Part 1 - Summary Details

CRDC Project Number: **CRC 56** **CCC CRC Project Number: 3.1.37 AC**

Project Title: The Impact of Sodicity on Cotton Cropping Systems

Project Commencement Date: 2003 **Project Completion Date:** 2005

CRDC Program: On-Farm

Part 2 – Contact Details

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Part 3 – Final Report Guide (due 31 October 2008)

Objectives

The aim of this project is to determine the impact of sodic soils on the nutrient uptake, growth and lint yield of cotton crops. It was hypothesized that sodicity could influence the performance of cotton through both its effect on the physical and chemical properties of the soil. Thus, an additional aim of this project was to determine the relative importance of the physical and chemical characteristics of sodic soils in affecting the performance of cotton crops.

Outcomes

1. To conduct a review of the scientific literature related to this area of study.

This milestone was completed in the first year of the project and has allowed the research project to focus on the most important unanswered questions in this area of research.

2. To undertake field experiments in order to gain an understanding of the type of growth and nutritional issues occurring in cotton crops grown on sodic fields.

This milestone was completed in the first year of the project and yielded valuable information as to the impact of different levels of soil sodicity on the patterns of nutrient uptake and growth by a cotton crop under field conditions.

3. To develop the methodology necessary to quantitatively determine the relationship between the level of sodium in the soil and the growth and nutrient uptake of cotton plants and to separate the effects of physical and chemical soil properties in this relationship.

This milestone was completed in the second year of the project and involves a variety of different experimental and laboratory techniques.

4. To carry out the experiments necessary to quantitatively determine the relationship between the level of sodium in the soil and the growth and nutrient uptake of cotton plants and to separate the effects of physical and chemical soil properties in this relationship.

This milestone is currently being carried out and is well on-track to being completed in the second year of the project.

Research Highlights

The major research highlights coming from this project have included;

- The development and use of new laboratory and experimental methods for creating and analysing sodic soils.
- The development and use of new experimental methods for separating the physical and chemical effects of sodicity on plant performance

Publications

Conference papers:

- Dodd, K., Guppy, C., Lockwood, P. and Rochester, I. (2004) Comparing applications of sand and polyacrylamide for separating the physical and chemical properties of sodic soils on the growth and nutrition of cotton (Gossypium hirsutum), *Supersoil 2004*: Proceedings of the 3rd Australian New Zealand Soils Conference, University of Sydney, Australia, 5 – 9 December 2004.

Conferences Presentations:

- Dodd, K., 2004, Comparing applications of sand and polyacrylamide for separating the physical and chemical properties of sodic soils on the growth and nutrition of cotton (Gossypium hirsutum), *Supersoil 2004:* 3rd Australian New Zealand Soils Conference, University of Sydney, Australia, 5 – 9 December 2004.

Seminars, Workshops & Trade Shows:

- Dodd, K., 2004, Nutrition in Sodic Soils, CRDC and Cotton CRC Farming Systems Forum, 29 & 30 November 2004, Narrabri.
- Rochester, I. and Dodd, K. 2004, Cotton Nutrition, Cotton Conference "Hands On" Workshops, August 2004, Gold Coast.

2004/05 Awards:

- Dodd, K. Supersoils Conference: Symposium 6 Award, December 5-9 2004, University of Sydney, Australia.

Part 4 – Final Report Executive Summary

Sodicity is an excess of sodium in the soil and a sodic soil is commonly described as one that has an exchangeable sodium percentage (ESP) value of greater than 6%. Approximately 80% of the irrigated agricultural area in Australia is occupied by sodic soils, making this a common problem in Australian cotton production systems.

This PhD project aims to determine the mechanisms, by which soil sodicity impacts on the uptake of nutrients and growth of cotton crops, in order that soil sodium levels can be factored into crop nutritional management decisions.
The mechanisms, by which sodium impacts on cotton nutrition include;

- Influencing the ability of plant to access nutrients by affecting soil structure and hence PAWC, waterlogging and root growth.
- Altering the availability of nutrients to plants through soil pH, exchange equilibrium and oxidation-reduction potential changes
- Interacting directly with nutrients at the membrane surfaces throughout the plant.

An understanding of these factors has important practical implications for crop nutritional management and may lead to the development of appropriate tools for the diagnosis of sodicity-induced nutritional imbalances.

The nature of the impact of sodicity on the growth and nutrition of cotton in the field was determined through a program of plant measurements and tissue analysis in a cotton crop grown on a field with varying levels of sodicity in different parts of the field. The results showed that as the level of sodium in the soil increased, there was a corresponding increase in the uptake of sodium and decrease in the uptake pf phosphorus ad potassium by the crop. These results are illustrated in the attached graph (Dodd_SodicityGraph).

The quantitative relationship between the level of sodium in the soil and the growth and nutrition of the cotton plant is currently being determined in a glasshouse experiment, in order that the variability present in a field situation can be removed. Sodic soils were artificially created by leaching large volumes of solutions with different cation concentrations through given volumes of soil. In this way, the ESP of the soil could be manipulated while keeping other factors, such as soil electrical conductivity, mineralogy and nutrient levels constant. Analysis was carried out in order to determine that the synthetic soil conditioning agent polyacrylamide has no impact on the availability of nutrients to the plant in the soil solution. The effects of the physical and chemical properties of sodic soil were then separated in the glasshouse experiment using polyacrylamide treatments. The progress of this experiment is illustrated in the attached photograph (Dodd_Glasshouse_Photograph).

It is hypothesized that the relationship between the level of sodium in the soil and the performance of the cotton plant is affected by a number of factors, especially the presence of salinity and high levels of magnesium in the soil profile. Following the completion of the above glasshouse experiment, it is envisaged that any chemical effect of sodicity on the performance of the cotton plant and its interaction with salinity and magnesium will be further investigated through solution culture experiments. This data will then be related to soil test data through soil solution analysis. Additionally, the physical effect of sodicity on the performance of cotton and its interaction with salinity and magnesium will be further investigated by quantifying how these factors influence soil physical structure.