

BREEDING COTTONS FOR AUSTRALIAN CONDITIONS

N.J. Thomson,
CSIRO Cotton Research Unit.

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 COOL 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 Verticillium 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 it 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 minimal 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		Mites
	As % of DPL 61	Eggs/M	% of SICOT 3 plants affected
	High Activity Period 5	Mean Over Whole season	% 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.

No of Sites	SEASONS			Mean
	81/82	82/83	83/84	
	4	32	17	
SIOKRA	1923	1851	1764	1846
DPL 61	1828	1781	1482	1697
<u>% SIOKRA</u>				
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 Verticillium 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.

No of Sites	SEASONS			Mean
	81/82	82/83	83/84	
	3	11	8	
Namcala Seln	1991	1731	1700	1807
Namcala	1835	1598	1609	1681
<u>% Seln</u>				
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.

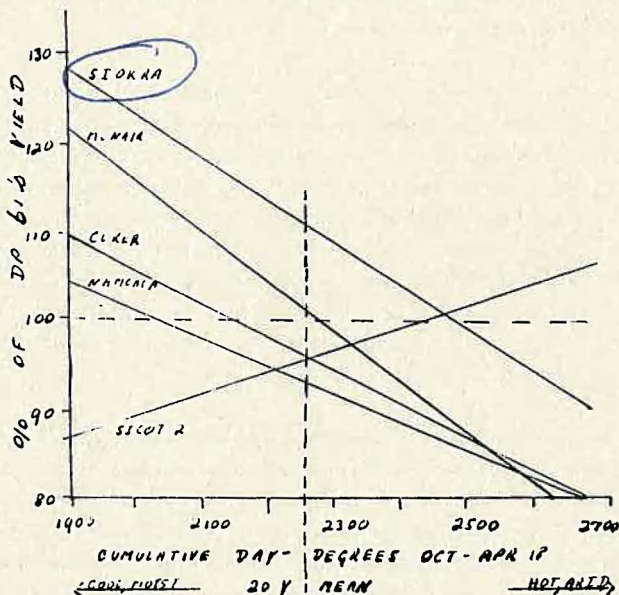


Fig. 1. RELATIONSHIPS: RELATIVE YIELD AND SEASONAL WARMTH

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			Remarks
	81/82	81/82	83/84	
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 Lockett our group is made up of long serving technical officers Craig Patrick and Lindsay Heal, with David Sheil being a more recent appointee. 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 Agriculture 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.