COTTON RESEARCH AND DEVELOPMENT CORPORATION

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Long-Term Effects of Cotton Rotations on the Sustainability of Cotton Soils 1996-1999

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SUMMARY

A survey of cotton growers in 1992 (CRDC Project DAN 76C) showed widespread interest in the use of rotation crops, plus a need for more information about the benefits of legume rotations and the effect of rotation management on subsequent cotton crops. To investigate the effect of rotation crop type and management on soil properties, cotton growth and yield, and economic returns, 3 irrigated field trials (at Merah North, WeeWaa and Warren in NSW), and 2 dryland trials (at Warra and Emerald in Queensland) were set up in 1993. During the first phase of this project monitoring of soil and crop growth was limited to the irrigated sites in NSW (CRDC Project DAN 83C). From 1996-1999 monitoring of soil properties was done in all five experimental sites. The rotations sown at each site included continuous cotton, long-fallow cotton, N fertilized and unfertilized cereals such as sorghum and wheat, double-cropped cereals (in the dryland sites), winter and summer legumes such as lablab, faba and field pea. In all sites rotation crop stubble was incorporated. Minimum tillage systems were used at Warren, Merah North and Emerald, reduced tillage at Wee Waa and conventional tillage at Warra. Soil measurements were made in all sites with the aim of detecting changes in structure and fertility which could affect the soil's ability to produce a profitable crop of cotton. Changes in soil moisture, crop growth, development and yield of all rotation crops and cotton; and economic returns were also monitored. Additional observations were made (a joint project with UNE/World Bank fellow Mr. J. N'Kem) during the rotation phase in 1997 at Wee Waa on soil faunal populations and their effects on soil physical and chemical properties.

Amelioration of soil compaction was best where wheat was sown. This was because the fine, fibrous roots of the wheat was able to penetrate the large numbers of soil micropores which occur in a compacted soil, thereby intensifying the wetting/drying process more than the thicker and lower numbers of roots of tap-rooted rotation crops. The long crop duration (approx. 6-7 months) also increases the number of wetting/drying cycles that a soil under the wheat is subjected to in comparison with a lesser number of wetting/drying cycles with a short-duration crop. Increases in sub-soil salinity were observed at Warren and Merah North, but not at Wee Waa. Salinity increased most during the cotton phase of a rotation. Soil organic matter (SOM) decreased with time in all treatments at Warren and Merah North but remained unchanged at Wee Waa. In the dryland sites, at Warra SOM was higher after chickpea, whereas no differences were evident between rotations at Emerald. Short-term increases in soil N were substantial after leguminous crops in all sites. Legumes (their seed material in particular) had an allelopathic effect on cotton growth and yield at Wee Waa. Fluctuation in exchangeable Ca, Mg and K were observed at Warren, Merah North, WeeWaa and Warra between years. With respect to Ca and Mg this was caused by a combination of an interaction between calcium and magnesium carbonates and SOM, and reversible displacement of exchangeable Ca and Mg by agrochemicals during the cotton phase of the rotation. The changes in exchangeable K were directly related to SOM, although the mechanism involved has not been clarified as yet. Soil faunal numbers, particularly ants, were higher in the fertilized wheat plots at Wee Waa. Ant mounds facilitated infiltration; and their soil had higher levels of exchangeable Ca, P, N and organic matter, and was less sodic than the surrounding soil. Surfaces of ant mounds were, however, more compacted than adjacent soil. In the irrigated sites, gross margins/ha were in the order of continuous cotton > cotton-fertilized wheat > cotton-unfertilized wheat > long-fallow cotton $\geq$ cotton-legumes. When gross margins were evaluated on the basis of ML of irrigation water supplied, they were in the order of cotton-unfertilized wheat $\geq$ cotton-fertilized wheat > long-fallow cotton $\geq$ cotton-legumes >> continuous cotton at Warren and Wee Waa, and long-fallow cotton > cotton-legumes fb. cotton-wheat > cotton-lablab = continuous cotton > cotton-faba at Merah North.