PROGRESS IN COMMERCIAL VARIETIES - WHAT'S AROUND THE CORNER HERE AND IN THE U.S.A.

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INTRODUCTION

In agriculture we often hear reports of new wonder varieties that are about to revolutionise agriculture, yet when these varieties are released, if indeed they are released, they seem to fall far short of the publicity that heralded them. A major technological break-through in variety development is rare. Most improvements come in rather small steps. In the next few years improvements will be in small but positive steps.

It is my endeavour here to present you with an objective assessment of what you, the grower, can hope to expect from cotton varieties in the near future.

WHY CHANGE VARIETIES AT ALL?

We should start this examination by asking the obvious question of why should we change varieties in the first place? Of course if you are a grower the answer is simple. Growers will change variety for a perceived improvement in yield, grade or a more stable micronaire. While these reasons are fine we as an industry should really look where our cotton sits in the market place. Improved yield is worth little if we can't sell the lint or if it brings a lower price. The needs of the market are supreme and we need to keep in view what the market wants from us. Commercial history is littered with industries that didn't heed the requirements of the market and lost out to competitors. We have a formidable competition in the synthetic fibre industry.

At present the spinning industry prefers a stronger fibre than we presently produce with Deltapine 61. It also appears that the latest developments in spinning will continue this demand for higher and higher strength fibre. Our primary aim should be to develop a stronger fibre. If we can improve yield and other fibre qualities at the same time, all the better. Not only will this improve our sales position but we can also improve the returns of the grower.

THE SOURCE OF NEW VARIETIES

The Australian Cotton Industry is in a rather unique situation with regard to varieties. The factors leading to this unique position are:-

(i) there is only one cotton planting seed company operating in Australia

(ii) the company does not engage in plant breeding at all

(iii) there are no plant variety protection rights operating in Australia yet

Cotton Seed Distributors Ltd is able to scout the world for potential new varieties and objectively evaluate each one. Most overseas seed companies are willing to supply experimental seed to us with the understanding that a reasonable royalty would be paid if the seed was to be used commercially. The conditions have helped to keep royalty levels in check. However, a change in any of these three conditions would undoubtedly lead to higher royalties and an increase in the cost of seed to the grower.

While we scout the world for potential new varieties there are two major sources of new varietal material. They are the USA and Australia. Varieties from all major cotton growing areas of the USA have been tested. This includes varieties from the Eastern USA, Mid South USA, Missouri, Texas, New Mexico, Arizona and California. Historically, the Deltapine type have performed by far the best in Australia and hence most of our effort in looking for new material is concentrated in this area, although other varieties are checked for suitability.

With our own CSIRO breeding programme in Australia now, we can expect to see more and more good Australian varieties becoming available. I would expect eventually that the Australian varieties will become the most important varieties here as the Australian breeders tailor their varieties for Australian requirements. For instance, in the USA now there is virtually no further breeding for bacterial blight resistance. In the areas where bacterial blight was a significant problem such as Texas they have specifically resistant varieties. However, these varieties do not perform particularly well in Australia. In the remainder of the USA bacterial blight is no longer considered a problem with acid delinted seed. This does not appear the case in Australia. Australian plant breeders are aware of this and bacterial blight resistance is a feature of some new CSIRO varieties.

THE IMMEDIATE FUTURE

As far as a yield performer, the present main variety, Deltapine 61, is a good variety and consequently it must be a good variety that will displace it.

At present there are two potentially promising varieties under development that are likely to replace Deltapine 61.

One of these varieties is Deltapine 90. This is a Deltapine variety with some acala parentage. It appears to be a reasonable yielder in Australia and has a stronger fibre which will make it an attractive variety for the spinners. Cotton Seed Distributors Ltd will be releasing this variety commercially for 1985 planting. While this is a Deltapine type it does exhibit some differences to Deltapine 61. Growers will need to adjust their management to achieve the best performance out of this variety. Deltapine 90, while it is considered marginally shorter in season length to Deltapine 61 in the USA, holds off squaring to a later time than Deltapine 61. Once it commences to square it does so at a phenominal rate. Of course poor crop management during this period would be disasterous as any loss of fruit will result in reduced yield potential. The variety is taller than Deltapine 61 and can exhibit a tendency to go rank with excess nitrogen or squares being stripped off. While the variety can perform well it needs a good management to achieve results. I would draw the analogy between different models of a motor car. If Deltapine 61 is like the FJ Holden, Deltapine 90 is probably akin to a new Commodore. If you expect the Commodore to perform well you have to look after it and treat it a lot better than you treat the old FJ. The same is true of the new high performance varieties. We are all aware of the difficulties some growers experienced in changing from their old model T Fords (Deltapine 16) to the FJ Holdens (Deltapine 61). Once again we are going to have to learn how to handle this new variety to achieve its maximum potential.

While we can reasonably expect a better yield from Deltapine 90 and a better fibre strength, I see no escape from the unstable micronaire that Deltapine varieties have traditionally exhibited in Australia. In very warm seasons the micronaire is likely to be high and in cool seasons the micronaire will be low. While the seed quality of Deltapine 90 is better than Deltapine 61, and we should expect to see some improvement in its crushing qualities and hence a slight improvement in returns for the seed, the seed quality is not so high that care in the selection of seed treatment of the planting seed can be relaxed. Some seed treatments will reduce the vigour of Deltapine 90 planting seed.

The other promising variety is Siokra (formerly N74-367) which is a CSIRO variety. This variety has good colour and yield, a higher strength fibre than Deltapine 61. Normally short season cottons are unable to utilise a

DP 90 available 50% Aust. Cotton area 85/86. Needs protection at squaring.

longer season, however, this variety does have this capability. In a longer growing season it shows a yield advantage of about 5% over Deltapine 61. In a short season, such as last year, the yield advantage is about 20% over Deltapine 61. This characteristic of being capable of handling either a long season or a short season makes the variety exceedingly good for Australia where we experience such variable seasonal conditions compared to overseas cotton growing areas. It is thought that Siokra requires fewer heat units to produce a boll than conventional varieties. The variety is also bacterial blight resistant. Siokra does not have a normal leaf but an ockra leaf and we are examining closely the effect this has on lint grade. In the dry harvest last year there was no difference between the grade of Siokra and Deltapine 61. This may be different in a wet harvest. This variety will be available for commercial release in 1986.

Reduce Boll Rot.
Hairy Leaf → grade ↑
Round leaf.

If I look into my crystal ball these two varieties, Deltapine 90 and Siokra, are the most likely varieties to replace Deltapine 61 and it could be within the next couple of years. These varieties appear to overshadow all the existing varieties in Australia and would consequently be expected to replace them. Namcala, with its high quality lint, still stands out. However, its popularity with growers is quite low. It is one of the few varieties in the world to have a fibre strength high enough for use with some of the future spinning techniques. A new selection of Namcala is being tested for yield performance. Yield ↑ *by CSIRO of 8%.*

SHORT SEASON COTTON

There are various reasons for growers to look to short season cottons. Some regions have a short growing season and hence require a short season cotton to achieve reasonable yields. In the USA there is an increasing interest in short season cotton in areas that have a normal season length but are infested with boll weevil. With a short season cotton spray costs can be reduced significantly at the end of the season when the weevil population has increased dramatically. Here in Australia we may have a parallel type need, should we fail to contain heliothis amigera resistance to synthetic pyrethroids.

Other possible uses for short season cotton are replanting after seedling disease, hail destruction or where weather conditions have prevented normal field preparation. With the developing interest in dryland cotton in Australia a shorter season cotton may also be appropriate here as well.

Our exceedingly variable climate in Australia makes the decision of whether to use a short season variety or a full season variety quite complex. Since most short season varities are incapable of utilising a normal length or long season, some yield is sacrificed in these longer growing season years. On the other hand, the full season varieties will perform very poorly in the short seasons. The grower has to weigh up the frequency of short and long seasons, how well his operation can cope with large fluctuations in income from year to year and even the influence the income pattern has on his level of taxation. It is only when all these factors are considered that the real importance of a variety such as Siokra is appreciated. This is a short season variety that can utilise the longer season and hence does not suffer the normal yield loss in a full season condition.

A number of promising short season varieties are under evaluation. From Deltapine there a couple of short season varieties developed for Mississippi. These are Deltapine 50 (or Strain 150) and Deltapine 52 (or Strain 102). Deltapine 50 has been under increase in Australia for two years. It will be in its first yield trials this year and appears the more promising line. The fibre properties appear good with a fibre strength of 90,000 pressley. The variety will need to be checked for season length in Australia as a number of these shorter season varieties from the Mid-South of the USA are not short season in Australia. Under our climate, many of these varieties develop into full season varieties. Deltapine 41 falls into this category.

Also of interest in the short season area is Deltapine 30. In Southern California and Arizona this variety is used for planting after grain. While our season may not be long enough for this variety to excell, it could still be a valuable variety for replanting after seedling disease or hail. This line is still under seed increase and will be in its first trials next season.

Probably the most promising of all short season lines is the CSIRO variety Siokra. This was discussed fully in the previous section.

DRYLAND COTTON

At present there is a lot of interest in dryland cotton. This interest has been generated by the good returns from cotton compared to the returns from other summer crops and the shortages of irrigation water in recent years. The returns from dryland cotton last year have also boosted interest in dryland cotton although growers should be aware that such a favourable rainfall pattern can be expected probably only once per decade on averages.

For reasons I am unaware, people associate dryland cotton with Texas and hence look for Texas type varieties for dryland cotton in Australia. In actual fact, most of the US cotton crop is grown as dryland cotton so I don't understand this facination with Texas and the exclusion of all other cotton areas as a source of dryland cotton varieties for Australia. Probably the most distinctive feature of the Texas crop of the High Plains and Rolling Plains apart from the quantity of cotton produced is its low yield and low quality. We need to take the blinkers off and look everywhere for the best dryland cotton varieties.

Over the last few years Cotton Seed Distributors Ltd has run dryland cotton trials. This has covered a broad spectrum of seasonal conditions from the hot dry season to the cool wet season last year. Our general conclusions from these trials are that the varieties that perform well under irrigation also perform best in dryland conditions. This is not unusual. In the USA the same varieties are used as either dryland or irrigated varieties in the one district.

HYBRID COTTON

In many areas of agriculture hybrid varieties have increased yields and quality. There has been hope that similar results will occur in cotton. Considerable effort has been put into developing hybrid cotton, yet it appears extremely unlikely that we shall see commercial hybrid cotton before 1990 and it could be most likely much later than this. Many plant breeders feel that conventional cottons will compete favourably with hybrid cottons when they do arrive because of the high cost of hybrid seed production and the steady improvements being continually made in varieties by conventional breeding techniques.

TISSUE CULTURE DEVELOPMENT. FOR VARIETY SCREENING.

CONCLUSION

As growers of Australian cotton you can look forward to an interesting period ahead with new variety development. Of course the price of progress can be high. As the varieties become more specialised they need greater control and management to achieve their full potential. Remember the motor car analogy. The higher the performance, the more care and management the varieties will require from you the grower.

BREEDING COTTONS FOR AUSTRALIAN CONDITIONS

N.J. Thomson,
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Introduction

I will first mention some of the features distinguishing "Australian Conditions". Our industry has developed almost exclusively as a mechanised high-input industry with water and nitrogen being supplied liberally together with frequent insecticide applications to control insect pests. Thus it is similar to the American irrigated industry but is dissimilar from less intensive forms of production practised in many less-developed countries. However it should also be realized that despite many similarities there are also important differences between Australian and U.S.A. growing conditions.

Compared to the western U.S.A. irrigated industry some readily recognisable differences include our rainfall being more variable and often far heavier, and our pest complex being different: here Heliothis spp. are usually more damaging with plant bugs being less important. Generally too, Bacterial Blight is more serious for us and it should also be appreciated that U.S.A. cotton is mostly grown farther from the equator (U.S.A. 28° to 37°: Australia 23° to 32°).

Our industry is also distinguished by the now overriding importance of export markets and by the severity of the cost-price squeeze experienced over recent years.

How does this sort of knowledge influence breeding? Perhaps its greatest importance is that it gave us the initial "heart" to believe that we could breed varieties better adapted to local conditions since U.S.A. breeders are primarily concerned with their own industry. Many questioned at the start of our program whether it was reasonable to expect us to compete with the large U.S.A. breeding programs. I believe this question is now being decisively answered - we can and are producing better adapted genotypes, although in breeding terms, our program is still youthful.

Aims and Plant/Crop Characteristics sought in the CSIRO Program

I described these at the ACGRA conference at Goondiwindi in 1982 but because of the number of new growers entering the industry since then will now restate them. Initially the program's main thrust was on insect resistance but as other shortcomings in American varieties became apparent, the emphasis was shifted towards seeking a general improvement of performance. Our aims are now to breed varieties with high yield and readily marketable quality that have at least some resistance to diseases and pests.

The traits that we consider most important are shown below.

1. SEEDLING VIGOUR - CRITICAL WITH COLD WET PLANTINGS
2. DISEASE RESISTANCE : SEEDLING, BACTERIAL BLIGHT,* VERTICILLIUM WILT, BOLL ROTS
3. PEST RESISTANCE
4. GOOD HARVESTABILITY
   - ERECT STANCE
   - EASY DEFOLIABILITY
   - SLIGHTLY STORM RESISTANT BOLLS
   - CLEAN EFFICIENT PICKING
5. HIGH GIN-OUT
6. HIGH YIELD
7. READILY MARKETABLE PREMIUM QUALITY
   - GRADE
   - LENGTH
   - STRENGTH
   - MIKE

Seedling vigour is particularly important where cool wet periods often occur during sowing as for most New South Wales areas and also for the Darling Downs. While high seedling vigour can't insure a commercial stand under adverse conditions, it certainly increases the chances of success. Besides seedling diseases which may be caused by a number of pathogens, the most important cotton diseases present in Australia are Bacterial Blight and Verticillium Wilt. Although the amount of damage occasioned the cotton crop by Bacterial Blight varies, it is clear that the races present in Australia can decrease yield of susceptible varieties. For instance, in one of our breeding populations, following heavy Bacterial Blight infestation during the season, lines equivalent to Deltapine in susceptibility yielded on average six per cent less than their resistant counterparts. Fortunately major genes for resistance to this disease exist, and are being used in our program.

The case of Verticillum Wilt is somewhat different. Commercially it seems that in recent years the disease has been less damaging, probably because rotation of cotton with other crops has increasingly been practised, and also because climatic conditions have been less favourable for the pathogen. Yet this is not to deny that is is potentially a very serious disease and in our program we select against susceptibility.

Boll rots are caused by a number of organisms of which Bacterial Blight is only one. Thus it should be appreciated that Bacterial Blight resistance will not prevent boll rot, although it may lessen the incidence as will okra leaf - a reduced form of leaf.

A number of plant characteristics effect pest resistance and are considered in our background paper on Host Plant Resistance (Thomson, Reid and Fitt). At Narrabri we are concentrating on glabrousness, nectarilessness, okra leaf and frego bract.

I think the importance of the good harvestability characteristics listed are clear as is the desirability of high ginning out-turn. Characteristic No 6 - high yield - is, of course, the central integrative one, both biologically and commercially "pulling together" most of the preceding characteristics. Finally quality is of major economic moment. The importance of grade and staple is highlighted by the substantial premiums and discounts applied to departures from the base category of middling 1 3/32" so I won't comment further. Strength is not so well "sign posted" but is nonetheless extremely important. Many American varieties suffer a strength loss when grown in Australia and in our program we are aiming towards a <u>minimal</u> increase of stelometer strength of 1.5 g/tex (equivalent to about 6000 Pressley strength units). Micronaire is another difficult attribute - it is very "environment-sensitive", fluctuating widely, depending on growing conditions. Our aim is to curb some of this sensitivity so that our cotton more and more falls into the commercially desirable readings from 3.6 to 4.9 micronaire.

Progress

The aims of the first project we began in 1974 was to develop glabrous and frego bract cultivars. Our first releases from this program were SICOT 1 (a conventional type), SICOT 2 (glabrous leaf), and SICOT 3 (glabrous leaf, frego bract). Since release, further growing and testing of these varieties has been done. From this it can be said that SICOT 1 is an established alternative to Deltapine 61 having better seedling vigour and better seed and oil quality while SICOT 3 has shown that it has a higher yield potential (although not always realised, see accompanying background paper on its commercial performance). It also produces a better grade of fibre. In the 1983/84 season Heliothis egglay, under high pressure conditions, was lower on this variety than nearby Deltapine 61, thus confirming research-based expectations (Table 1).

TABLE 1. PEST NUMBERS ON SICOT 3 AND DP 61 IN ADJACENT COMMERCIAL PLANTINGS.

	SICOT 3 Eggs/M As % of DPL 61 Eggs/M High Activity Period 5	Mean Over Whole season	Mites % of SICOT 3 plants affected % of DP 61 plants affected
Farm 1	77	88	75
Farm 2	80	92	89
Farm 3	24	29	100
Farm 4	65	69	78

Interestingly SICOT 3 also appeared to be associated with less mites. By contrast SICOT 2 has not performed as well commercially as anticipated and has been dropped from the seed increase program.

Lines from later-started projects are now entering the commercial arena. We are taking advantage of this conference to release two new varieties - SIOKRA and Improved Namcala. SIOKRA (previously known as N 74 367) is an early maturing, bacterial blight resistant, okra leaf type that has given higher yields than Deltapine 61 in three years of tests (Table 2).

TABLE 2. MEAN YIELDS (KG/HA) OF SIOKRA cf TO DELTAPINE 61.

	SEASONS			
	81/82	82/83	83/84	Mean
No of Sites	4	32	17	
SIOKRA	1923	1851	1764	1846
DPL 61	1828	1781	1482	1697
% SIOKRA / DPL 61	105	104	119	109

This variety also has a high ginning out-turn and higher strength than Deltapine 61. Okra leaf has shown in our work as a good pest resistant character (see paper by Thomson, Reid and Fitt) so given the combination of good properties inherent in the variety we are confident that it will benefit the industry considerably. Cotton Seed Distributors started increasing this variety last season and by the 85/86 season there should be enough seed available to plant 10,000 ha. (7,000 — 10,000)

Although Namcala has high quality and Verticillum tolerance very little is now grown because of its low yield. Peter Reid therefore (as an interim measure until David Luckett's program had time to achieve results) selected within Namcala for higher yields. The success of the program is shown by the results achieved in 3 seasons of multisite testing (Table 3).

TABLE 3. MEAN YIELDS (KG/HA) OF CSIRO NAMCALA SELN cf TO NAMCALA.

	SEASONS			
	81/82	82/83	83/84	Mean
No of Sites	3	11	8	
Namcala Seln	1991	1731	1700	1807
Namcala	1835	1598	1609	1681
% Seln / Namcala	109	108	106	107.5

Many other promising advanced lines coming from our program cover a range of morphological types and varying characteristics, although some still need further selection to overcome deficiencies or to achieve morphological uniformity.

Relationship of relative performance to climate

I recently looked at some of our results and found some interesting relationships between climate and the performance of varieties, relative to commercial Deltapine 61. I did this by first using a 200 day period from October 1st to April 18th to denote a "growing season". Then as a preliminary characterisation of seasons I obtained rainfall totals, mean daily evaporation rates, maximum and minimum temperatures and radiation and cumulative day degrees for this period. Then, using trial results from both the Australian Cotton Cultivar Trial (jointly run by us and the Q'ld. Dept. of Primary Industries) and where necessary other trial data for the Namoi and Macquarie sites, I looked to see whether there was any relationship between the yield of various varieties (relative to the yields of the commercial standards Deltapine 16 and/or Deltapine 61) and these climatic indices.

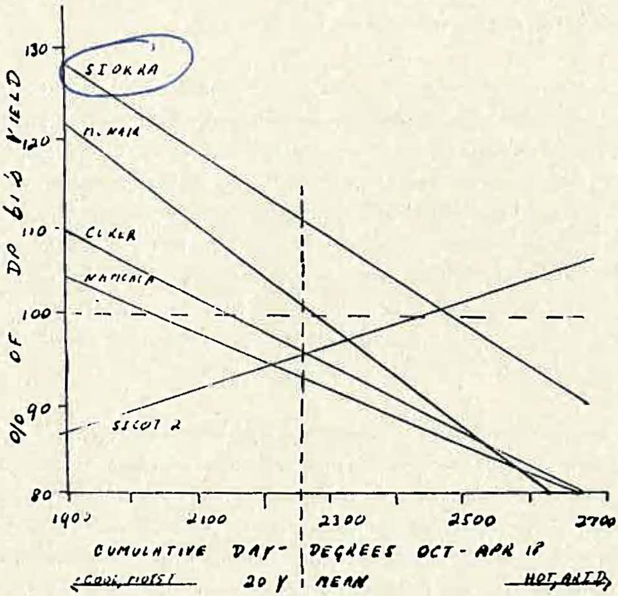

Fig 1. RELATIONSHIPS: RELATIVE YIELD AND SEASONAL WARMTH

In many cases there was a strong relationship. Usually the best relationship was with cumulative day degrees and I've used this to construct Figure 1.

From this we can see that, relative to Deltapine 61, Namcala, Coker, McNair and N 74 367 did better under cool moist conditions and worse under hot dry conditions. SICOT 2 is an exception doing worse under cool moist and better under hot dry conditions. However this relationship also allows an estimate to be made of when (under what seasonal conditions) a variety will yield absolutely more or less than Deltapine 61. This is shown by looking at the 100% relative yield dotted line. We can see from this that Namcala would only be expected to outyield Deltapine 61 in an exceptionally cool wet year whereas McNair 220 intersects this line near the 20 year mean and therefore could be expected to do so around 50% of seasons. However McNair's yield drops off very rapidly in hot dry seasons and it produces very poor grades. Encouragingly, with our new variety SIOKRA, we can see that we would expect that in all except the hottest seasons it should exceed Deltapine 61's yield.

Some words of warning. It should be understood that these relationships have been based on the trial results from one MacQuarie and two Namoi Valley sites, and the climatic indices used were for Narrabri Agricultural Research Station at Myall Vale. Although the relationships hold also for the Moree-Gwydir area they fall away and become far less strong when Queensland sites are included. Therefore too much should not be read into them. Also I again stress that they are based on relative values. It doesn't mean that say with Namcala you wouldn't necessarily get a good yield in a hot dry year - it's just saying that all else being equal Deltapine 61 will give an even better yield.

Nevertheless I believe that this analysis helps considerably in understanding the often perplexing variability between variety performance that we see from season to season and site to site. With McNair, SIOKRA and SICOT 2 the relationships seem in turn to be related to earliness or lateness. McNair and SIOKRA are early maturing varieties and do best in cool (= short seasons) and SICOT 2 is a late maturer doing better in hotter (= longer) seasons. However in the use of Coker and Namcala their behaviour doesn't seem to be related so strongly to maturity. We've usually considered they're about the same maturity as Deltapine 61.

Breeding for Dryland Cotton and New Areas

So far I've been discussing irrigated cotton. However dryland cotton looks like being of considerable importance in the future. Sensing this, since 1981 we have planned to sow at least one dryland trial in the Namoi Valley and have supplied seed for the Queensland Department of Primary Industries to test at Biloela. Trials were successfully carried out in both districts in 1981/82, were not sown in 1982/83 because of drought while in 1983/84 the Namoi trial was literally "washed out". However the Biloela trial was a success.

TABLE 4. SOME VARIETY RESULTS IN DRYLAND TRIALS
LINT YIELD AS % OF DELTAPINE 61

Variety	Trial Site 81/82	81/82	83/84	Remarks
SIOKRA			113	Perhaps doubtful if would do so well in arid year
N95 A1	119	123	110	CSIRO: Insect res prog
N70 28/3	100	108	102	" " " "
N74 956			106	Our general program
DP 41			102	Deltapine variety
SICOT 1	115	104	92	Although poor in small scale Biloela trial did well large scale
SICOT 2	108	112	97	
DP 61	100	100	100	
DP 90			98	
Namcala	79	119	99	
McNair 220	78	110	98	Short season variety
TAMCOT CAMDE	61	82	86	Texas short season variety
DPL 61 (kg/ha)	214	401	1575	

Results for these three trials (Table 4) are interesting in that, despite the hot dry conditions of 1981/82 resulting in low yields and the cool moist conditions of 83/84 giving high yields, a few lines behaved consistently e.g. N 95 A 1 was high yielding relative to Deltapine in all three trials and the Texas short season line Tamcot CAMDE was low yielding each occasion.

Despite initial misgivings then it seems that we will be able to identify consistently good dryland varieties fairly readily. Another general observation we can make from these trials is that, contrary to many expectations, the Texas short season varieties have not performed well whereas some of our locally bred material has, despite it having been selected under irrigated conditions. We therefore will increase our work on dryland cotton in the future, starting off by testing a wider range of our locally bred material. This year we intend to sow trials at Narrabri, North Star and Biloela.

Earliness and New Areas

We have been breeding for earliness for a number of years despite the cessation of cotton growing in the short season MIA environment in the early 1970's. We believe that early maturity will be valuable for late sowing in all areas and for normal sowing on the Downs and the upper Macquarie.

While we have made considerable progress by pursuing early maturity as a primary consideration along with yield and quality our best combination of yield, quality and earliness has been achieved with SIOKRA where earliness was really incidental to yield and quality. An estimate of the earliness of this variety, McNair 220 and another of our high performance lines is given below.

DAYS EARLIER (TO 60% BOLL OPENING) THAN DELTAPINE 61
FOR DIFFERENT BOLL MATURATION PERIODS

	MARCH	APRIL	MAY
75007-3	8	12	21
McNair 220	6	9	15
N74 367	6	9	15

SIOKRA is interesting in that it is not a short season variety in the traditional mould of being early to flower, rather it is as late as Deltapine 61 but then sets and matures its fruit more rapidly (probably a consequence of its okra leaf).

Most of the new cotton growing areas in New South Wales have a much shorter season than Narrabri. Their advent gives new impetus to our short season program. Peter Reid has much of interest coming along which should be beneficial to these more marginal areas. In the interim we see SIOKRA as being better suited than SICOT 1, SICOT 3, Deltapine 61 or 90 for these areas.

Acknowledgements

Plant breeding is very much a team activity and besides Peter Reid and David Luckett our group is made up of long serving technical officers Craig Patrick and Lindsay Heal, with David Sheil being a more recent apointee. While 'running the show' technically Craig and Lindsay have been responsible for many innovations in planting, harvesting and processing samples. Thanks are also extended to the New South Wales Department of Agriculuture for many services while of course we co-operate closely with the Queensland Department of Primary Industries. Thanks are also due for the long continued support of all cotton farmers via the ACGRA and CRC and specifically to those individual farmers who co-operate in district trials.

BREEDING CULTIVARS FOR SPECIFIC ENVIRONMENTS - THE QUEENSLAND EXPERIENCE.

Peter Lawrence, John Berthelsen, Jenelle Hare.
Queensland Department of Primary Industries.

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 82/83, 83/84	3 seasons 81/82-83/84	4 seasons 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	

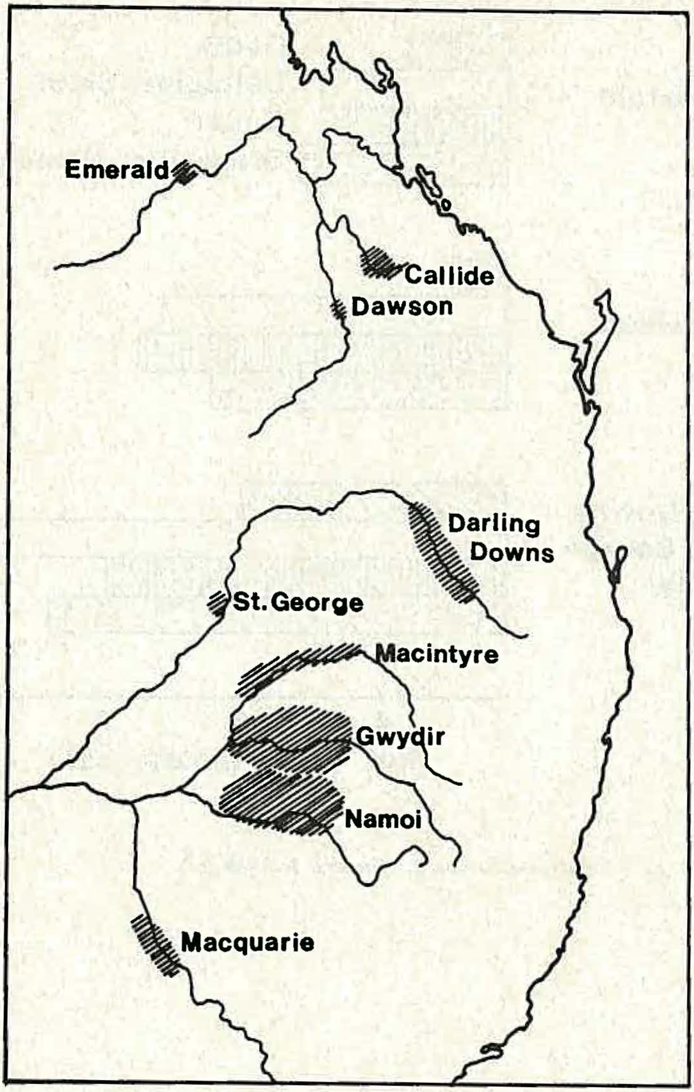

FIG. 1. Cotton growing areas in Australia.

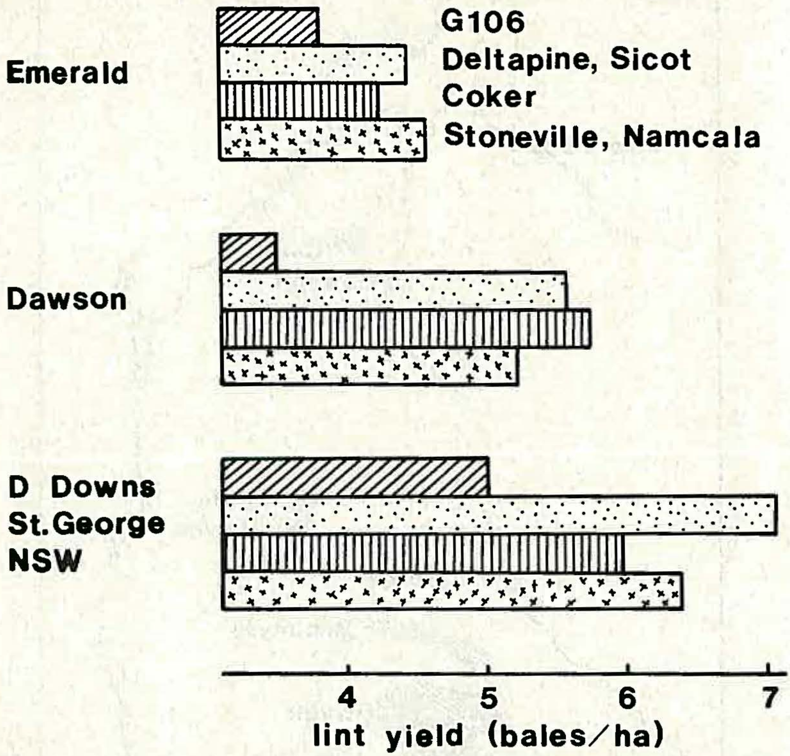

FIG. 2. Genotype-environment patterns for 1980/81.

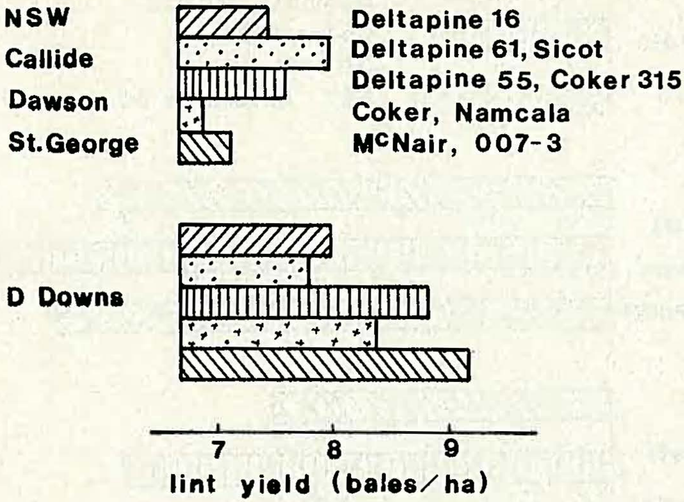

FIG. 3. Genotype-environment patterns for 1981/82.

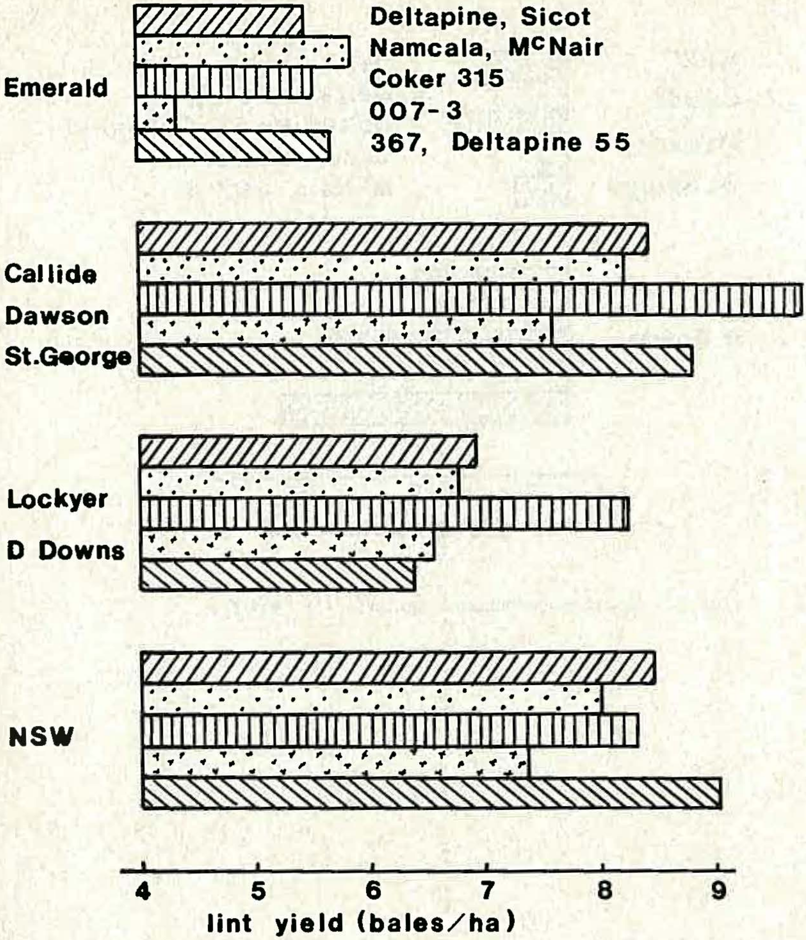

FIG. 4. Genotype-environment patterns for 1982/83.

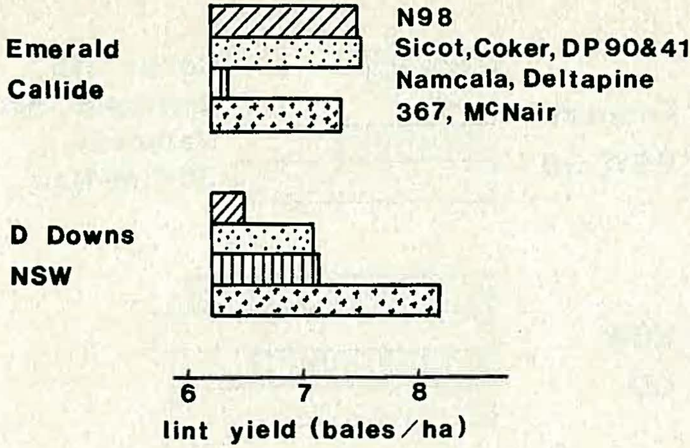

FIG. 5. Genotype-environment patterns for 1983/84.

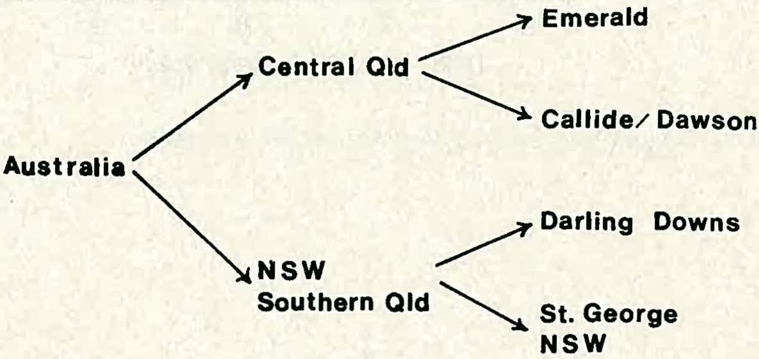

FIG. 6. Division of Australian cotton growing areas into regions.

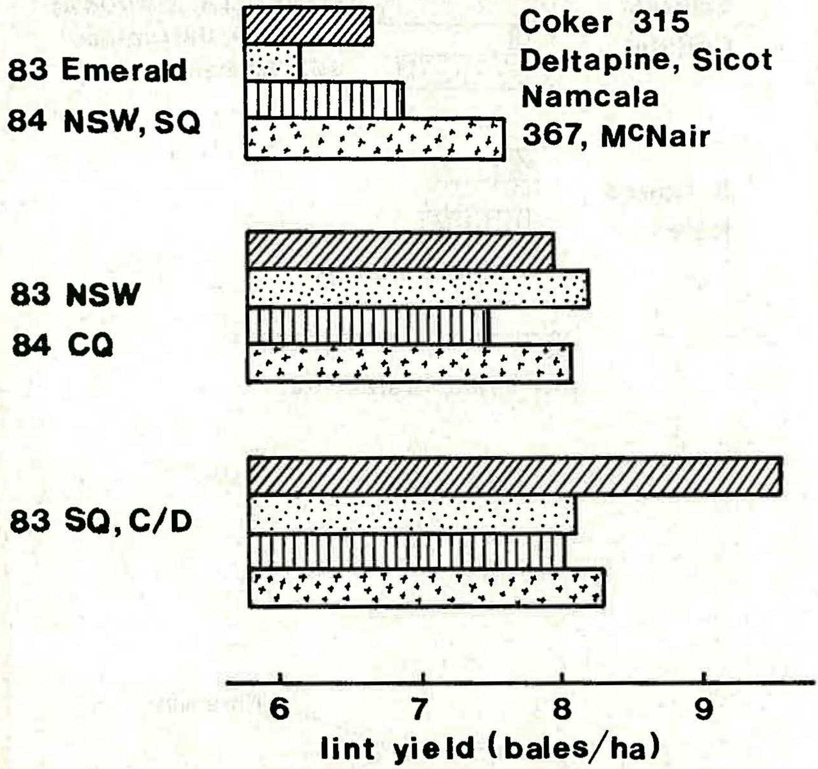

FIG. 7. Genotype-environment patterns for 1982/83 and 1983/84.

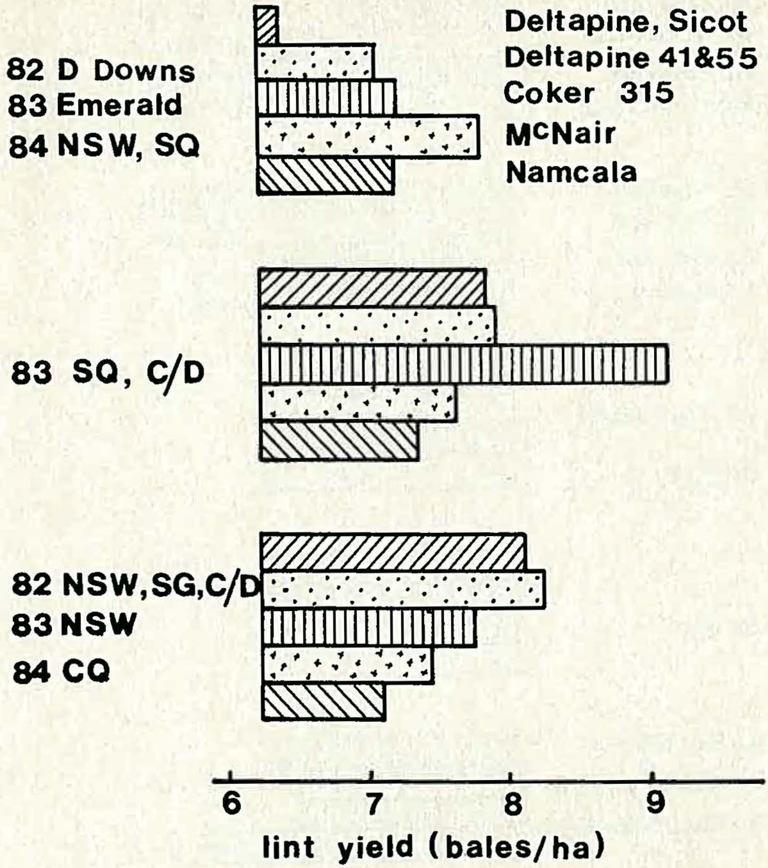

FIG. 8. Genotype-environment patterns for 1981/82, 1982/83 and 1983/84.

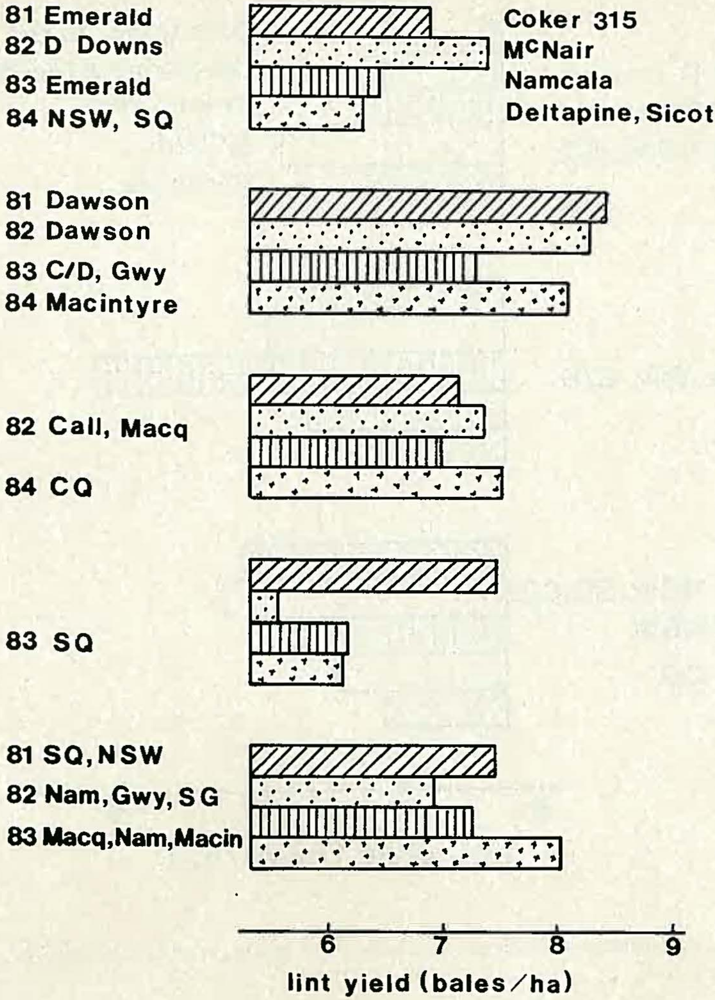

FIG. 9. Genotype-environment patterns for 1980/81, 1981/82, 1982/83 and 1983/84.