BREEDING CULTIVARS FOR SPECIFIC ENVIRONMENTS - THE QUEENSLAND EXPERIENCE.

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INTRODUCTION

Queensland cotton production has increased substantially over the past eight years - from 20 000 to 160 000 bales - and further expansion is predicted. Throughout this period, cotton growers have been dependent on U.S.A. developed cultivars, Deltapine SL, Deltapine SL 13 (a selection from Deltapine SL made by Queensland D.P.I.), Deltapine 16, and Deltapine 61.

Different cultivars are now becoming commercially available including Australian bred cultivars, and cotton growers now have a choice of which cultivar to plant. Hence, the question is, do the different cotton growing regions in Australia require different cultivars, and which cultivars are best adapted to each of these regions?

GENOTYPE - ENVIRONMENT PATTERS

To help understand the adaptation of cultivars to the different regions, C.S.I.R.O. and Queensland D.P.I. have been growing cooperative cultivar trials in all major cotton growing regions of Australia, since 1974/75 (Fig. 1). During the first few years, these trials contained cultivars developed in the U.S.A. However, in the last few years, these trials have contained many cultivars and experimental lines developed by C.S.I.R.O. and adapted to Australian conditions.

For our discussion, we will consider the lint yield results from the past four seasons, 1980/81 to 1983/84. The trials contained 25 cultivars or experimental lines and were tested at nine to eleven locations each year (Table 1). Of the 25 cultivars or experimental lines tested each year, some were common over a number of years (Table 2).

I have taken the results from these trials, and looked for patterns in the data. At each location the cultivars and experimental lines were ranked for lint yields and the rankings were compared between locations. If the ranking of cultivars is similar at two locations, then those two locations are combined into one group. In the simple example (Table 3), locations A and B are similar; and locations B and C are different even though the average yields for locations B and C are the same.

Yield data from all locations in a single season were investigated for genotype-environment patterns. Patterns in 1980/81 (Fig. 2) indicate that Deltapine cultivars yielded best in N.S.W. and southern Queensland, Coker was best in the Dawson, and Namcala/Stoneville cultivars were highest yielding at Emerald.

Early maturity cultivars were highest yielding on the Darling Downs in 1981/82 (Fig. 3); whereas, Deltapine 61 and Sicot were the best cultivars in all other regions of N.S.W. and Queensland.

Deltapine 55 and 367 were superior in N.S.W. in 1982/83 (Fig. 4); Coker 315 was best in the Callide/Dawson and the Darling Downs; and there were no large differences between cultivars at Emerald.

In 1983/84, the early cultivars, 367 and McNair were highest yielding in N.S.W. and the Darling Downs (Fig. 5), while Sicot and some N98 selections were best in central Queensland.

Genotype-environment patterns for these four seasons, suggest that the cotton growing areas of Australia could be divided into regions. If we wish to have two regions, then the division is central Queensland and southern Queensland/N.S.W. (Fig. 6). If we wish to have four regions then the division is Emerald, Callide/Dawson, Darling Downs, and St. George/N.S.W. Hence, the N.S.W. cotton growing areas are environmentally uniform; whereas, the Queensland cotton growing areas are environmentally diverse.

The genotype-environment patterns become more interesting when results for two or more years are combined. Twelve cultivars were common in the 82/83, 83/84 trials (Table 2); ten cultivars were common in the three season 81/82, 82/83, 83/84; and eight cultivars were common over the four seasons 80/81 to 83/84. Patterns obtained from these combined analyses (Fig. 7, 8, 9) show that Deltapine type cultivars performed best in N.S.W./ southern Queensland in 80/81, in N.S.W. in 81/82 and 82/83, and in central Queensland in 83/84. Early maturity cultivars performed best at Emerald in 80/81, on the Darling Downs in 81/82, at Emerald in 82/83, and in southern Queensland/ N.S.W. in 83/84. Coker 315 was highest yielding in the Callide/Dawson in 80/81, in the Dawson in 81/82, in Callide/Dawson, southern Queensland and northern N.S.W. in 82/83, and in northern N.S.W. in 83/84.

These patterns are slightly different from the patterns obtained from single seasons, because 25 cultivars were used to generate patterns for a single season, whereas 12, 10 and 8 cultivars were used to generate patterns for two, three, and four seasons combined.

Although I previously suggested that it may be possible to use the yield performance of different cultivars to divide the Australian cotton growing areas into different regions; the patterns obtained from the analyses combined over seasons suggest that this may not be possible. At a particular location/ region, the environmental variation from one season to the next is quite large - e.g. in one season Deltapine cultivars produce the highest yields, whereas, in another season early maturity cultivars are the best yielders.

With this large difference between seasons for genotype environment patterns, farmers and researchers must obtain the yield performance of cultivars over a number of seasons (3 or 4 seasons) before deciding on the best cultivar for that region. To shorten the time required to collect yield performance data, plant breeders use the variation between locations within one season to simulate the variation between seasons at the same location. For example, yield performance of cultivars in N.S.W. in 81/82, 82/83 and 83/84 (Fig. 8) could have been determined by using data from N.S.W. in 81/82 and 82/83 and data from the Darling Downs in 81/82. That is, the 81/82 Darling Downs environment is being used to simulate the 83/84 N.S.W. environment.

This is one reason why C.S.I.R.O. and Queensland D.P.I. jointly organize the Australian Cotton Cultivar Trials which are tested in all cotton growing areas of Australia.

CULTIVAR TRIALS

The best of the 25 cultivars or experimental lines in the small plot trials, are evaluated in commercial-sized trials containing approximately 4-6 cultivars. One reason we use commercial-sized trials is because results obtained from large trials, grown and ginned under commercial conditions, are more readily accepted by cotton growers than results obtained from small plot trials. The relationship of lint yield results from small and large plot trials is illustrated in Tables 4, 5, 6, and 7. This relationship may not seem very good, however, we must remember that a yield difference between cultivars of 3% or 0.2 bales/ha is less than the experimental error associated with these trials.

Lint yield results of cultivars and experimental lines in Queensland for the past three seasons have been summarized into three regions, Darling Downs, Callide/Dawson and Emerald. I suggest, that when farmers or researchers are discussing cultivar performance for a region, the results from that particular region and results from other regions must be considered.

Darling Downs

Coker 315 is the most promising of the cultivars tested in large plots on the Darling Downs (Table 4). Fibre length, strength and micronaire are acceptable, however, one disadvantage of Coker 315 is its hairy leaf and consequently lower grades. Other promising cultivars from the small plot trials are the Namcala selection 8/30 and the okra leaf selection 367, both of which have good fibre quality.

Early maturity cultivars are ideally suited to the Darling Downs. High yielding cultivars or experimental lines that are significantly earlier than Deltapine 61, the current commercial cultivar, are 81 023-24, Coker 315, 367, McNair 220 and 75 007-3 (Table 4). McNair 220 and 75 007-3 both have low lint percentages and hairy leaves which reduce the grades of the lint.

Information on the performance of Deltapine 90 is limited but promising.

Callide/Dawson

Two promising cultivars for the Callide/Dawson are 367 and Deltapine 90 (Table 5). Both these cultivars have yield and fibre quality superior to Deltapine 61. Experimental line 367, with its earlier maturity and okra leaf may require different insect and/or water management than the current commercial cultivar, to realize its full yield potential.

Information on the performance of Deltapine 90 is limited but promising.

Emerald

We have a limited amount of trial data from Emerald (Table 6), but the results suggest that okra leaf selection 367, and the Namcala selection 8/30 are promising. Selection 8/30 has a fibre quality similar to Namcala and a yield similar to Deltapine 61. The early maturity cultivar, 367, maybe high yielding at Emerald in some seasons.

Dryland

Production from non-irrigated cotton has increased dramatically over the past three years, because many farmers have discovered that gross margins from dryland cotton are substantially better than from traditional dryland summer crops such as sorghum. Dryland cotton in central Queensland is grown as skip row (ie. plant 2 rows, skip 2 rows), whilst on the Darling Downs dryland cotton is grown either as skip row or as complete rows.

Australia does not have a cotton breeding program specifically for breeding cultivars adapted to dryland conditions. However, experimental lines and cultivars from the irrigated breeding programs are being tested under dryland conditions. Small plot and large plot cultivar trials were evaluated in central Queensland in 1981/82 and 1983/84 under skip row conditions. Yields varied dramatically between seasons; 81/82 was a low yielding season, in 82/83 virtually no cotton was planted, and the 83/84 season produced good yields (Table 7).

These trials have identified a few promising experimental lines for dryland conditions (Table 7). Okra leaf selection 367 and experimental line N95 A1 have high lint yields and good fibre quality. Namcala and the Namcala selection 8/30 are also promising choices for dryland environments. The Texas stripper type cultivar, Tamcot Camd E, yielded poorly under these skip row dryland conditions of central Queensland.

Dryland cotton production will certainly expand in the future, hence there is a need to identify suitable cultivars for dryland environments.

ACKNOWLEDGEMENTS

Cotton breeding is a cooperative effort. We thank all the cooperating farmers who willingly let us carry out trials on their properties. We express our appreciation to the C.S.I.R.O. cotton breeding team, Cotton Seed Distributors, and the Queensland Cotton Marketing Board for their vital cooperation. Financial assistance from the Cotton Research Committee is gratefully acknowledged.

TABLE 1. Locations where the Australia Cotton Cultivar Trials were successfully grown.

80/81	81/82	82/83	83/84
Emerald		Emerald	Emerald
	Callide	Callide	Callide
Dawson	Dawson	Dawson	
Darling Downs	Darling Downs	Darling Downs	Darling Downs
St. George	St. George	St. George	
		MacIntyre	MacIntyre
Gwydir (2)	Gwydir (2)	Gwydir (2)	Gwydir (2)
Namoi (2)	Namoi (2)	Namoi (2)	Namoi (2)
Macquarie	Macquarie	Macquarie	Macquarie

TABLE 2. Cultivars included in the pattern analyses combined over seasons.

2 seasons	3 seasons	4 seasons
82/83, 83/84	81/82-83/84	80/81-83/84
Deltapine 16	Deltapine 16	Deltapine 16
Deltapine 55	Deltapine 55	Deltapine 55
Deltapine 61	Deltapine 61	Deltapine 61
Sicot 1	Sicot 1	Sicot 1
Sicot 2	Sicot 2	Sicot 2
Namcala	Namcala	Namcala
McNair 220	McNair 220	McNair 220
Coker 315	Coker 315	Coker 315
Deltapine 41	Deltapine 41	
N40 439H	N40 439H	
N74 367		
N91 8/30		

TABLE 3. An example of genotype-environment patterns.

Cultivar	Location			
	A	B	C	A/B
Deltapine	6	10	8	8
Coker	4	8	8	6
Namcala	2	6	8	4
Average	4	8	8	6

TABLE 4. Performance of some lines and cultivars on Darling Downs.

Cultivar or line	Yield as % of Deltapine 61 (no. of trials)		Remarks
	Small plots	Large plots	
81 023-24	127 (1)		Narrabri, short season
Coker 315	120 (4)	109 (2)	South Carolina
Deltapine 90	117 (1)		Arizona
N91 8/30	114 (3)		Narrabri, Namacala selection
N74 367	112 (4)		Narrabri, okra leaf
McNair 220	111 (5)	104 (1)	South Carolina
75 007-3	110 (4)	95 (1)	Narrabri, short season
Deltapine 41	108 (4)	94 (4)	Mississippi
Namcala	107 (4)	97 (4)	Commercial
N40 439H	106 (4)		Narrabri
Deltapine 55	102 (4)	95 (5)	Commercial
Deltapine 61	100 (5)	100 (9)	Commercial
Deltapine 16	98 (4)	93 (1)	Past Commercial
Sicot 1	96 (4)	101 (6)	Commercial
Sicot 2	95 (4)	102 (3)	Narrabri, glabrous leaf
Yield Deltapine 61 (bales/ha)	5.86	6.09	

TABLE 5. Performance of some lines and cultivars in Callide/Dawson.

Cultivar or Line	Yield as % of Deltapine 61 (no. of trials)		Remarks
	Small plots	Large plots	
Deltapine 90	109 (1)	102 (1)	Arizona
N74 367	109 (3)	101 (1)	Narabri, okra leaf
Coker 315	105 (5)	102 (2)	South Carolina
N40 439H	103 (5)		Narrabri
Deltapine 41	102 (4)	96 (3)	Mississippi
Sicot 2	101 (5)	99 (2)	Narrabri, glabrous leaf
McNair 220	100 (5)		South Carolina
Sicot 1	100 (5)	101 (7)	Commercial
Deltapine 61	100 (5)	100 (10)	Commercial
Deltapine 55	98 (5)	99 (10)	Commercial
N91 8/30	98 (3)	97 (1)	Narrabri, Namcala selection
Deltapine 16	92 (5)	93 (2)	Past commercial
Namcala	87 (5)	89 (5)	Commercial
Yield Deltapine 61 (bales/ha)	8.17	6.42	

TABLE 6. Performance of some lines and cultivars at Emerald.

Cultivar or Line	Yield as % of Deltapine 61 (no. of trials)		Remarks
	Small plots	Large plots	
N74 367	105 (2)	106 (1)	Narrabri, okra leaf
McNair 220	105 (2)	93 (1)	South Carolina
N91 8/30	103 (1)		Narrabri, Namcala selection
Deltapine 55	102 (2)	97 (4)	Commercial
Deltapine 61	100 (2)	100 (6)	Commercial
Deltapine 90		100 (1)	Arizona
N40 439H	100 (1)		Narrabri
Namcala	100 (1)	87 (4)	Commercial
Deltapine 16	98 (2)	82 (4)	Past commercial
Coker 315	98 (2)	80 (1)	South Carolina
Deltapine 41	97 (1)	91 (3)	Mississippi
Sicot 2	91 (1)	95 (2)	Narrabri, glabrous leaf
Sicot 1	87 (1)	95 (6)	Commercial
Yield Deltapine 61 (bales/ha)	5.88	5.97	

TABLE 7. Performance of some lines and cultivars in central Queensland under dryland conditions.

Cultivar or Line	Yield as % of Deltapine 61				Remarks
	83/84		81/82		
	small plots	large plots	small plots	large plots	
N74 367	113	118			Narrabri, okra leaf
N95 A1	110		123		Narrabri, insect resistance
N70 28/3	102		108		Narrabri, insect resistance
N91 8/30	101				Narrabri, Namcala selection
Namcala	99	109	119	110	Commercial
Deltapine 61	100	100	100	100	Commercial
McNair 220	99		110		South Carolina
Deltapine 55	96	102		103	Commercial
Sicot 2	97		112		Narrabri, glabrous leaf
Sicot 1	92	115	104		Commercial
75 007-3	91		95		Narrabri, short season
Tamcot Camd E	86		82		Texas, stripper type
Yield Deltapine 61 (bales/ha)	7.00	6.31	1.93	0.98	

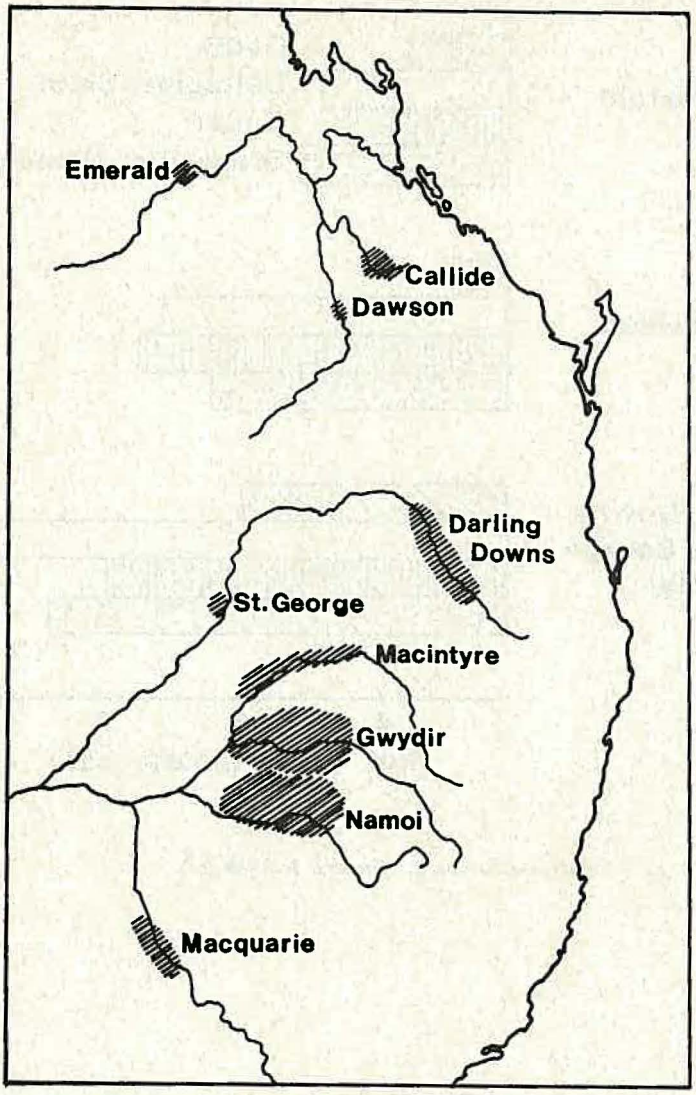

FIG. 1. Cotton growing areas in Australia.

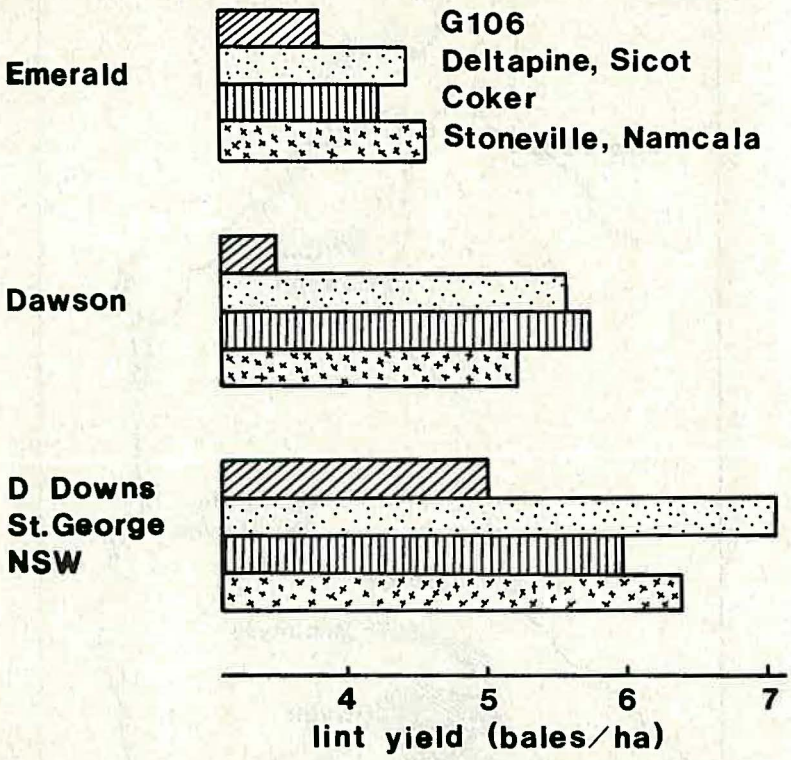

FIG. 2. Genotype-environment patterns for 1980/81.

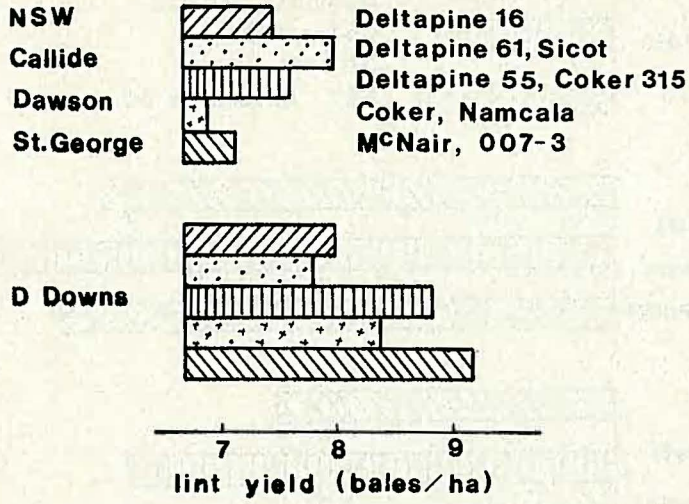

FIG. 3. Genotype-environment patterns for 1981/82.

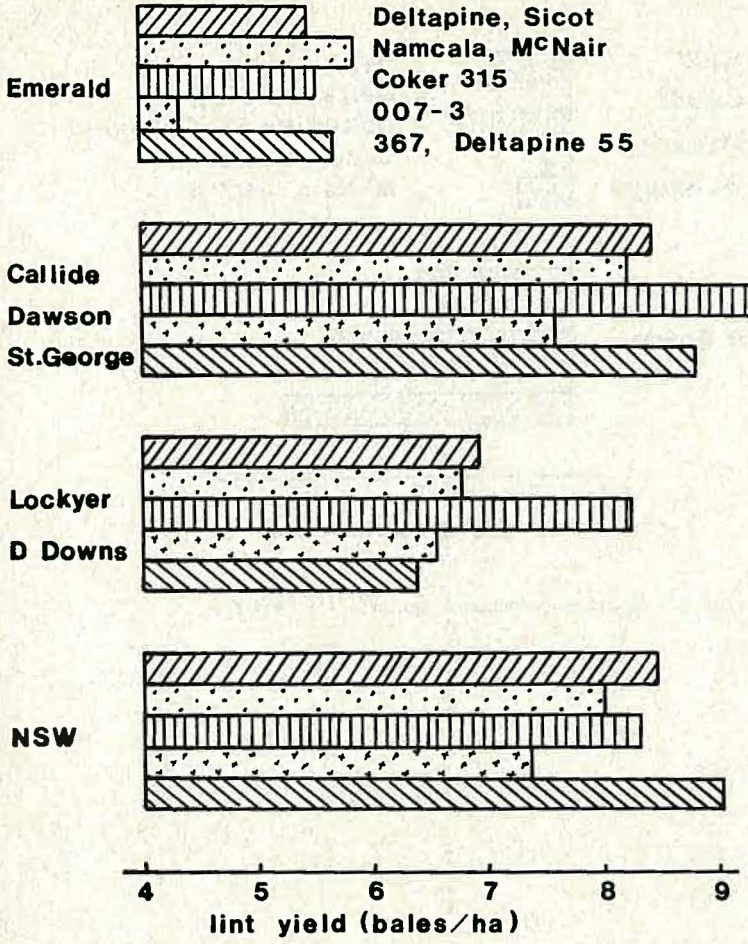

FIG. 4. Genotype-environment patterns for 1982/83.

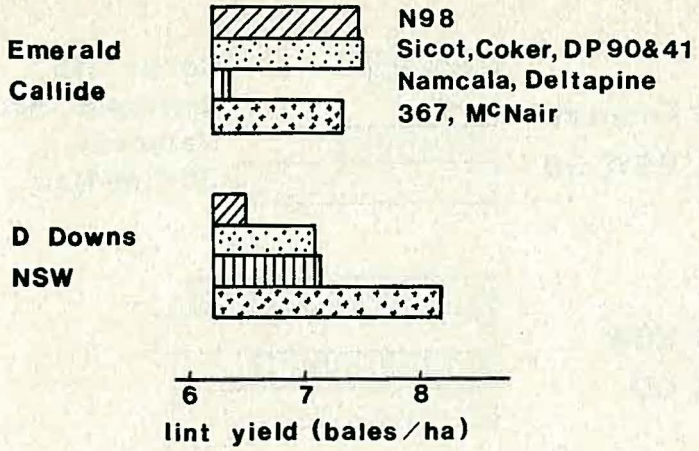

FIG. 5. Genotype-environment patterns for 1983/84.

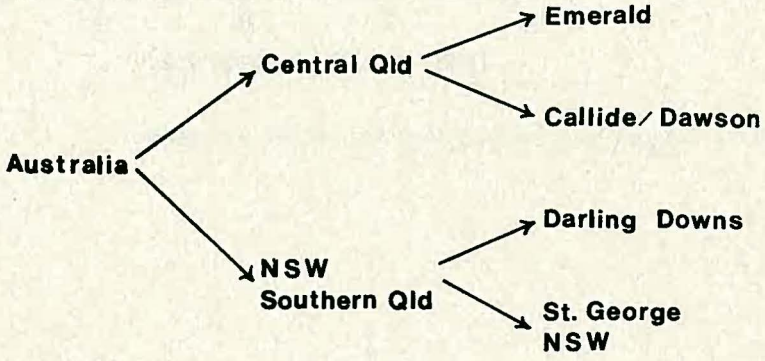

FIG. 6. Division of Australian cotton growing areas into regions.

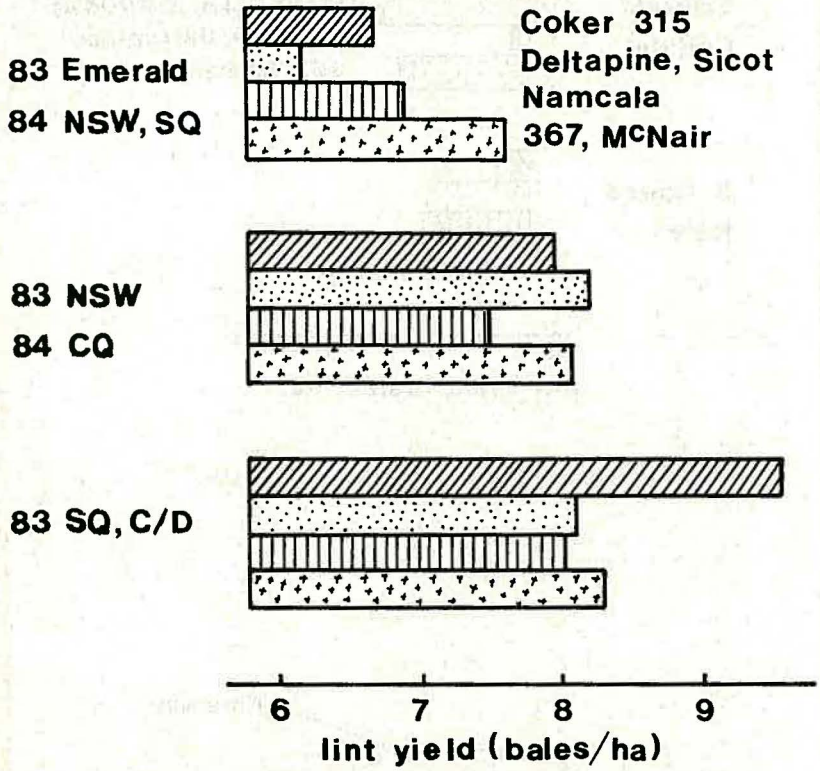

FIG. 7. Genotype-environment patterns for 1982/83 and 1983/84.

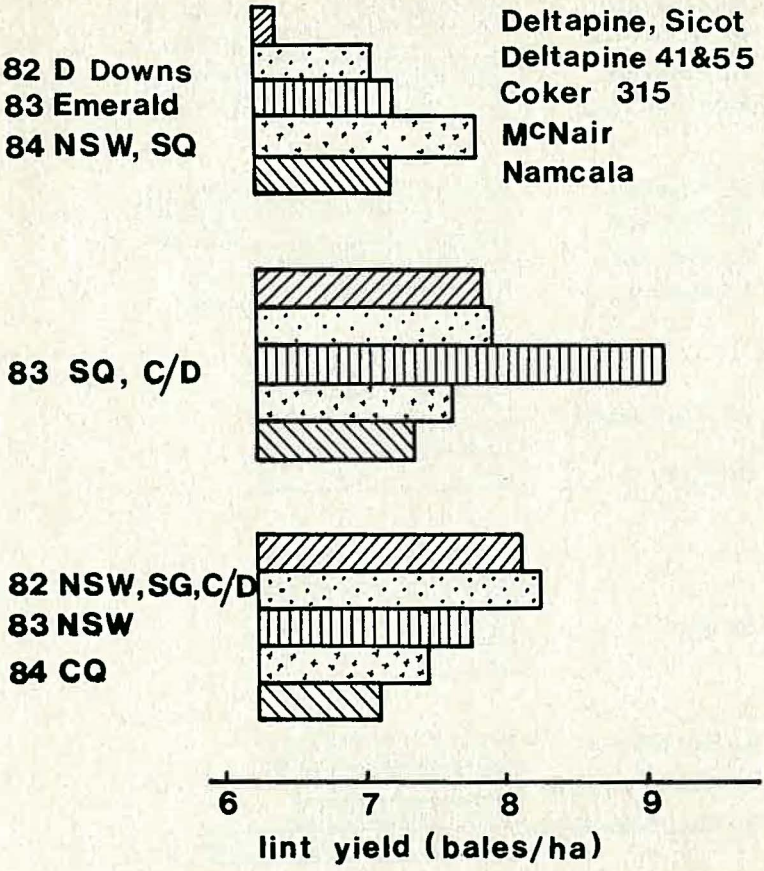

FIG. 8. Genotype-environment patterns for 1981/82, 1982/83 and 1983/84.

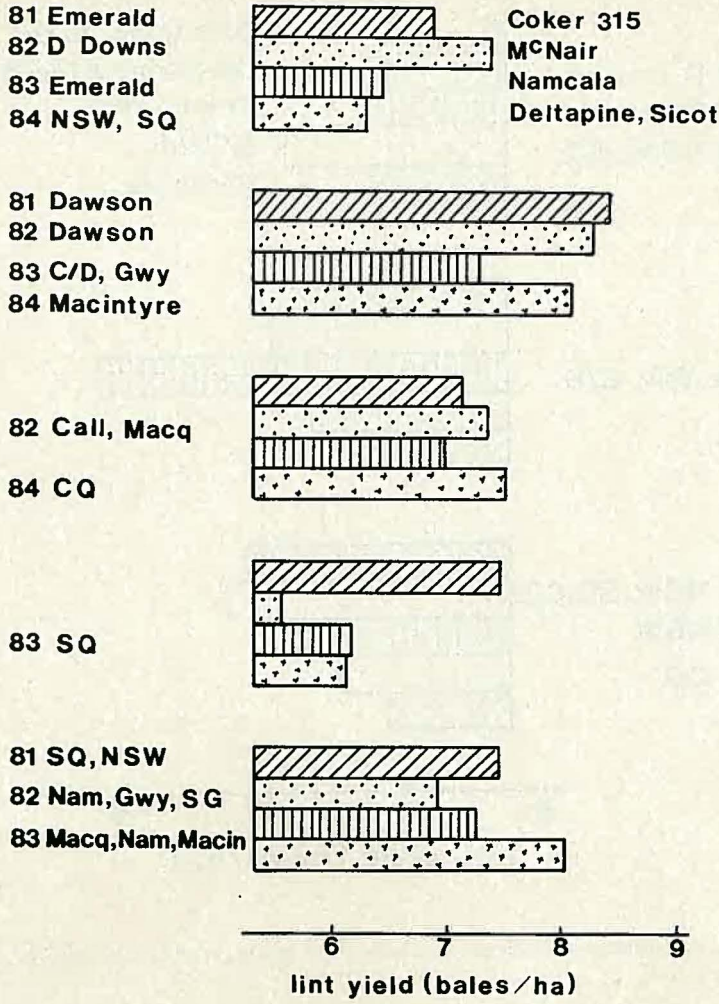

FIG. 9. Genotype-environment patterns for 1980/81, 1981/82, 1982/83 and 1983/84.