1999

Report Cover Sheet for Annual & Final Reports

The following Reporting Requirements MUST BE MET

All Projects
You must submit an **ANNUAL PROGRESS REPORT** by the first Friday in February 1999, detailing the progress of your research. NOTE: IF you are seeking continuation of funding for 2000–2001 for the project, this report will form the basis for CRDC's consideration of ongoing funding. Please complete the budgetary requirements if this is a continuing project.

Terminating Projects
A **FINAL REPORT** must be submitted within three months of completion of the project. This applies in **ALL** cases including research projects, travel, conference attendances, postgraduate, postdoctoral and funded capital items.

Tick Report Purpose

Annual Progress Report *(Due 1st Fri Feb. to determine continuation of funding)*

Final Report (Due 30 September or 3 months after completion of project) ✓

Actual start date: ***1/1/1999***

Anticipated completion date: ***31/1/1999***

OFFICE USE ONLY:
Date of receipt:

Project title (as per original application)

Travel — Phil Goyne to Beltwide Conference in USA January 1999

CRDC Project Code DAQ91C

CRDC Responsible Director (if known)

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Project Title

Travel – Phil Goyne to Beltwide Conference in USA, January 1999 (DAQ91C)

Background

The 44th National Cotton Council of America, Beltwide Conference 1999 was held at the Orlando World Centre Marriott, Orlando, Florida from January 3rd to January 5th, 1999. The conference consisted of four days of individual reports, panel discussions, hands-on workshops and seminars on the latest developments in research, ginning, milling and marketing.

Conference Format

The conference commenced with a general session on Production dealing with the economics of new technologies, ultra narrow cotton, integrated crop management, profit enhancing measures, seed quality and variety performance, and precision agriculture.

Concurrent sessions then followed, each referred to as a "conference":

- Cotton and Other Organic Dusts Conference
- Cotton Economics and Marketing Conference
- Cotton Engineering Systems Conference
- Cotton Ginning Conference
- Cotton Insect Research and Control Conference
- Cotton Improvement Conference
- Cotton Physiology Conference
- Cotton Quality Measurements Conference
- Cotton Soil Management and Plant Nutrition Conference
- Cotton Textile Processing Conference
- Cotton Weed Science Research Conference

Over 580 papers were presented in these sessions. In addition, there were poster presentations and trade displays.

Paper Presentation

I presented the following paper (copy attached) during the Soil Management and Plant Nutrition Conference:

"Soil water extraction dynamics of dryland cotton in various row configurations".

Conference Summary

The following are some key points I noted whilst attending the general sessions and selected presentations of the various subject conferences:

- USA Cotton Industry
  Inspite of low prices plantings are expanding. There is concern about competition from textiles and low prices. The 1998 season was not a good one for US producers: In the South East yields were about 600lbs/ac and some growers were not happy with the performance of Bt and Round Up Ready (RR) varieties. The crops were drought affected. In the Mid South, drought, then late season rains and late season insects influenced yield and quality. Weather conditions dominated in the South and Far West regions also. The former had a record dry year whilst the latter experienced wet conditions.

  From 1981, yields started to increase in the USA at 6lbs/ac/year. In the last 15 years, yield hasn't been increasing – yield and genetic progress is on a plateau.

  Ultra narrow row (UNR) cotton, Bt, RR, centre pivot irrigation with hoses dragging in the furrows, were all discussed as enhancing production.

- World Scene
  William Dunavant Jnr provided a summary of the world market situation. As his address has been published in 'The Australian Cotton Grower' I will not repeat what is written there except to note that:
  - US quality in 1998 was very poor, and has never been as bad except for 1984.
  - Cheap textile imports are lowering prices.
  - US export sales have come to a halt.
  - China is not importing and has some good cotton to market in the future.
  - Australian producers are the only ones in the world making big profits.
  - US acres will increase because competing crop prices are not good.
  - US is importing because of quality.

  A paper presented by Mr Chaudhry, International Cotton Advisory Committee Washington DC, compared costs of cotton production throughout the world. Of the exporting countries the lowest production costs are in Australia and the highest in the USA, basically because of irrigation water costs.

- Biotechnology
  Main points discussed were:
  - Seeds will be modified to give more efficient nutrient uptake.
  - Crop quality traits will be enhanced. Advantages will be agronomic traits, yield and quality, plants as factories (eg, producing plastics).
  - Over the next 10 years, 50 new products will be released by Monsanto.
  - DNA chip analysis will dramatically enhance plant breeding efforts.
  - However, biotechnology might narrow the existing germplasm for conventional breeding. Seed companies taking an extension role could lead to a bias situation.
  - Transgenics will require a different system of growing.

- Precision Agriculture
  - Yield monitors are making progress, but they are still not ready for "prime time".
  - The best way to monitor yield variability is using a 35 mm camera in a single engine aeroplane.
  - Yield maps in cotton have a long way to go before they are as good as grain yield maps. A problem is lint sitting on the sensor eye giving a false reading.

- UNR Cotton
  - A panel discussion was dedicated to aspects of UNR cotton followed by a session where papers were presented on aspects of UNR research. The current interest in UNR is that it is believed it can provide a significant opportunity for US producers to increase yields and reduce input costs if managed correctly.
  - Increase in percentage of ground cover through UNR leads to an increase of photosynthesis and yield increase.
  - UNR is good for late planting.
  - Plant stand (100,000 plants/ac suggested) and growth management are essential.
  - Under drought conditions in Texas UNR gave 30% to 60% higher yield than conventional but no difference in fibre quality.
  - Spindle pickers rather than strippers have been used with UNR resulting in better quality. Product is cleaner, yields are higher and there are no extra ginning costs.
  - Efficient drying and removal of trash essential for ginning UNR.
  - Ginning costs will be higher.
  - Stripping can give chewed up cotton and will therefore be of poor quality for milling.
  - West Texas UNR trades as a discount which is probably the result of stripper picking.
  - Some mills will not take stripper picked cotton because of bark content. A good physical standard for grass and bark is needed to give a good quality discounting scheme.
  - Harvest methods are most important. Harsh ginning will lower quality.
  - There is a market for UNR but don't overproduce until the technology catches up!

- Agronomy and Physiology

  Due to large number of interesting topics it was difficult to decide which session to attend. I look forward to reviewing those papers which I missed when the conference proceedings are published in the next few months. The proceedings will be available in printed and CD Rom versions.

  Some of the topics which were covered in the sessions I attended were: nitrogen fertilisation (time and method of application, precision fertilisation); early fruit removal and compensatory growth; late season fruit removal; tracking stress with COTMAN (a cotton management expert system); use of chlorophyll meters; conservation tilling; effects of mechanical topping; performance of Delta Pine Bollgard varieties.
  I particularly noted the following:

  There are two peaks in nitrogen uptake – pinhead square and first bloom; there were no differences in yield between foliar and side-dressed applications of nitrogen; there is a close association between chlorophyll content and nitrogen status of the crop but chlorophyll meters are variety specific and require a lot of calibration; most growers prefer to over-fertilise rather than do costly soil sampling for nitrogen analysis, but environmental issues might change this in favour of precision applications; plants compensate well for first and second position fruit removal but maturity is delayed; there has been some yield increase with square removal at NAWF (nodes above white flower) = 5 + 350 heat units; COTMAN is being widely used to pace crop growth. SCOUT MAP is a new program which gives information on crop damage, shedding etc; NAWF is related to soil status.

Post Conference Study Tour (self-funded)

Following the conference I spent two days visiting the Texas A & M University, Blackland Research Centre at Temple, Texas.

My primary contact was Dr Tom Gerik whose interests are in identifying genetic and management constraints to dryland cropping systems. Dr Gerik expressed his willingness to collaborate with QDPI cotton researchers should an appropriate project arise.

Other personnel with whom I had discussions were:

Dr Bill Dugas	– Director of the Centre, whose interests are in agricultural meteorology. He measures fluxes of energy and mass from croplands and rangelands throughout Texas.
Dr Wes Rosenthal	– Crop modelling.
Dr Jim Kininy	– Crop modelling and physiology.
Dr John Morrison	– Sustainable agricultural production system technologies for clay soils. Conducting research in residue management, tillage machine systems and measurement techniques.
Dr Ray Griggs	– Agricultural engineer, model applications.

On the second day of my visit to Texas I was invited to accompany Dr Gerik to the College Station campus to attend the annual Agriculture Program Conference. During this conference an update on Precision Agriculture was preseuted. Some aspects of this are worth mentioning:

University researchers and educators have joined forces to concentrate most of their efforts on the Texas High Plains, an area that requires more agricultural inputs to grow crops. These efforts, it is hoped, will establish Texas as a leader in precision agriculture. This should generate uew economic opportunities for agriculture and related businesses.

Most of the equipment innovations required for precision agriculture applications are commercially available, (except for a good cotton sensor). However significant research is needed to establish cost effective procedures for characterising the variability of soil and pest parameters in fields and to establish economic thresholds for implementing variable rates of inputs such as fertilisers and pesticides. The program has five goals:

- Determine spatial and temporal variability of factors that can be addressed by precision of probes.
- Develop and evaluate new precision agriculture technology.
- Determiue economic and physical feasibility for implementiug new technology/methods.
- Develop and evaluate variable-rate application technology.
- Transfer technology through the AgriPartners program.

Dr Gerik leads the Central Texas Precision Agriculture Group.

During my visit to Texas I presented my Beltwide Conference Paper to a gathering of Blackland staff who showed much interest in the findings.

Conclusions

My attending the conference and visit to Texas has provided an opportunity to update on recent US research and experience and has enabled me to meet a number of US cotton researchers. This will lead to continued networking and future collaboration and enhance the effectiveness of my research activities.

Acknowledgments

My thanks to CRDC and QDPI, Farming Systems Institute, for supporting this trip.

SOIL WATER EXTRACTION DYNAMICS OF DRYLAND COTTON IN VARIOUS ROW CONFIGURATIONS

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Abstract

The soil water extraction dynamics of dryland cotton grown in various row configurations on some major Queensland cotton soils are being quantified. The data will assist in the further development of a cotton simulation model "CERCOT". This model is to be used to determine the outcome of various management scenarios relating row configuration, planting time and plant available water supply. This paper presents some results obtained on one soil type during the 1997/98 season.

Introduction

Monteith (1986) proposed a scheme for determining soil water supply to crops which has been used for sorghum (Robertson et. al. 1993) and sunflower (Meinke et. al. 1993). A full explanation can be found in Meinke et. al. (1993) but briefly:

The analytical framework of the scheme comprises a function describing the downward movement of the extraction front and a function which accounts for the extraction behaviour of a static root system. When the root front arrives at a particular depth and starts to extract water, the soil water begins an exponential decline following the relationship (Figure 1):

$$AWC = MAWC \quad \text{if } t \leq t_c$$
$$= MAWC \times \exp(-kl(t-t_c)) \quad \text{if } t > t_c \qquad (1)$$

MAWC = maximum plant available volumetric water content in each soil layer
AWC = available water content remaining in each layer at time t (days after sowing, das)
t = time (das)
t_c = time of first water extraction in a layer
l = root length density (cm root per cm^3 of soil)
k = constant relating to the diffusivity of water flow (cm^2 per day)

The derivative of equation (1) with respect to time gives the extraction rate:

$$dAWC/dt = 0 \quad \text{if } t \leq t_c$$
$$= (-kl) \times AWC \quad \text{if } t > t_c$$

k and l are not determined individually, but are treated as a combined kl 'plant soil constant' ie the rate at which water is extracted within each layer.

tc for each layer can be found from the depth of the extraction front (EF) at any time:

$$EF = EFV \times (t-t_0)$$

EFV = extraction front velocity
t_0 = time (das) at which the extraction front commences its descent at rate EFV.
t_c = $EF/EFV + t_0$

The current project is deriving values for the parameters kl, t_c, EFV and t_0 for major cotton soils.

Discussion

Row configurations used were no skip, single and double skips based on 1.0m row spacing. Crop development, biomass accumulation, radiation interception, root length density, yield and fibre quality were monitored. The time course of soil water depletion between rows (P1) on the plant line (P2) and at 0.5m intervals from the plant line into the skip area (P3, P4, P5) (Figure 2) was followed weekly with a neutron moisture meter at 10 cm increments down the soil profile to a depth of 1.8m. Parameter values for soil water extraction were fitted via an iterative optimisation procedure (Hammer et. al. 1982).

There were three contrasting soil types in the 1997/98 season one being a heavy black cracking clay (Waco), common in the Darling Downs agricultural region of Queensland. This soil holds about 280mm of plant available water to a depth of 1.8m. Cotton variety Siokra $V15_i$ was planted on 14 October 1997 and thinned to an in-row spacing of 6 plants per metre following emergence. As with other soils in the region that season, little water was held beyond 1.0m at planting and did not increase with rainfall as the season progressed (Figure 3).

An example of the fit of equation (1) for four depth intervals at P2 in a single skip on the Waco soil is shown in Figure 4. Similar relationships for each depth at each sampling position enabled evaluation of t_c. Regressing t_c against depth for each sampling time gave values for t_0 and EFV, (Figures 5, 6, 7).

In the no skip treatment soil water extraction dynamics were similar for positions P1 and P2. EFV averaged 2.0cm/day and t_0, 37.7 das (Figure 5). In the single skip (Figure 6) the extraction front commenced its descent 30.6 das (t_0) in P2, whereas t_0 for P1 and P3 was on the average 11 days later. At P4, t_0 was significantly ($p<0.01$) later (59.9 das) than at the other positions. EFV was similar for P1, P2 and P3 averaging 2.1cm/day but at P4 was significantly faster being greater than twice this rate ($p<0.01$).

Soil water extraction from the double skip was very similar to the single skip (Figure 7). The extraction front commenced its descent much later in P4 and P5 than at the other three positions (P5 = P4>P1 = P2 = P3, $p<0.05$) and its descent rate in P4 and P5 was greater than twice the rate of the other three positions (P5 = P4>P1 = P2 =P3, $p<0.01$).

These EFVs for P1, P2, P3 are in agreement with the "effective rooting depth" rate of progression reported by Lacape et. al. (1998) which ranged from 1.8 to 3.0cm per day.

Water use beyond 0.85m was negligible in all sampling positions for all row configurations. Very low root densities were found at this depth, which was reached during flowering.

Analysis of yield data showed no significant advantage of one configuration over another and averaged 3.3 bales lint per ha for the experiment. This agrees with Marshall et. al. (1994) who showed there was no yield advantage with skip row configurations for yields beyond 3.0 bales lint per ha. However yields per plant were significantly different: double skip>single skip>no skip $p<0.05$). In general longer, stronger and more uniform fibre was obtained from the skip row treatments.

Summary

Soil water extraction dynamics were similar for single skip and double skip row configurations for the Waco soil in 1997/98. EFV for P1, P2, P3 averaged 2.0cm per day. EFV for P4 and P5 was about twice the rate of P1, P2, P3. Soil water extraction reached 0.85m. Data from other soil types across seasons will enhance the capabilities of the prediction model, CERCOT.

Acknowledgements

We thank the Queensland Department of Primary Industries, Farming Systems Institute and the Cotton Research and Development Corporation for their continued support. Our sincere thanks go to P. McVeigh, R. Skerman and J. Bidstrup for providing experimental sites and assisting in crop management.

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Robertson, M.J., Fukai, S., Ludlow, M.M. and Hammer, G.L. (1993). Water extraction by grain sorghum in a sub-humid environment. I. Analysis of the water extraction pattern. *Field Crops Research.*

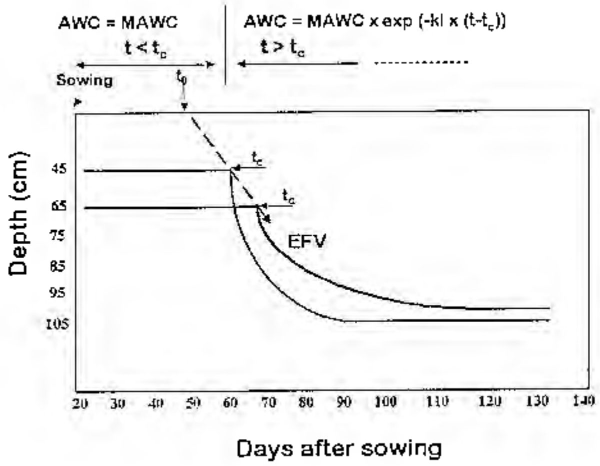

Figure 1. Analytical framework showing the exponential decline of soil water from the 45cm and 65 cm layers.

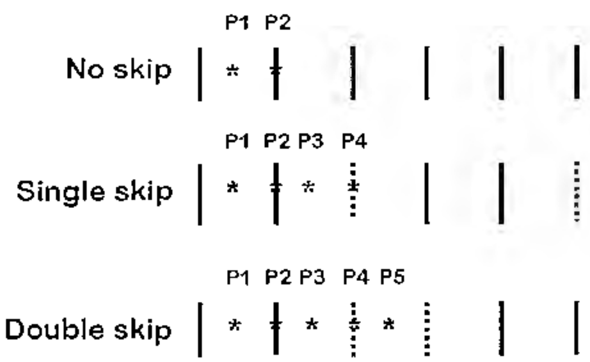

Figure 2. Positions (P2, P2 etc) of the neutron moisture access tubes in relation to the planted rows (solid lines) and the skips (broken lines) for each configuration.

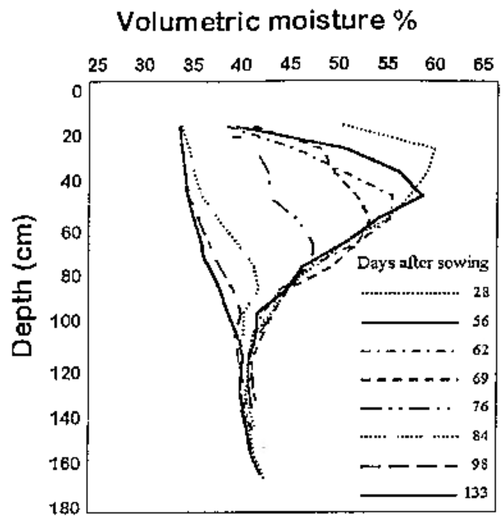

Figure 3. Volumetric moisture content of no skip P2 profile for selected sampling times.

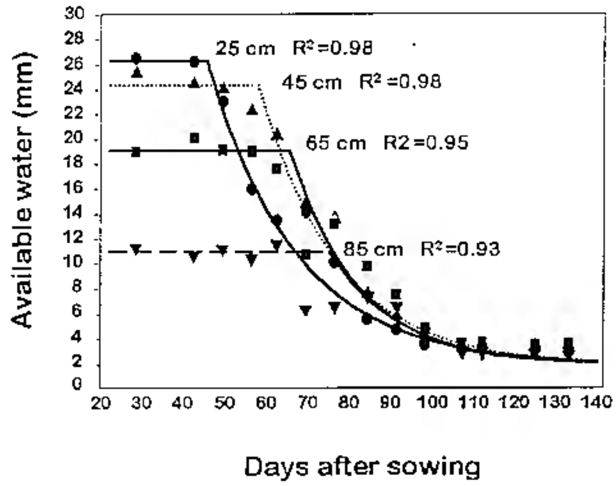

Figure 4. Soil water extraction for four depth intervals at P2 in a single skip configuration.

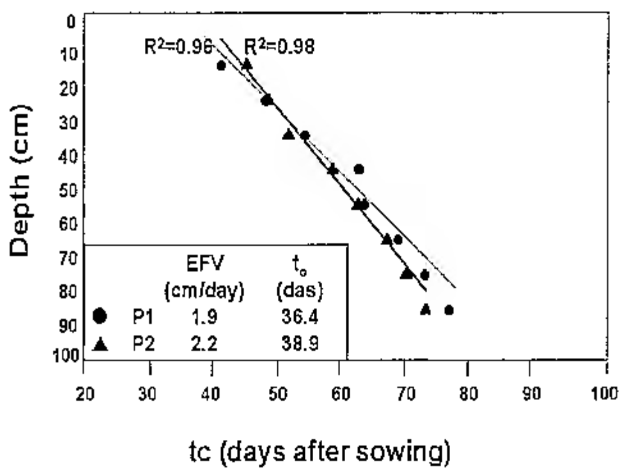

Figure 5. EFV (slope of regression line) and T_o determined by regressing t_c against depth for no skip configuration.

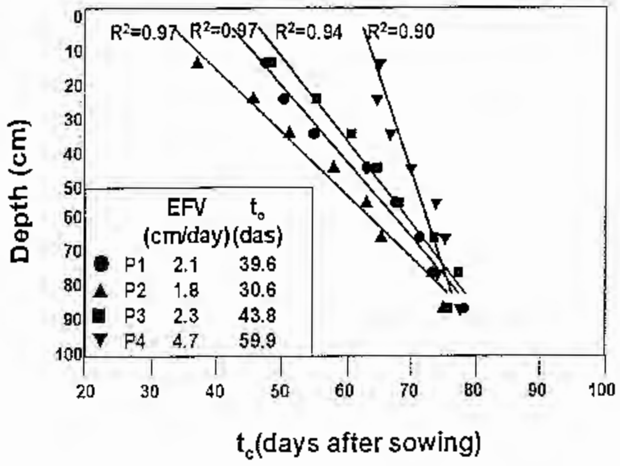

Figure 6. EFV (slope of regression line) and T_o determined by regressing t_c against depth for single skip configuration.

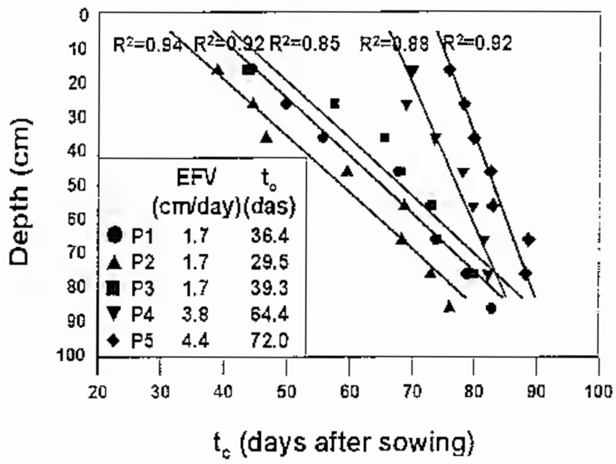

Figure 7. EFV (slope of regression line) and T_o determined by regressing t_c against depth for double skip configuration.