

WHEAT/COTTON DOUBLE CROPPING

A farming system to reduce soil erosion and pesticide use

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Introduction

There has been a heavy reliance on agri-chemicals in the Australian cotton industry over the past 20 years to increase production and profitability. The off-farm movement of these chemicals has created a number of environmental issues of concern for the industry (Edge, 1996).

There is an urgent need for the development and adoption of management practices which reduce our reliance on chemicals and are agronomically and environmentally sound.

Recent industry funded research has identified key transport mechanisms and highlighted the importance of storms and sediment in moving pesticides off-site. High risk periods include early season (when ground cover is low) and soon after chemical application (when field burdens of pesticides are high). Research in the grain industry has identified the capacity of stubble cover to reduce erosion and that winter cereals provide the most effective cover. Plot scale (< 1ha) research in cotton found that a significant reduction in pesticide movement was achieved from surface treatments such as wheat stubble (Simpson *et al.*, 1996 and Silburn *et al.*, 1996).

Our CRDC project commenced in June 1997 to develop management strategies to minimise off-site movement of pollutants at the paddock or farm scale. In particular, our goal was to apply the research findings with wheat stubble at the paddock scale and to assess the practicality and feasibility of this management practice.

The aims of the project are :

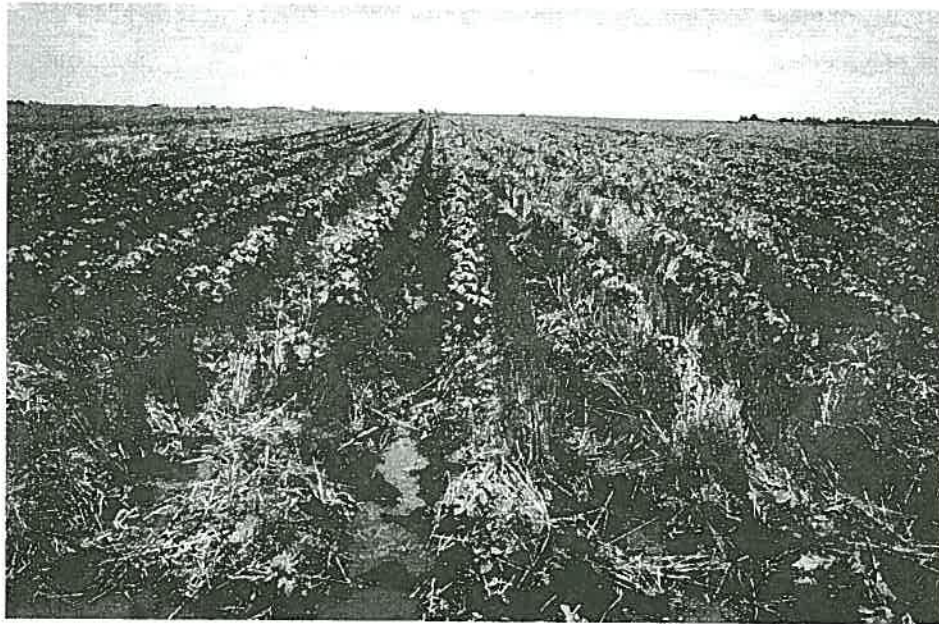
- Develop practical and innovative management practices to reduce off farm movement of sediment, insecticides, herbicides and nutrients.
- Identify relationships between management practices and pollutant transport processes at the farm scale.

The project is also looking at other innovative management techniques to reduce pollutant transport such as polyacrylamides in irrigation water and vegetative filter strips (data not presented here).

Materials and method

The experimental sites are located at Scott Black's farm, Emerald. The soil is a shallow open downs cracking clay soil on 1% slope. Two treatments were compared, a conventional cotton (C-C) rotation and a wheat cotton double crop rotation (W-C). Following the cotton harvest in March 1997, irrigated wheat was planted on a 30 ha paddock (April 1997). The wheat received two subsequent irrigations and was harvested in early October 1997. The paddock was then irrigated and cotton was planted into the standing wheat stubble in late October 1997 (Figure 1).

Figure 1. Cotton planted into standing wheat stubble



Tail drain outlets were instrumented from 30 ha W-C and an adjacent C-C paddock. Runoff, sediment, nutrient and pesticide samples were collected for all irrigation and rainfall events. Additional information such as predator and heliothis numbers and farm operations were recorded on a weekly basis.

Results and Discussion

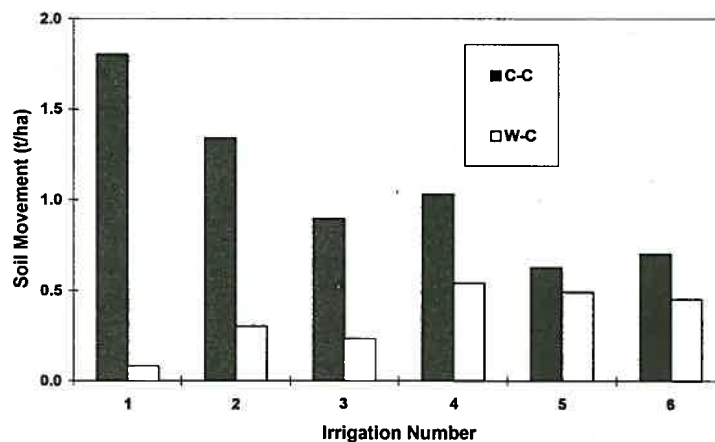
Runoff and soil movement

There was negligible runoff from rainfall for the 1997/98 cotton season due to below average rainfall (336 mm; long term average 635mm).

The W-C treatment reduced soil movement for all irrigations (Figure 2) and resulted in a 70% reduction over 6 irrigations (W-C 2.1 t/ha; C-C 6.4t/ha). Soil movement increased slightly for W-C after inter-row cultivation commenced (irrigations 4,5 and 6).

Inter-row cultivation was not required for the first 2 irrigations due to low weed competition. The high surface cover levels provided by the anchored wheat stubble prevented soil detachment by raindrop impact and overland flow. Since rainfall runoff typically produces 80% of seasonal soil erosion (Carroll *et al.*, 1995) the reduction in soil movement for W-C is expected to be even greater in wetter years.

Figure 2. Soil movement by irrigation for wheat/cotton double crop (W-C) and conventional cotton (C-C)



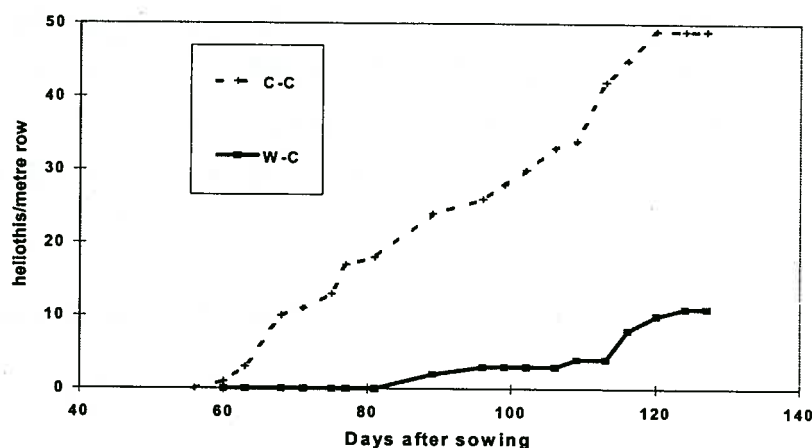
Simpson *et al.*, (1996) found that there was a high correlation between sediment concentration and endosulfan concentration in runoff water and that endosulfan export was reduced by 73% by wheat stubble during the first irrigation. We expect similar reductions in pesticide concentrations (data not available at time of printing).

Insect pressure

The presence of the wheat stubble reduced the cumulative mean heliothis numbers for the season from 49 (C-C) to 12 (W-C) (Figure 3). A likely explanation for the reduction in numbers is that the wheat stubble is acting as a physical barrier preventing heliothis moths finding the cotton plants. Total predator numbers were also found to be 20% higher for the W-C treatment. Once the cotton emerged above the standing wheat stubble, there was no difference in chemical application for heliothis control between treatments.

Further research work is required in this area to gain a better understanding of the effects of stubble on heliothis behaviour.

Figure 3: Cumulative mean heliothis numbers/metre row for 1997/98 cotton season



Reduced sprays

There were 3 less endosulfan sprays required for the W-C treatment over the season (1 spray for W-C, 4 sprays for C-C). This was the second consecutive season 3 less sprays were required (Black pers. comms.). Several benefits to be gained from the reduced spray application: 1) less endosulfan available for off-site movement in runoff 2) crops are not sprayed during the high risk period of the season when the potential for off-site movement of chemicals is at its maximum 3) reduced chemical costs.

Crop Yield

In 1996/97 Black (pers. comms.) found no reduction in yield for W-C with both treatments yielding 7.5 bales/ha. The W-C cotton yield for 1997/98 was 6.25 bales/ha versus 7.5 bales/ha for C-C. The larger volume of wheat stubble present in the second year due to different planting techniques and higher planting rates resulted in lower plant establishment. Further development work is required to overcome these problems.

Financial benefits

Enormous environmental benefits have been demonstrated but at what cost? The returns from the irrigated wheat and savings from 3 less sprays yielded a gross margin of \$508/ha. These savings equate to an additional bale of cotton. In addition, the 75% reduction in soil movement reduces sump de-silting costs.

Adoption constraints

The project has highlighted some constraints to wide spread adoption which need to be addressed in the short term. These include

- available machinery not suitable to plant into standing wheat stubble
- limited water available to grow wheat
- cotton planting delayed until after wheat harvested and pre-plant watering completed
- potential for rain to occur prior to cotton planting which would delay planting even further
- requires additional water at pre-plant irrigation due to additional water use by wheat

By modifying planting machinery and wheat planting techniques, plant establishment will improve. Irrigating to establish the wheat only, will save water, grow a smaller crop (easier to handle and earlier harvest) and potentially reduce soil water demands. These refinements will be developed through on-farm action research in the coming seasons.

Conclusion

Benefits of W-C

- W-C has significantly reduced soil movement with an expected similar reduction in pesticide movement.
- endosulfan sprays were reduced from 4 to 1 due to lower heliothis pressure and higher predator numbers.
- W-C is potentially a much improved farming system with enormous environmental
- benefits with some agronomic and economic problems to overcome

In future seasons, we will develop better agronomy, study the effects of stubble on heliothis behaviour and hopefully test the wheat/cotton double cropping system in higher rainfall years.

References

- Carroll, C., Mollison, J., Halpin, M., Secombe, D. (1995). The effect of furrow length on rain and irrigation-induced erosion on a vertisol in Australia. *Aust. J. Soil Res.* **33**, 833-50.
- Silburn, M., Wockner, G., Bourke, J., Hargreaves, P., Thomas, E., Connelly, R., Spann, K., Freebairn, D., Osborne, B., Beasley, H., Kimber, S., Kennedy, I., Dorr, G., Woods, N., Hogendyke, C., Gaynopr, H. (1996) Rainulator studies of pesticide movement from cotton production systems Pesticide dissipation from soil and subsequent transport in runoff. *Proc. 4th annual Pesticide workshop*. Brisbane, September 17-18.
- Simpson, B., Thomas, E., Hargreaves, P., Noble, B., Kuskopf, B., Carroll, C., Spann, K., Budd, N., Osborne, B., Ruddie, L., Lee, B., Hastie, M. (1996) Pesticide transport from cotton production systems - Queensland site. *Proc. 4th annual Pesticide workshop*. Brisbane, September 17-18.
- Edge, V. (1996). Environmental issues facing the cotton industry related to pesticide use - *Proc. 8th Australian Cotton Conference*. Gold Coast- Qld, August 1996, 47-54