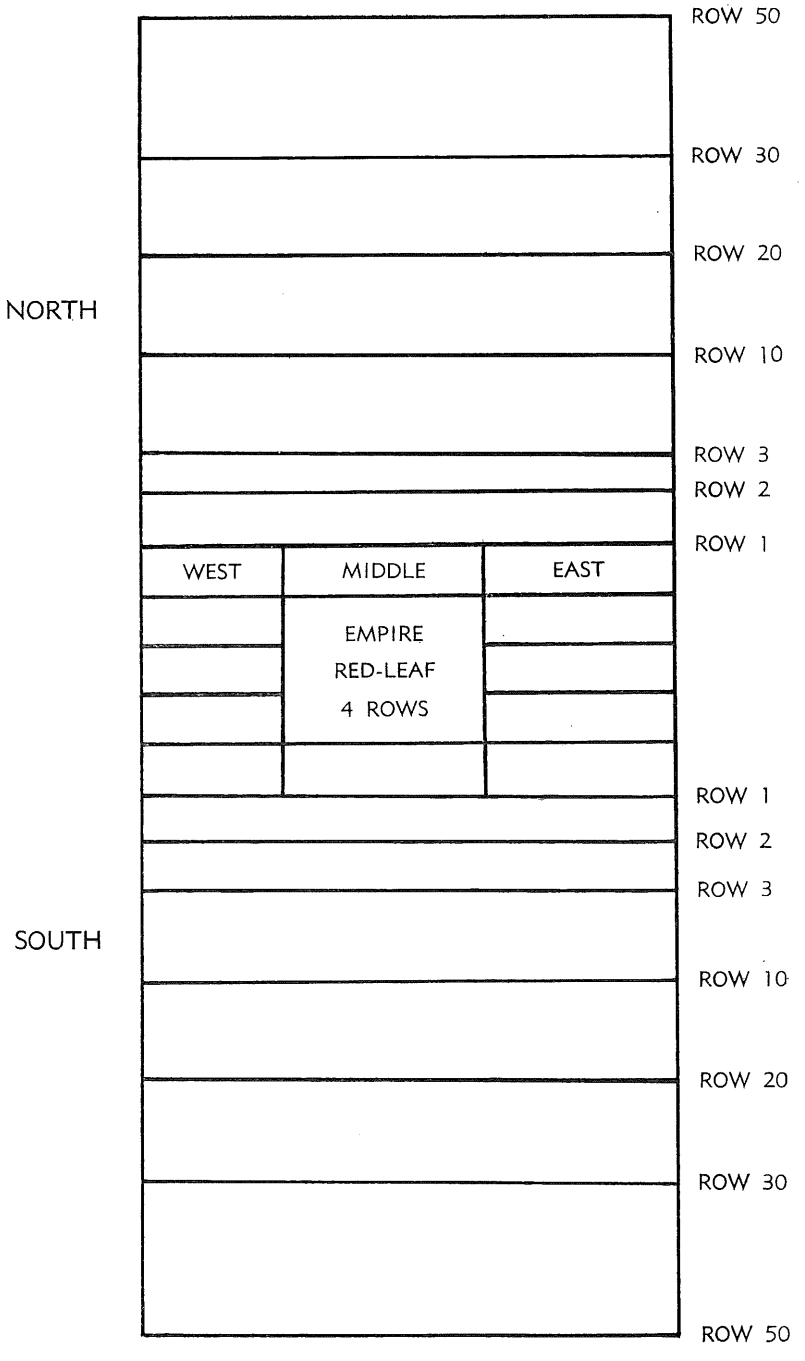
Seed-cotton samples large enough to give approximately 1,000 seeds were taken from the Deltapine Smoothleaf (green) 1, 2, 3, 10, 20, 30 and 50 rows distant from the Empire Red Leaf pollen source.

In addition, in Deltapine Smoothleaf row 1 north and south, 100 bolls were tagged at three different times during the season, namely at the commencement of flowering, at peak flowering, and at late flowering.

Samples were also taken from the east, middle and west of row 1, north and south.

This experiment was conducted in 1964-65 and repeated in 1965-66.

Fig. 1. Field plan of experiment I.



Experiment II.—To measure natural crossing in a cage and in the field in 1964-65, red and green plants were grown alternately in a bee-proof cage. All seed of the green plants was harvested and bulked. In 1965-66, four rows, each containing alternate red and green plants, were grown. A bee-proof cage was placed over the two inside rows for a distance of 10 ft. Nineteen green plants were harvested from both inside and outside the cage from the two inside rows (only 19 plants were available inside the cage).

The seed of all samples was planted separately the following season and the number of red plants counted to yield the percentage of natural crossing occurring at the various sampling points.

Row spacing in both years was 3 ft 6 in. In 1964-65 the plot received six sprayings with insecticides, and in 1965-66 a weekly spraying programme was carried out from the commencement of squaring.

III. RESULTS

For experiment I, the percentages of crossing occurring at varying distances from the Empire Red Leaf pollen source, at three different positions in the adjacent rows and at three different times during the season, are summarized in Table 1.

TABLE 1

PERCENTAGE OF NATURAL CROSSING AT BILOELA RESEARCH STATION IN 1964–65 AND 1965–66

Distance in Rows from Pollen Source	1964–65				1965–66				Two-year Mean
	No. Counted	% Red			No. Counted	% Red			
		North	South	Weighted Mean		North	South	Weighted Mean	
1	412	1·30	3·00	1·70	1,494	2·13	1·35	1·74	1·72
2	513	0·00	0·80	0·19	1,521	0·91	0·53	0·72	0·45
3	554	0·00	0·30	0·18	1,535	0·36	1·26	0·78	0·48
10	693	1·20	0·00	1·00	1,653	0·25	0·12	0·18	0·59
20	562	0·00	0·60	0·18	1,598	0·12	0·00	0·06	0·12
30	223	0·00	0·00	0·00	1,307	0·00	0·00	0·00	0·00
50	725	0·30	0·00	0·14	1,582	0·00	0·00	0·00	0·07
1 East edge ..	489	0·30	2·50	1·20	1,461	4·24	1·33	2·74	1·97
1 Middle	543	0·40	0·30	0·40	1,509	0·41	1·53	0·99	0·69
1 West edge ..	359	0·90	0·40	0·60	1,461	2·96	1·39	2·19	1·39
1 Early season ..	1,958	2·80	2·70	2·80	2,663	0·80	0·08	0·45	1·62
1 Mid-season ..	1,128	0·24	0·00	0·18	1,437	4·31	1·95	3·13	1·65
1 Late season ..	177	1·80	0·70	1·70	755	7·44	3·01	5·30	3·50
Mean		1·00	1·14			1·51	0·83		

In Table 2, the percentages of natural crossing occurring between contiguous red and green plants grown inside and outside a bee-proof cage in experiment II are given.

TABLE 2

COMPARISON OF CROSSING INSIDE AND OUTSIDE A BEE–PROOF CAGE

—	Plants Grown Inside Bee-proof Cage (1964–65)	Contiguous Plants Grown Inside Bee-proof Cage (1965–66)	Contiguous Plants Grown Outside Bee-proof Cage (1965–66)
No. of green plants tested	Bulk sample	19	19
Average number of offspring per green plant ..	100 (bulk sample)	149	141
No. of green plants giving red offspring ..	0	1	18
Percentage red plants in offspring of green plants tested	0	0·03	4·17

IV. DISCUSSION

The overall results indicate that the percentage of natural crossing is very low at Biloela. In the rows adjacent to the Empire Red Leaf marker, it was in the vicinity of 1·7% in both years, while in rows beyond this it fell to less than 1·0%, with a negligible amount at 20 rows (70 ft) distant. These results are similar to those of workers in other countries, viz. Afzal and Khan (1950) in the Punjab and Simpson and Duncan (1956) and Fryxell (1956) in the United States.

In both years there was a tendency for a greater amount of crossing at the two outside edges of the plot than in the middle. This is in general agreement with the results obtained by Fryxell (1956).

In 1964-65 there was a trend for a greater percentage of crossing at early and late flowering, with a reduction at peak flowering. In 1965-66, however, there was a progressive increase in the percentage of crossing from early to late flowering, that at the peak of flowering being intermediate in magnitude. Thus it is apparent that although there is no consistent trend over the two seasons, in both there were relatively large differences in levels of natural crossing occurring at different times of the flowering period. It is therefore probable that cultivars exhibiting different flowering characteristics would have different levels of natural crossing with a common foreign pollen source.

The results from the contiguous planting of alternate red and green plants showed that the level of crossing between plants within rows is some 2½ times that between plants in adjacent rows. Enclosure of the contiguous planting in a bee-proof cage reduced the amount of natural crossing between plants by over 99%. This should prove an effective technique in preventing crossing between small initial seed increases of introduced varieties and strains, where the location

of these in isolation from other cotton presents a problem. In Egypt, the practice of selfing plants by transplanting to bee-proof cages has been reported by Puransingh Sangwan (1957).

It is noted from Table 1 that there was little difference between the mean level of crossing to the north and south of the Empire Red Leaf plot in 1964-65, but in 1965-66 the level to the north was almost twice that to the south. Why this occurred is not known, although the chief wind direction experienced in the area is from the south-east. This may affect the movements of honey-bees, which were very prevalent in the plots in both seasons (despite a programme of weekly spraying with insecticides) and are thought to be the chief cross-pollinating agents.

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