

SOIL COMPACTION REPAIR WITH WET/DRY CYCLES USING CROPS FOR DRYING

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INTRODUCTION

Even in the 1990's, soil compaction remains a major problem for cotton growers (Shaw, 1993).

The nature of the problem has changed from the 1970's and 1980's when compaction could be found over 100% of a cotton field. Now, the retained bed system is widely practised in the Australian cotton industry, with 80% of irrigated cotton on retained beds (Pillai-McGarry and McGarry, 1992). Growers can now control compaction, not only by restricting it to the furrows with perhaps some "invading" the shoulders of beds but also by more carefully selecting the time of cultivation. So, in the 1990's the major issue with compaction under cotton is how to best repair compacted furrows and any compaction in the beds.

The need for repair strategies arises from the short lifetime of beds in any one field - being between 3 and 8 years. With increasing number of years the guess-rows widen, rotation crops lessen furrow definition and fields may need re-levelling.

Whether the beds are only realigned or completely removed and rebuilt it is vital that compacted soil is repaired so that it is not buried beneath the new beds. One study in Queensland showed a 50% yield reduction (6.5 to 3.3 bales per hectare) in areas of the field where new hills were placed over old furrows (McGarry, 1990). The cotton plant roots could not penetrate the old furrow and they formed "right angles" at 20cm (8 inch) depth.

THE CURRENT STUDY

This CRDC-funded project is studying the effect of repeated wet/dry cycles, **with drying by rotation crops**, on the structure repair of a black, cracking clay.

The cotton industry knows that the majority of its soils (cracking clays) respond to wet/dry cycles, to repair structure. Past studies succeeded in showing soil structure repair of the topsoil by repeated wetting/drying where the drying was solely by evaporation (Pillai-McGarry and McGarry, 1992). Other field studies have examined the role of rotation crops in drying the soil profile to prevent compaction in subsequent cultivation (Hodgson and Chan, 1984 and Hulme et al, 1991).

METHODS

Intact soil cores (310 mm diameter x 450 mm high, i.e. 12 inch x 18 inch) were collected from wheel furrows of a commercial cotton farm near Pittsworth, Darling Downs. The soil was a self-mulching black earth. The cores were coated with latex on the sides to ensure evaporation occurred only from the soil surface. The cores were placed in a constant environment glasshouse (mean temperature 25°C, mean relative humidity 62%).

Each of sorghum and wheat were planted in the cores when the soil water profile was full. Seed and fertiliser were supplied by the grower whose soil this was, and his sowing and fertiliser rates were used.

The cores were then dried, as the plants grew and extracted moisture from the soil. When the plants wilted (i.e. when there was no more available water) the soil was wet by surface flooding. This wet/dry cycle was repeated three times in one set of cores and six times on a second set.

Data collected

Each core was weighed just before and just after flood-wetting. The water use up to three and between three and six wet/dry cycles was gained by adding these weighings together.

After each of three and six wet/dry cycles, the cores were prised open and the core split in half (depthwise). Metal sampling cubes (120 x 120mm, i.e. 5 x 5 inch) were hydraulically pushed into the exposed soil face at each of four depths down the soil profile.

The cubes, full of intact soil, were carefully dug-out then resin-impregnated for image analysis. This technique "captures" soil structure on any one occasion and permits statements on soil pores and the shape and size of soil aggregates to be made.

These soil images from the glasshouse experiment were compared with the soil before any wet/dry cycles began. On the day the cores were collected in the field, metal sampling sleeves (240mm deep x 120mm square) were hydraulically pushed into the same wheel furrows being sampled for cores. These samples were also resin impregnated.

RESULTS

A. Water Use

Table 1 presents the water used by the sorghum and wheat for up to three wet/dry cycles and between three and six wet/dry cycles. It can be seen that almost double the amount of soil water was used by the plants (both wheat and sorghum) between three and six cycles than up to the initial three cycles. This indicates that structure development with more than three cycles has doubled water availability to the plants than from just the three cycles. This extraction could be from within a particular depth of the soil profile, or from deeper depths.

Table 1: Water use, (mm) of sorghum and wheat for up to three wet/dry cycles and between three and six wet/dry cycles.

Crop	3 wet/dry cycles	3 to 6 wet/dry cycles
Sorghum	75 +/- 14	140 +/- 7.3
Wheat	78 +/- 14	145 +/- 5.6

B. Image Analysis

Figure 1 presents digital images of three soil profiles: (a) at time zero, (b) after 3 wet/dry cycles, (c) after 6 wet/dry cycles. The profiles under sorghum are used here as an example of the general trend.

The major finding is that as the number of wettings and crop-dryings increase, then soil structure is formed deeper in the soil.

At time zero, there are cracks and air spaces to approximately 140mm in the furrows, but below that the soil is quite massive and compacted (white in the image). After three wettings and dryings this massive layer becomes cracked and fissured to approximately 200mm, below which the soil is massive and compacted. After six wet/dry cycles the cracking extends to 240mm, and there are even signs of cracking in the 330-400mm layer.

DISCUSSION

This study demonstrates the important role of rotation crops in drying the soil and re-forming soil structure, in wetting/drying cycles. Both sorghum and wheat repaired the soil to the same extent, in terms of soil water extraction. The soil images show that with increased number of wettings and dryings, structure re-forms (i.e. soil aeration improves) to greater depths in the soil. This allows plant roots to penetrate deeper and to actively extract water from these deeper

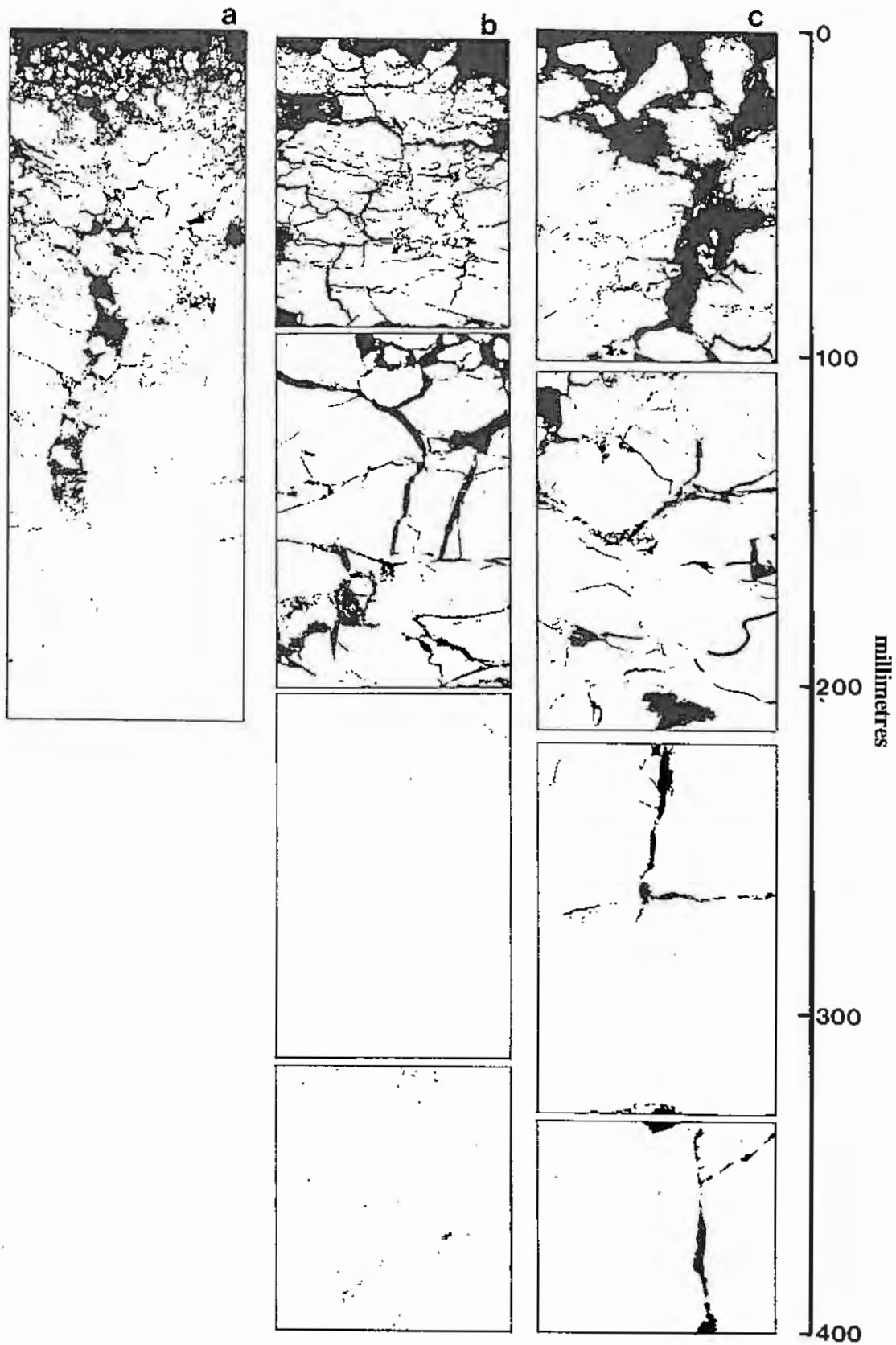


Figure 1: Three digital images of soil structure. In all images the soil pores (air spaces) are black and the soil solid is white.

- (a) The soil profile of the wheel furrow on the day the cores were collected. This equals "time zero", i.e. before any wet/dry cycles.
- (b) The soil profile after 3 wet/dry cycles.
- (c) The soil profile after 6 wet/dry cycles.

layers, as shown by the almost 100% increase in extracted water between three and six cycles than up to three.

It is important to note that the greatest improvements in soil structure condition will be obtained by first thoroughly drying, then thoroughly wetting the soil. Thorough drying not only permits maximum water infiltration but also maximum swelling at the next irrigation. Under ideal conditions, the rotation crop then extracts this water until it almost wilts, before another irrigation is applied. This method of "extreme" wetting and drying produces more rapid results to greater depths in the soil profile.

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