

Project Title:

“Structure regeneration of compacted cracking clays using wet/dry cycles and rotation crops”.

Project Number:

UQ18C

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Project:

Structure regeneration of compacted cracking clays using wet/dry cycles and rotation crops.

Executive Summary:

The Australian cotton industry has implemented the “retained bed” system of cotton growing in the majority of the irrigated areas. The system works well for cotton-beds on 1m or 2m spacing, tractors most commonly with 2m axles and all equipment conforming to 6, 8 or 12m widths. The system is one form of controlled traffic, where all wheels are restricted to specific furrows and the beds are only lightly cultivated when the soil is dry.

The system has been in use for approximately ten years, and some beds have been known to last for seven seasons. This poses the problem of periodic restoration of soil structure. Restricting all wheels to specific areas, results in extreme high density “lines” in the cotton paddock. Repair is required either where compaction in the furrow begins to invade the cotton hill, or where hills become mis-aligned so that guess rows widen and become unmanageable. In these situations it is vital that structure restoration of the furrows commences before the hills and furrows are removed. Once removed, the unique marker system that demarcated good and bad structure is lost and there is strong potential of placing new hills over old furrows; an error that led to a 50% reduction in cotton lint yield on a commercial cotton farm.

Results from previous studies have shown that soil structure, in the majority of irrigated cotton soils, responds positively to wet/dry cycles.

The main objective of this current work was to extend previous studies in terms of both assessing the effect of wet/dry cycles in different soils, and the use of selected break crops with wet/dry cycles to enhance and accelerate soil structure repair.

Studies were carried out on two irrigated cotton soils - one a soil capable of strong swelling/shrinking with wet/dry cycles, the other with only moderate potential. The wet/dry cycles were implemented on large (0.5m depth x 0.3m diam.) intact soil cores collected from the compacted wheel furrows at each site. For all cores wetting was by flooding to mimic field conditions. Drying for both sites was by evaporation, and also with break crops for the strong swell/shrink soil. The crops were: wheat, sorghum, lab lab and mung bean. Soil samples were collected after each of 3, 6 and 9 wet/dry cycles for all cores. Soil strength, soil clods for bulk density and image analysis were sampled down each profile. Carefully split cores were photographed for soil structure and root growth, and soil water use/infiltration were calculated for all cores.

Results from the site with moderate potential for swell/shrink repair with repeated wet/dry cycles showed that more than one wet/dry cycle was necessary to significantly improve structure. Flood wetting was more effective than rain wetting, giving deeper repair. Water infiltration (water intake at irrigation) increase x2 after five wet/dry cycles, and this was associated with a marked reduction in soil strength, demonstrating the development of a better plant root environment. Increasing the number of wet/dry cycles produced finer soil structure, important for seed placement and germination.

Results from the site with strong potential for swell/shrink repair with repeated wet/dry cycles gave strong treatment effects. Clod data showed that wetting and drying both with and without crops did improve structure condition, but to greater depths (up to 0.4m) and more rapidly with crops, particularly mung bean and lab lab. Image analysis results corresponded reasonably well with the clod data. Wheat and sorghum gave deep cracking of the soil (to 0.45m), at nine wet/dry cycles, but mung bean and lab lab gave finer structure (better aggregation) to depth by six wet/dry cycles. These results matched well the visible soil structure in the split soil cores, that also showed the legumes gave deep rooting patterns of many fine roots. The shear vane proved better at measuring strength differences between treatments. One season of wheat in the field significantly decreased strength to 0.3m in both the hills and furrow. Strength, with wet/dry cycles alone (no crops), did not decrease significantly. Soil water use was greater beneath the legumes, that matches well with greater and more rapid structure development under these crops. Greater drying gives greater shrinkage, so more potential for re-fill at irrigation; i.e. a greater cycle of wetting and drying, leading to rapid compaction repair.

In conclusion, the lab lab and mung bean crops improved soil structure to greater depths and more rapidly than the wheat and sorghum. This was evident in the visible soil structure, greater evapotranspiration, finer porosity in the images, reduced soil strength and greater porosity in the soil clods. The structure repair would have been greater if these experiments had been conducted on hill material - the plants would have developed better root systems, more rapidly in the loose surface mulch. The structure repair would then have probably encompassed the whole hill, including hard shoulders on the sides of the hills. Wet/dry cycles have again been shown to be a critical method of repairing compaction in these soils. Even the moderate swell/shrink soil showed good potential for repair (with evaporation the only drying medium). Generally, the greatest improvements occurred after six wet/dry cycles, particularly in terms of deep fracturing and small aggregate formation below 0.2m, as seen in the soil images and soil profile photographs. Shear strength was a more sensitive method of demonstrating treatment effects and to greater depth than the penetrometer. The clod data showed that one season of a wheat "break crop" in the field significantly increased porosity to 0.2m. The benefit of this is that shallow ripping of furrows after the wheat crop (if the soil was at or below the plastic limit) would break-out this better structured soil and assist aggregate formation. These finer aggregates may then be incorporated into the hill, giving better hill/furrow demarcation.