

V K 91

7/1991

**Cotton Research and Development Corporation**  
**FINAL REPORT ON OVERSEAS TRAVEL**

**Project: DAN 57C - Study tour to USA - G A Constable**  
**Organisation: CSIRO Cotton Research Unit**  
**Officer: G A Constable, Principal Research Scientist**  
**Itinerary: July 1 to July 21; California and Georgia (see attached)**

**Summary:** This visit was made to study recent research. The topics of most interest were crop nutrition, mycorrhizae, growth regulators, row spacing and breeding. The following sites were visited: University of California at Berkeley, Davis, Riverside, West Side Field Station and Kearney Agricultural Center. USDA Cotton Research Station, Shafter. CPCSD Research Station, Shafter. University of Georgia at Athens, Tifton and Griffin. USDA Forest Service, Athens.

*This visit has been invaluable in establishing the applicability of USA cotton research under local conditions. We have opportunities for collaborative research with research groups in the USA which could be utilised.*

Points of note were:

Waterlogging induced iron chlorosis was observed on cotton in California. Those symptoms were on their heavier soil and with border check irrigation. Experiments are underway to address potassium deficiency, including a comprehensive study with 11 sites in most cotton producing States of the USA. Copies of computer programs from Georgia evaluating soil or plant tissue nutrient balance were obtained to compare with similar work at Narrabri.

Research in California has identified alternative Pix application strategies, particularly for narrow rows (75 cm). This visit has enabled us to place those results in comparison with Australia. Early plant and fruit development in California was not constrained - giving all plants with perfect architecture. Under those conditions most fruit loss is due to physiological shedding, so yield and maturity responses to rowspacing and growth regulators would be expected. In Australia, early season conditions often adversely affect plant architecture and fruit set. Fruit shedding is less likely due to physiological factors and more to insect damage, so we would expect less response to Pix and narrow rows.

There was no evidence of a syndrome in the USA similar to our Galathera problem. The visit identified a number of research approaches and contacts for future work.

**Financial summary (\$):**

Allocation	Amount
From CRDC	4086
From Hoechst	1000
<b>Total</b>	<b>5086</b>

Expenditure	Amount
Airfares	2192
Internal travel	767
Accom & meals	2345
Others	204
<b>Total</b>	<b>5508</b>
Difference	-422

Copy on Final Reports File  
Copy sent to Directors

## RECOMMENDATIONS

1. Travel and the exchange of scientists with other countries is an essential part of scientific research, especially in Australia where we are relatively isolated. The experience gained with such visits is invaluable, so the cost is cheap compared with other costs of research projects.
2. For VAM subjects, although no similar problems were found, the contacts made may help with establishing treatments and interpretation in future results.
3. There are opportunities for collaborative work on nutrition. The waterlogging induced iron chlorosis subject could be addressed by similar experiments in both NSW and California. We should make contact with the potassium project in Arkansas, under Dr D Oosterhuis, with a view to having a similar experiment in Australia. Our future understanding of potassium deficiency would be assisted by this connection. Both these projects could be taken up by the new Research Agronomist position in NSW Agriculture.
4. Pix and rowspacing studies in Australia should consider testing a range of sowing dates. Moderate sowing dates may produce plants with suitable architecture and vigour to be responsive to Pix and narrow rows. Evaluation of our cultivars under narrow row conditions is also necessary. These research projects will begin in 1991/92.

## ACKNOWLEDGEMENTS

Dr Bill Weir, Farm Advisor with the University of California and Dr Johnny Crawford Extension Plant Pathologist with the University of Georgia, were tireless in their assistance with the visit. They provided comprehensive guided tours of research facilities and friendly hospitality after hours.

Hoechst Australia kindly contributed to the costs of the trip and their support of local research should be applauded.

## ITINERARY

Date (July)	Location	Name	Subject
2	Berkeley	Tom Isakiet O Huisman	VAM verticillium
3	Davis	Mike Davis Roland Meyer Stuart Pettygrove	VAM nutrition nutrition
4	Davis-Merced		public holiday
5	Merced	Bill Weir	K trials
8	Westside	Claude Phene Tom Kerby	Water Pix
9	Shafter	Bruce Roberts John Rodriguez Stephen Oakley Tom Leigh	General Boswells CPCSD Entomology
10	Merced Kearney	Field day Hamilton	Mapping trees and vines
11	Riverside	David Crowley	Fe, VAM
12	Riverside	Tom Embleton	nutrition
15	Athens	Johnny Crawford	General
16	Athens	Nancy Barber (for Sumner) Ron Roucadori Don Marx	DRIS VAM VAM
17	Athens	Owen Plank J Benton Jones	nutrition publications
18	Tifton Griffin	Steve Hodges Reuben Beverly	nutrition DRIS

## SUMMARY OF DISCUSSIONS

### Tom Isakeit

(Plant Pathologist, Plant Pathology Department, University of California, Berkeley)

Discussion on effects of herbicides on soil fungi. Soil type has a strong bearing on that effect. Publications on that subject located with Stephen Allen.

### Mike Davis

(Plant Pathologist, Plant Pathology Department, University of California, Berkeley)

Suggested mixing sterilized soils in different ratios to determine soil pathogen status.

Suggested the following reference: T C Paulitz (1991). Mycorrhizal interactions with soil organisms. In Handbook of Applied Mycology. Ed D K Arora *et al*, Marcel Dekker Inc, New York. (Address: Macdonald College of McGill University, Ste. Ann de Bellevue, Quebec, Canada).

Commercial VAM inoculum is available from: Tim Woods, Native Plants Incorporated, 417 Wakara Way, Salt Lake City, Utah, 84108, Ph 801-5820144.

### Stuart Pettygrove

(Extension Soils Specialist, Dept of Land, Air and Water Res., University of California, Davis)

He is using a Minolta chlorophyll analyser to measure rice N status. This is a hand held instrument, giving a numerical output; cost \$1200. For iron problems in orchards, they inject acid ( $H_2SO_4$ ); FeEDDHA as a soil treatment is not effective. Foliar treatments give a visual colour response not necessarily a yield response.

### Roland Meyer

(Extension Soils Specialist, Dept of Land, Air and Water Res., University of California, Davis)

He suggested that high soil P can inhibit VAM infection, as could be the case with our Galathera syndrome. Acidification with  $H_2SO_4$ ,  $NH_4SO_4$  and/or  $ZnSO_4$  may make zinc more available on alkaline soils. Application strategies for zinc in California can be opposite to what is recommended in Australia: they recommend banding zinc fertilizer; we recommend incorporation. Those differences are associated with different species and with soil pH and texture. I have since mailed him scientific papers and Australian extension literature on that subject.

### Bill Weir

(Farm Advisor, Merced County, University of California, Merced)

Bill Weir conducts many cotton field experiments each season. These include nutrition, growth regulators, varieties and defoliants. There are sites in Merced County where cotton develops potassium deficiency symptoms by August. At these sites, fumigation with methyl bromide has increased potassium status and yield. For example in 1990, the following result was obtained at a site with 100 ppm soil K:

Treatment	July 30 petiole K (%)	Lint yield (kg lint/ha)
Fumigated	4.06	1503
Control	2.33	630

Note that Australian cotton soils have >500 ppm K. Further field experiments are being conducted in 1991, including soil and foliar K treatments. One K experiment is part of a detailed study being organised by Dr D Oosterhuis in Arkansas; with 11 sites in the cotton belt: AK, CA(2), AZ, TX(2), NC, MS, TN, GA and MO.

## Breeding

Cotton variety tests in Merced County, 1990. Average of three sites, from Weir 1990.

Variety	Yield (% Acala SJ2)
Acala Royale	107.2
Acala SJ2	100.0
Acala Maxxa	97.4
GC 510	97.3
Acala SJ5	97.2
DP 6166	95.6
GC 356	94.0
Acala Prema	91.4
Pima	76.5

Results with Maxxa were better in other Counties. The following table summarises yields of new varieties relative to Acala SJ2 (GC510 is now the standard). Average of at least 16 sites.

Variety	Yield	Fibre length	Fibre strength	Micronaire
GC510	104	99	107	104
GC356	102	100	105	99
DP6166	105	100	106	99
Maxxa	112	101	108	97
Royale	113	102	110	96

The excellent results with Maxxa and Royale are notable in yield and fibre strength. This superiority is particularly evident at high verticillium wilt levels.

The following comments were made about varieties on a tour of one site at Westside.

**SJ2:** One of the standards, strength moderate (28).

**GC510:** Also common, better strength (30).

**Prema:** For fibre quality it is the highest strength (34), also long and fine. Believed to be sensitive to ozone, mites and low temperature.

**Royale:** Good strength (32); poor seedling vigour from low temperature sensitivity.

**Maxxa:** Good strength (31); good for 30" rows.

**DP6166:** Strength moderate (30); derived from DP90\*SJ5 in Arizona.

**GC 356:** declining area, but verticillium tolerant.

Other entries in the trial included: **C2881** (Maxxa\*Prema), **CBX7** (F2 hybrid from Chembred), **GC8902** and **columnar-2** (short branches - for narrow rows ?), **8994** (from Prema), **DP900** and **Pima**.

Claude Phene and Tom Kerby had a detailed drip irrigation field experiment at Westside with 6 irrigation treatments (3 stress \* 2 growth stages), 3 varieties (Columnar, Pima, Acala-GC510) and 2 Pix treatments. The experiment was sown on 30" rows, with drip laterals buried beneath every second furrow.

**Boswell Ranch at Corcoran**  
(John Rodrigues, Manager)

1. Narrow rows. Sown on flat, irrigation with border check. Sown with Challenger (36" belts) in 20-row sets. Interrow cultivation by tractor with spread duals (14.9" tyres). Plant density was 45,000 plants/acre. Note that is 8 plants/m<sup>2</sup> - the same as recommended in Australia.
2. Experiment using saline water of different salt contents (range 400-9,000 ppm). Stand establishment was affected by water of 9,000 ppm; 1,500 ppm water had no effect on cotton.
3. Experiment testing different irrigation layouts including beds v flat, and using sprinkler as well as flood irrigation. Symptoms of waterlogging induced iron chlorosis were observed in some fields. Nitrogen fertilizer rates were only 100 lb N/acre after cotton.
4. Experiment testing different soil preparation impliments (rip, chisel, disc). Disc was worst.
5. Rotation with safflower. DeVay was quoted as saying safflower increased VAM (*Glomus fasciculata*). It was observed from the air that the wheat or safflower windrow after harvesting, gave a green stripe across the following cotton crop.
6. Organic cotton plot. Can obtain certification after 2 years of growing organic crop in the one field; enabling price premiums. Insect control by alfalfa trap crops and treatment of cotton with dusting sulphur. Fertilizer was legume manure crop (Lana woolly pod vetch was best, also breseem clover and field peas) and/or 5 ton chicken manure/acre. Weeds such as nutsedge built up without herbicides.

**David Crowley**

(Asst Prof, Soil and Plant Relations, University of California, Riverside)

He is working on the mechanism of iron nutrition in plants. He has found that monocots release their own chelates from phytosiderophores; this mechanism is important for iron, zinc, manganese and copper nutrition. Cultivars that are resistant to iron chlorosis can secrete protons into the soil solution, reducing redox potential and pH, making iron more available.

**Tom Embleton**

(Emeritus Prof, Botany and Plant Sciences, University of California, Riverside)

He has much experience with nutrition, particularly with citrus. Points of discussion were:

1. Correcting zinc deficiency. Alkaline soils better response to foliar treatments, particularly with high concentration sprays. Acid soils best to use soil application. Phosphorus is antagonistic to zinc. Large species effects: for zinc deficiency levels in leaf, orange is 18 ppm; lemon is 8 ppm.
2. Iron nutrition. He believes there is a yield reduction with iron chlorosis, but there is no control method to determine this effect. The first iron deficiency problems were found where excessive copper fertilization had occurred. For orchards, the best control was to avoid waterlogging, by irrigating alternate furrows. Fertilizer application with either foliar FeHEDTA, including a surfactant was most effective. Soil application as EDDHA (25 lb/ac) was ; that lasts 18 months. High potassium induces iron chlorosis in avacado.
3. Soil manganese is released during flooding.

**Nancy Barber**

(Agronomy Department, University of Georgia, Athens)

She works with Prof Malcom Sumner in developing a Diagnosis and Recommendation Integrated System (DRIS). This method utilises the ratios between nutrients in a leaf tissue analysis to determine nutrient deficiency. Calibration data is available for crops such as wheat, soybean, sugar cane, but there is no data available on cotton. A project is starting in India, which may obtain data for cotton. The decision support program is now being rewritten in Pascal.

A copy of current Georgia cotton standards (guesses) and BASIC and Pascal DRIS programs were obtained for comparison with similar developments at Narrabri. It is interesting to note that we have at least as much DRIS calibrating data for cotton as they do.

**Ron Roncadori**

(Department of Plant Pathology and Plant Genetics, University of Georgia, Athens)

He has many years experience with mycorrhizal research, including cotton. In Georgia, some VAM problems occur in conjunction with nematodes (pathogenic nematodes are not present on cotton in Australia). High phosphorus also can inhibit VAM infection - a factor that does exist in our Galathera syndrome. His references on VAM are now located with Stephen Allen.

**Don Marx**

(USDA, US Forest Service, Athens)

Forestry is very important in Georgia, notably for reclaiming eroded soil from overcropping in the past 200 years. This work is concentrated on reestablishing forest trees in strip-mined area, cutbanks, etc. They culture an ectomycorrhiza on mushroom spawn. This culture is used for *Pinus radiata* and *Eucalyptus cintonious* and can double the growth of tree seedlings under stress (there is no effect without stress). This product is marketed by a commercial company in 17 countries.

## Possible VAM contacts:

Karen Cooper Ministry of Agric & Fish Hawkes Bay Ag Res Cent PO Box 85 Hastings NZ	David Hayman Rothamstead (worked with Barbara Mosse)	Joseph Bagyaraj Agricultural Microbiol University of Agric Sci GKVK Campus Bangalore Karnataka 560065 India	Ian Hall Invermay Ag Res Centre PB Mosgiel NZ
International Cultural Collection of VA Mycorrhizal Fungi Dept of Plant Pathology University of Florida Gainesville Florida USA	P Jeffries and J C Dodd The use of mycorrhizal inoculants in forestry and agriculture. In Handbook of Applied Mycology. Vol 1: Soil and Plants. Ed D K Arora et al (1991), Marcel Dekker Inc, New York. p 155-85.	International Directory of Mycorrhizologists 1990 Valentin Furlan Station de Recherches Agriculture Canada 2560, Boul. Hochelaga Saint-Foy Quebec G1V2J3 Canada	Charles Johnson Dept of Hort & LAR Washington State Univ Pullman 99164 USA  (Note he worked at both Riverside and Griffin. He has experience with VAM pathogens).

**Owen Plank**

(Extension Agronomist, Soil Testing and Plant Analysis, University of Georgia, Athens)

He operates the laboratory which services Georgia agriculture (approximately 130,000 samples per year). Since many soils are relatively poor, they have much experience and data on diagnosing nutrient deficiency in all crops.

**Steve Hodges**

(Extension Agronomist-Soils and Fertilizers, Coop Extension, University of Georgia, Tifton)

He is responsible for all crops, but has a particular interest in cotton. In association with Owen Plank, he has developed an expert system for fertilizer recommendation in Georgia, based on soil tests. A copy of that program (UGFERTEX) was bought back for evaluation and comparison with similar developments at Narrabri.

**Johnny Crawford**

(Plant Pathology, Cooperative Extension, University of Georgia, Athens/Tifton)

Although nominally a pathologist, he is also trained in agronomy and owns a small farm where he grows his own cotton. He therefore has a unique knowledge of, and is interested in, all aspects of the cotton production system.

Variety development (Shelby Baker) is aimed at disease resistance and prevention of excessive vegetative growth. The local line GaT 85-278 averaged 4.5% more than DP90 and 5.7% more than DES119 across nine sites in 1989.

**Reuben Beverly**

(Asst Prof, Department of Horticulture, University of Georgia, Experiment)

He did his PhD on DRIS with Prof Sumner. His recent evaluation of methods of diagnosing nutrient deficiency, has shown that DRIS is accurate only 50% of the time, and so is no better than the critical level system that it was proposed to replace. The debate that now exists about the relative merits of different methods of diagnosing deficiency, appears to be eroding the reputation of tissue testing (further).

**Weeds**

Although no weeds researchers were met, the following names were mentioned for reference.

California researchers at USDA Cotton Research Station, Shafter  
Paul Keeley (weed physiology) and Bob Thullen (herbicides)

California extension  
Harold Kempen (Bakersfield) and Bill Fisher (Fresno)

Georgia researcher, USDA Coastal Plain Experiment Station, Tifton. 31793, GA  
Clyde Dowler (is doing research on nutgrass control - using 'Reflex' from ICI)

## DOCUMENTS COLLECTED

### General

Kerby, T A, Keeley, M and Johnson, S (1987). Growth and Development of Acala cotton. Bull 1921. Division of Agriculture and Natural Resources, University of California.

Weir, W L (1991). Merced County cotton tests.

1989 Georgia Cotton Research-Extension Report. The University of Georgia - USDA, Tifton, Georgia

Cotton Defoliation and Crop Maturity. Cooperative Extension Service/The University of Georgia, College of Agriculture, Athens.

1991 Cotton Production Package. Cooperative Extension Service/The University of Georgia, College of Agriculture, Athens.

1991 Georgia Pest Control Handbook. Cooperative Extension Service/The University of Georgia, College of Agriculture, Athens.

### Nutrition

Crowley, D E, Wang, Y C, Reid, C P P and Szaniszlo, P J (1991). Mechanisms of acquisition from siderophores by microorganisms and plants. In Y Chen and Y Hadar (Eds), Iron Nutrition and Interactions in Plants, p 213-232. Kluwer Academic Publishers, Netherlands.

Soil and Plant Tissue Testing in California. Bull 1879. Division of Agricultural Sciences, University of California.

Beverly, R B, Stark, J C, Ojala, J C, and Embleton, T W (1984). Nutrient diagnosis of valencia oranges by DRIS. *J Amer Soc Hort Sci* 109, 649-654.

Beverly, R B (1987). Modified DRIS method for simplified nutrient diagnosis of Valencia oranges. *J Plant Nutr* 10, 1401-1408.

Beverly, R B (1987). Comparison of DRIS and alternative nutrient diagnostic methods for soybean. *J Plant Nutr* 10, 901-920.

Beverly, R B, Sumner, M E, Letzsch, W S and Plank, C O (1986). Foliar diagnosis of soybean by DRIS. *Commun Soil Sci Plant Anal* 17, 237-256.

Hodges, S C and Plank, C O (1990). UGFERTEX. Cooperative Extension Service. The University of Georgia.

Jones, J B, Wolf, B and Mills, H A (1991). Plant Analysis Handbook. A practical sampling, preparation, analysis, and interpretation guide. Micro-Macro Publishing Inc., Athens Georgia. 213 pp.

Plant Analysis Handbook. Cooperative Extension Service/The University of Georgia, College of Agriculture, Athens.

## Pathology/VAM

Marx, D H (1990). Strategic Plan. Institute of Tree Root Biology. USDA Forest Service, Forest Sciences Laboratory, Athens, Georgia.

Huisman, O C (1988). Seasonal colonization of roots of field-grown cotton by *Verticillium dahliae* and *V. tricorpus*. *Phytopathology* **78**, 708-716.

Gerik, J S and Huisman, O C (1988). Study of field-grown cotton roots infected with *Verticillium dahliae* using an immunoenzymatic staining technique. *Phytopathology* **78**, 1174-1178.

Isakeit, T and Lockwood, J L (1990). Increased exudation of carbon compounds from <sup>14</sup>C-labelled ungerminated *Cochliobolus sativus* conidia in response to several herbicides. *Mycological Res* **94**, 857-861.

Isakeit, T and Lockwood, J L (1989). Lethal effects of atrazine and other triazine herbicides on ungerminated conidia of *Cochliobolus sativus* in soil. *Soil Biol Biochem* **21**, 809-817.

Isakeit, T and Lockwood, J L (1990). Abiotic soil factors influencing the deleterious effect of atrazine on ungerminated conidia of *Cochliobolus sativus*. *Soil Biol Biochem* **22**, 35-41.

Isakeit, T and Lockwood, J L (1990). Evaluation of the soil microbiota in producing the deleterious effect of atrazine on ungerminated conidia of *Cochliobolus sativus* in soil. *Soil Biol Biochem* **22**, 413-417.

Hussey, R S and Roncadori R W (1977). Vertical distribution of soil microorganisms following subsoiling in a cotton management system. *Phytopathology* **67**, 783-786.

Roncadori, R W and Hussey, R S (1977). Interaction of the endomycorrhizal fungus *Gigaspora margarita* and root-knot nematode on cotton. *Phytopathology*, **67**, 1507-1511.

Hussey, R S and Roncadori R W (1977). Influence of *Aphelenchus avenae* on vesicular-arbuscular mycorrhizal growth response in cotton. *J Nematology* **13**, 48-52.

Pugh, L M, Roncadori, R W and Hussey, R S (1981). Factors affecting vesicular-arbuscular mycorrhizal development and growth of cotton. *Mycologia* **73**, 869-879.

Hussey, R S and Roncadori R W (1977). Vesicular-arbuscular mycorrhizae may limit nematode activity and improve plant growth. *Plant Disease* **66**, 9-14.

Tylka, G L, Hussey, R S and Roncadori, R W (1991). Interactions of vesicular-arbuscular mycorrhizal fungi, phosphorus and *Heterodera glycines* on soybean. *J Nematology* **23**, 122-133.

Gruhn, C M, Roncadori, R W and Kormanik, P P (1987). Interaction between a vesicular-arbuscular mycorrhizal fungus and phosphorus fertilization on sweetgum growth in loamy sand and kaolin spoil. *Reclamation and Revegetation Res.* **6**, 197-206.

Carling, D E, Roncadori, R W and Hussey, R S (1989). Interactions of vesicular-arbuscular mycorrhizal fungi, root-knot nematode and phosphorus fertilization of soybean. *Plant Disease* **73**, 730-733.

Price, N S, Roncadori, R W and Hussey, R S (1989). Cotton root growth as influenced by phosphorus nutrition and vesicular-arbuscular mycorrhizas. *New Phytol.* **111**, 61-66.

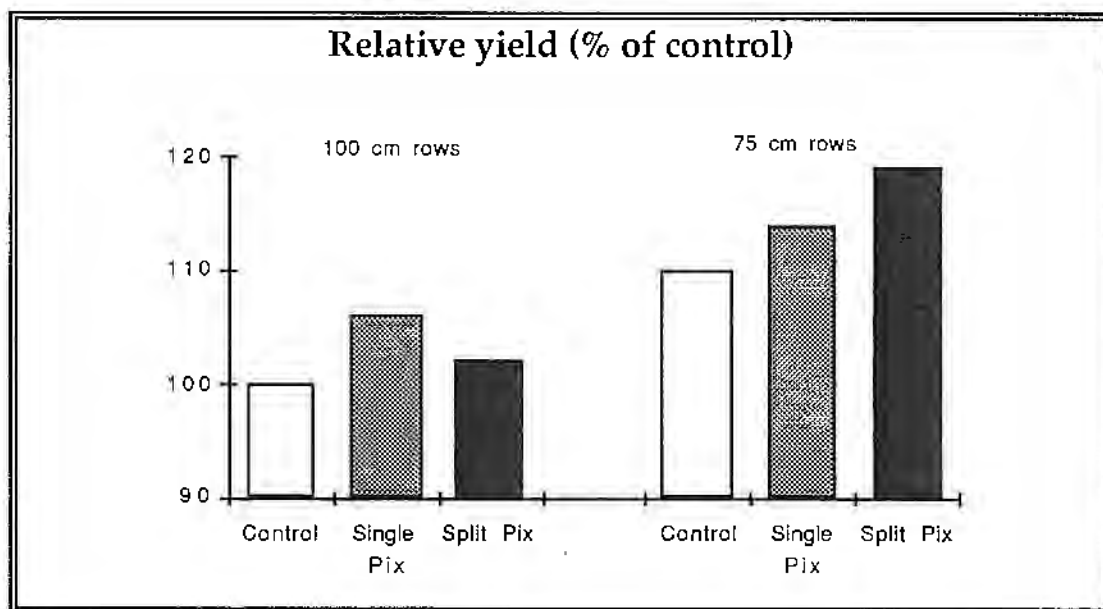
Smith, GS, Roncadori, R W and Hussey, R S (1986). Interaction of endomycorrhizal fungi, superphosphate and *Meloidogyne incognita* on cotton in microplot and field studies. *J Nematology* **18**, 208-216.

Strobel, N E, Hussey, R S and Roncadori, R W (1982). Interactions of vesicular-arbuscular mycorrhizal fungi, *Meloidogyne incognita* and soil fertility on peach. *Phytopathology* **72**, 690-694.

## Comments on Californian Pix research

### 1. Recent work

The most notable feature of recent Pix research from California has been the derivation of split Pix applications. This strategy came about from the desire to combine the advantages of Pix (early fruit retention) and avoiding the disadvantages (reduction in yield). As their research progressed, it became evident that the split Pix application strategy was particularly suited to their recent development of narrow rows (75 cm). The combination of yield increases from both Pix and narrow rows has led to a system with particular benefits for the San Joaquin Valley in California. That interaction is illustrated in the following figure, where the system of narrow rows with split applications of Pix yields up to 20% more than the original 100 cm row system.



The above Pix work has been completed, with future development of narrow rows concentrating on new cultivars and nutrition. An important result from their research is the development of vigour indices for their cotton crop to predict the responsiveness to management factors such as Pix. These vigour indices include vegetative (height, nodes) as well as reproductive (boll retention, flower position) assessments.

### 2. Present approach

Pix research is now concerned with evaluating late applications in order to enhance crop maturity. This aim has particular relevance during their present irrigation water shortages. It is hoped to maximise early crop setting with Pix and judicious irrigation timing, so that water use efficiency can be maximised. Late Pix treatments are intended to terminate vegetative growth. In this way, the last irrigation may be omitted without affecting profitability. In 1991 there are at least two experiments of this type in the San Joaquin valley. These types of treatment have not been successful in the past two seasons at Narrabri.

### 3. Consequences for Australian Pix research

California is not Australia. *We already have a higher yield than they do.* Transplanting technology directly from California to Australia is not always advisable as our cotton growing environment differs considerably from theirs in a number of key areas, particularly climate, soils and pests.

Temperature. Compared even with Narrabri, their season is shorter with a cooler start and finish although in the middle of summer their days are hotter and nearly a half hour longer. Given the more rapid decline into unfavourable temperatures during crop maturity in the San Joaquin, the need for earliness in their varieties and growing systems can be appreciated.

Rainfall. The San Joaquin Valley is a real desert with less than 20 mm rainfall in summer - most rain falls in winter outside the cotton growing season. As a result they very rarely suffer from boll rots or from alternaria leaf spot. Most of our cotton growing districts receive substantial summer rain with Narrabri averaging 216 mm rain in summer.

Soil type. Although there is a range within both areas, Australian soils are generally heavier than in California. As a result, compaction and waterlogging are more important factors in Australia than in California. Some Californian soils do not 'sub' well and may need closer row spacing for optimal wetting at irrigation. This is not usually a problem in the Australian grey clays.

Pests. There are very considerable pest differences: *Heliothis* is not normally a problem in the San Joaquin, their plants rarely get tipped out and they only have to spray a couple of times against lygus and/or mites. In contrast our cotton is attacked by a number of important pests early in the season, especially *Heliothis*. Even with careful pest management many plants can be tipped out. The aridity of their climate means there is little boll rot or alternaria leaf spot. Varieties can set bolls low on the stem without running the risk of boll rot.

Early plant and fruit development in California is less constrained - giving all plants with perfect architecture. Under those conditions and low insect pressure, most fruit loss is due to physiological shedding, so yield and maturity responses to row spacing and Pix would be expected. In Australia, early season pests and conditions often adversely affect plant architecture and fruit set. Fruit shedding is less likely due to physiological factors and more to insect damage, so we would expect less response to Pix and narrow rows.

### 4. Recommendation

Local research should aim to determine vigour indices for our cultivars. Some data for such an analysis has already been gathered from our experiments in 1989/90 and 1990/91. The 1991/92 experiments should establish different sowing dates to generate a wider range of plant vigour in each cultivar. This method will also generate cotton plants with intact architecture. Pix treatments can be superimposed over those sowings.