Managing irrigated cotton sown into standing stubble

By Nilantha Hulugalle[1], Lloyd Finlay[1], Fiona Scott[2], Tim Weaver[1]

Sowing cotton into standing wheat or vetch stubble retained on beds and in furrows can reduce erosion and runoff, increase water infiltration, reduce off-field movement of pesticide residues and nutrients, and reduce heliothis moth infestation in young cotton.

Disadvantages of standing stubble include blocking of gas knives by wheat stubble during injection of anhydrous ammonia as fertiliser, waterlogging during irrigation and inability to incorporate residual herbicides.

In an earlier article (*The Australian Cottongrower,* Sept–Oct 2000) we described how a simple machinery modification could avoid blocking of gas knives by wheat stubble during application of anhydrous ammonia. This involves attaching coulter discs to the front bar of the gas rig, in front of the gas tines, to cut through wheat stubble (see photo this page).

A press wheel, which follows the tine, seals the soil and leaves a rolled surface ready for planting. The gas tines and press wheels are fastened onto the back bar of the gas rig. During the pass of the rig, the only stubble disturbed is that on the top of the bed. After anhydrous ammonia has been injected, a 10 cm wide stubble-free strip remains on top of the beds.

In this article we report how timely management of stubble can avoid waterlogging, and the effects of standing stubble on cotton yields, gross margins and weed management costs. The results are from a long-term trial at ACRI, and two on-farm trials near Boggabri and Warren in NSW.

Avoiding waterlogging during irrigation in standing stubble systems

Waterlogging during irrigation events can be avoided by retaining the stubble in the furrows only until the start of the irrigation season (Figure 1A). This is done because the stubble facilitates rainfall harvesting during winter and early spring.

At this point, except for a two metre long strip in the furrows at the tail drain end of the field, the point of a sweep is run through the furrow to a depth of about 10 cm to clean out the stubble from the furrow bottom (Figure 1B).

Modified gas (anhydrous ammonia) rig with coulter discs in front of gas knives

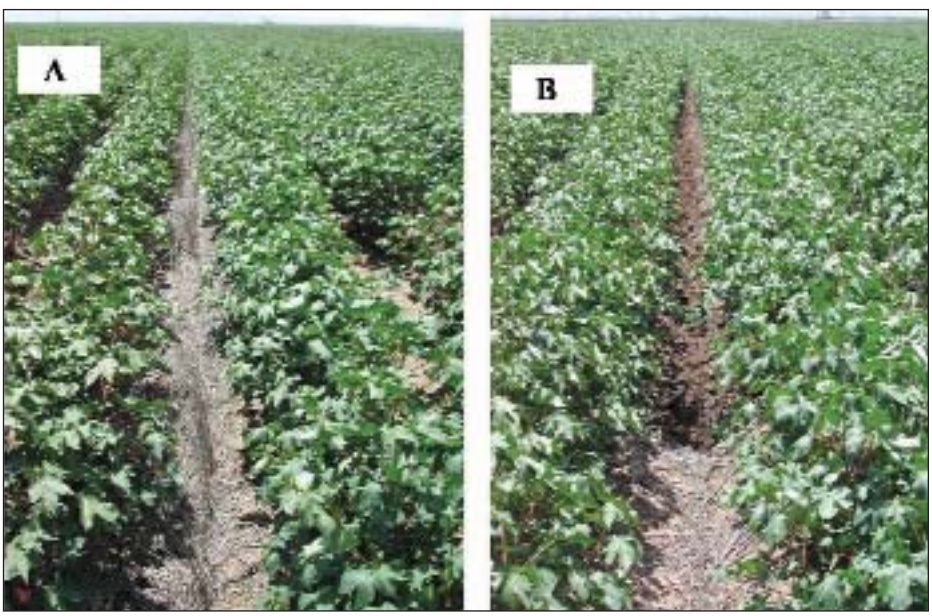

FIGURE 1: Clearing standing wheat stubble from furrows with sweeps. (A) Uncleared furrow with standing stubble; (B) Cleared furrow with two metre stubble buffer

This increases the rate of water flow through the field. But the retained two metre strip slows water flow just enough to settle out dispersed clay and silt (Figure 2). Salts, nutrients and pesticides attached onto clay particles are deposited in the furrow and do not move off the field with runoff (Figure 3).

Cotton yields

At ACRI, where Roundup-Ready cotton was sown in all treatments, average lint yields between 2000 and 2004 were:

- 6.8 bales per hectare with back-to-back cotton sown after conventional-tillage

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(disc and chisel ploughing followed by listering every year);

- 7.3 bales per hectare with back-to-back cotton sown on permanent beds; and,
- 8.6 bales per hectare with cotton–wheat where cotton was sown into standing wheat stubble on permanent beds.

In other words, sowing cotton into standing wheat stubble increased yields by 27 per cent over that in back-to-back cotton sown after conventional tillage and by 17 per cent over back-to-back cotton in permanent beds.

This compares favourably with cotton sown after wheat stubble incorporation at this site, which over a six year period resulted in lint yields higher than those in back-to-back cotton plots by between three and 10 per cent.

Cotton lint yields on permanent beds in the site near Warren were 4.5 bales per hectare after cotton and 6.9 bales per hectare when sown into standing wheat stubble — an increase of 51 per cent.

Near Boggabri, yields were 4.7 bales per hectare when cotton was sown into standing wheat stubble and 3.5 bales per hectare when wheat stubble was incorporated. Although yields were low in both fields at Boggabri because of high salinity and sodicity, sowing into stubble increased yield by 34 per cent.

FIGURE 2: Effect of two metre vetch buffer on sediment concentration in runoff from first irrigation in October 2003 at ACRI, near Narrabri

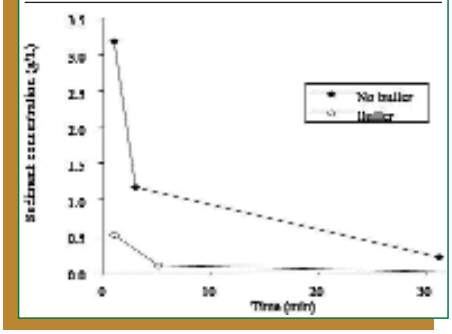

FIGURE 3: Runoff water from plots near Boggabri where cotton was sown either into standing wheat stubble (left) or after wheat stubble (right) was incorporated. Photograph M. Hickman.

Profitability

Financial returns and profitability for each treatment at the ACRI site were estimated by comparing gross margins per hectare from June 2000 to May 2004. During this period, cotton sown into wheat stubble on permanent beds had two cotton and two wheat crops, while the back-to-back cotton treatments had four cotton crops.

At ACRI, because of the higher frequency of cotton crops, the two back-to-back cotton treatments (four cotton crops) had substantially higher cumulative gross margins by May 2004 than when cotton was sown into standing wheat stubble (two cotton crops and two wheat crops — Table 1).

Yield and gross margins in the back-to-back cotton treatments also increased substantially between the 2002–03 and 2003–04 growing seasons. This was because the whole field was ripped in May 2003 to alleviate soil compaction.

The increase in compaction since 2001 had caused large decreases in cotton lint yields and gross margins in the back-to-back cotton plots (Table 1). In a commercial situation, the cotton–wheat rotation would not have been ripped as yield

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TABLE 1: Effect of tillage system and wheat rotation crop on profitability shown as gross margins in $/ha

Tillage system	Cropping system	2000 winter	2000–01 cotton season	2001 winter	2001–02 cotton season	2002 winter	2002–03 cotton season	2003 winter	2003–04 cotton season	Cumulative
Conventional	Back-to-back cotton	–28	2003	–28	1816	–45	1582	–54	1799	7045
Permanent beds	Back-to-back cotton	–28	2643	–39	1802	–45	1317	–54	2442	8083
Permanent beds	Cotton–wheat[1]	–81	2859	119	–194	–19	2051	212	–69	4946

[1]Wheat yielded 2.0 t/ha during winter 2001 and 2.8 t/ha during winter 2003

TABLE 2: Effect of tillage system and wheat rotation crop on cost ($/ha) of weed control during the cotton growing season (includes pre-season weed control)

Tillage system	Cropping system	2000–01 cotton season	2001–02 cotton season	2002–03 cotton season	2003–04 cotton season
Conventional	Back-to-back cotton	170	152	154	142
Permanent beds	Back-to-back cotton	170	165	166	142
Permanent beds	Cotton–wheat	239	—	161	—

decreases were far less than with back-to-back cotton.

At the same time, cumulative variable costs per hectare were $5042 with cotton sown into wheat stubble on permanent beds, $7944 with back-to-back cotton on permanent beds and $7764 with conventionally-tilled back-to-back cotton (Figure 4). Higher variable costs can expose a grower to greater risk of yield and income loss due to factors such as poor commodity prices, flood, hail or crop disease. As shown in Figure 4, on a dollar invested versus dollar return basis, back-to-back cotton and wheat–cotton on permanent beds performed better than conventional back-to-back cotton.

This analysis does not account for the off-field benefits of sowing cotton into standing wheat stubble such as minimisation of sediment and pesticide losses in runoff water. For example, depending on farm size, the cost of cleaning sediment deposited in irrigation channels ranges between $18 and $45 per hectare.

The on-field effectiveness of residual herbicides is also decreased with increasing erosion, as many of these herbicides are adsorbed onto the eroded sediments. Nutrients such as phosphorus are also lost with eroded sediments. The off-field and off-farm environmental costs associated with these adsorbed nutrients and herbicides in waterways have not yet been determined.

Cost of weed control

Cumulative weed control costs from 2000 to 2004 were $710 per hectare with cotton sown into wheat stubble on permanent beds, $645 per hectare with back-to-back cotton on permanent beds and $619 per hectare with conventionally-tilled back-to-back cotton.

The higher costs with cotton sown into wheat stubble on permanent beds were due to the use of Buctril (Bromoxynil) for Roundup-Ready volunteer cotton control during the fallow phase of the rotation. In the continuous cotton systems, mechanical weed control was good enough.

The need to retain the stubble in the cotton-wheat rotation meant that mechanical weed control was not an option. For example, weed control during the 2001–02 fallow cost $195 per hectare, of which Buctril application for Roundup-Ready cotton volunteer control comprised $144 per hectare.

While this is a disadvantage, these costs are outweighed by the increase in yield due to sowing cotton into standing wheat stubble. Cheaper alternative herbicides, which were not previously available locally, are also now available.

When cotton was sown into wheat stubble, the cotton seasons' weed control costs generally decreased with time (Table 2). Weed control costs in both back-to-back cotton systems also decreased with time but not by the same amount. The lower cotton weed control costs in 2003–04 were due to no chipping being required, which usually costs $60 per hectare.

This may have been due partly to applying Roundup as an over-the-top spray with Roundup Ready cotton and partly to the stubble mulch cover impeding weed emergence (that is, it functions as a weed mat). In the short-term, this permits early season control of weeds such as nutgrass within plant rows, and in the longer term, a decline in weed numbers.

Cotton sown into standing stubble.

Conclusions

Waterlogging during irrigation events can be avoided by retaining the stubble in the furrows only until the start of the irrigation season, when except for a two metre long strip at the tail drain end of the field, a shallow sweep is used to clean out the stubble from the furrow bottom. This increases the rate of water flow through the field yet minimises the sediment load in runoff water.

Cotton sown into wheat stubble on permanent beds has lower cumulative gross margins over time since the wheat yield and extra cotton yield per crop is not enough to make up for the cotton crops foregone. But on a dollar for dollar return basis, the cotton–wheat rotation was similar to the back-to-back cotton treatments.

Cumulative weed control costs in the cotton–wheat system were higher than in back-to-back cotton systems, but lower cost options than those used are now available.

FIGURE 4: Variation of gross margins with total variable costs

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1. NSW Department of Primary Industries and Australian Cotton CRC, Narrabri, NSW

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