Using Stubble as an Integrated Pest Management Tool in Cotton

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Introduction

Cotton planted into stubble has shown many advantages over conventional planting practices, including: reducing soil erosion, reducing pesticide and nutrient movement, and improving soil condition (Waters and Sequeira 2000). However the main focus of the current research is to identify the potential benefits in insect pest management.

There are many theories on why cotton is sprayed less when it is planted into wheat stubble, and these are currently being investigated. The two main ideas are that firstly, cereal stubble acts as a visual deterrent and obstruction to egg-laying heliothis moths and secondly that the stubble acts as a refuge for natural enemies which prey on or parasitise the heliothis eggs and young larvae.

Methods

To investigate these ideas, we conducted a trial at Jeff and Marilyn Bidstrup's property 'Prospect' at Warra on the Darling Downs. Dryland NuPEARL (Ingard®) was planted on the 25th October 2001 in a single skip configuration into standing wheat stubble, flat wheat stubble and bare ground. The trial design was a 5 x 5 Latin Square. Plots were 36 m long and 36 m wide containing 12 pair rows. Two additional treatments are not reported here.

For the purpose of this trial, the main period of interest was when cotton plants were shorter than the standing wheat stubble. This was considered to be the period when stubble effects would be most pronounced. Cotton planted into stubble lying flat on the ground was also investigated to see if stubble presence alone played a part in heliothis host plant selection.

Pest and natural enemy numbers were regularly monitored to determine if there was a difference between the treatments. Different sample methods were used to determine insect numbers on the ground (pitfall traps) and on the plants (suction samples and visual counts).

Conduit sleeves (41 mm diameter x 150 mm) were placed in the soil next to cotton plants using a soil auger, ensuring that the top of the sleeve was level with the surrounding soil.

Four sleeves were placed in the centre of each plot in a square formation (15 x 15 m). Pitfall tubes (120 mm x 40 diameter mm) were $^{1}/_{3}$ filled with 70% ethanol and placed into the conduit sleeves in the field weekly and collected after 48 hours. Each pitfall tube was examined in the laboratory and the contents recorded.

A Stihl BG72 suction machine was used to sample cotton plants for pests and natural enemies. Two random 10m lengths in each plot were sampled; with the contents of each sample was placed into a plastic sealable container containing 70% ethanol, and their contents were recorded in the laboratory. This was undertaken weekly until 39 DAS.

Visual inspections of five consecutive plants at four randomly selected sites per plot were examined for pests and a natural enemy was completed twice a week. All eggs, larvae/nymphs and adults were recorded.

Night and day observations of natural enemies were completed by visually inspecting 100 egg cards every hour in conventionally planted cotton and cotton planted into wheat stubble and the natural enemies feeding on the cards was recorded.

All insect counts were analysed using a generalized linear model with Poisson errors and over dispersion parameter estimated. Treatment means were compared using pair wise t-tests on the model parameters when there was a significant overall treatment effect. Counts from each measurement time were pooled over the whole trial period.

Plant measurements were taken at the end of the trial period (57 DAS). A shovel was used to remove ten cotton plants from each plot and the plants were placed into brown paper bags (42 x 30 cm), labelled and stored in an esky. In the laboratory, the root length, shoot length and number of leaves were recorded for each plant. Data was analysed by analysis of variance (ANOVA), and means were compared using Fisher's LSD technique.

Results

Low heliothis activity when the cotton plants were shorter than the stubble meant that we could not investigate stubble affects on egg-laying heliothis moths. The numbers of natural enemies were also low. Consequently it was necessary to combine insect data for the trial period to enable statistical analysis.

There were significantly more heliothis eggs in cotton planted into wheat stubble compared to other treatments and significantly more green mirids in cotton planted conventionally and into flat stubble compared to cotton planted into wheat stubble (Table 1). Spiders and green lacewings were the most abundant natural enemies but numbers were not significantly different between treatments.

Table 1: Collective visual counts of pests and natural enemies per 130 row metres for the trial period.

Treatment	Heliothis Eggs	Heliothis Larvae	Green Mirid	Jassids	Thrips	Green Lacewing	Spiders	Ants
CS	57.4_c	2.6	9.0_a	15.8	1.4	9.8	8.6	5.4
C	51.8_a	4.4	11.0_c	16.0	1.8	9.4	9.4	4.4
CFS	55.6_b	3.6	10.0_b	14.2	1.2	16.8	6.8	7.6
P Value	0.037	0.973	0.025	0.094	0.744	0.159	0.203	0.260

Means with the same subscript are not significantly different (P=0.05). Key to treatments: CS= Cotton planted into standing wheat stubble; C= Cotton planted conventionally; CFS= Cotton planted into flat stubble.

Heliothis larvae and spider numbers were significantly greater in the conventionally planted treatment. Cotton planted into flat stubble had significantly more wasps than other treatments (Table 2).

Table 2: Collective suction sample counts of pests and natural enemies per 700 row metres for the trial period.

Treatment	Heliothis Larvae	Green Mirid	Jassids	Apple Dimpling Bug
CS	5.4_b	31.2	403.6	5.6
C	12.8_c	30.0	464.8	9.4
CFS	4.4_a	21.4	433.0	4.4
P value	0.027	0.059	0.059	0.058

Treatment	Green Lacewing	Pred. Beetles	Pred. Bugs	Spiders	Wasps	Ants
CS	4.7	1.6	4.0	13.2_a	6.8_a	5.6
C	6.4	1.0	4.2	16.8_c	12.8_b	2.2
CFS	5.9	0.6	2.2	13.8_b	21.0_c	10.2
P value	0.257	0.178	0.263	0.002	0.033	0.503

Means with the same subscript are not significantly different (P=0.05). Key to treatments: CS= Cotton planted into standing wheat stubble; C= Cotton planted conventionally; CFS= Cotton planted into flat stubble.

Cotton planted into wheat stubble was taller, although the difference across treatments was relatively minor with the number of leaves per plant not significantly different across the treatments (Table 3).

Table 3: Plant measurements taken 57 DAS.

Treatment	Shoot Length (mm)	Root Length (mm)	Number of Leaves
CS	526.3_b	155.8_a	36.8
C	510.6_{ab}	182.6_b	40.4
CFS	480.5_a	159.7_a	32.9
LSD	43.45	9.18	

Means followed by the same subscript are not significantly different (P=0.05). Key to treatments: CS= Cotton planted into standing wheat stubble; C= Cotton planted conventionally; CFS= Cotton planted into flat stubble.

Night/day observations indicated that spiders (in particular night stalkers *Cheiracanthium* spp.) were most active at night and ants were more active mid morning (Table 4).

Table 4: Collective night/day observation data per 100 egg cards per treatment.

	20-21 Nov 2001				18-19 Dec 2001			
	Night		Day		Night		Day	
Treatment	Spiders	Ants	Spiders	Ants	Spiders	Ants	Spiders	Ants
C	2	3	0	34	3	0	0	2
CWS	4	7	0	52	1	0	0	3

Discussion and Conclusion

When heliothis finally appeared and eggs were laid, the cotton plants were taller than the wheat stubble. As a result this trial was inconclusive in determining if cotton planted into wheat stubble effects oviposition behaviour of female heliothis moths.

Although there was a significant difference in the number of green mirids recorded in visual counts, there was no significant difference in the numbers recorded using the suction machine. This difference may be a result of the difference in sampling methods as suggested by Scholz *et al.* (2001). Furthermore green mirid numbers were relatively low during the trial period.

The suction sampling method indicated a significant difference in the number of heliothis larvae in all treatments even though this was not obvious in visual counts. Heliothis larvae were only present at the end of the trial after the cotton was above the height of the stubble. Heliothis larvae were small-mediums and above and had moved from recently sprayed weeds. The difference in heliothis numbers may be a result of a lower density of weeds in cotton planted into standing and flat stubble compared to conventional planting methods, due to more competition for space. Therefore weed management is another important consideration.

The difference in the numbers of spiders, ants, green lacewings, predatory bugs and predatory beetles across the three treatments was not significant. This was expected as prey such as heliothis and aphids (which were negligible) was minimal in the trial period.

Compared to conventionally planted cotton, cotton planted into wheat stubble was often taller when below the height of the wheat stubble. However, once the plants were above the height of the stubble their growth was similar to conventionally planted cotton.

This is the first in a series of trials over three years. Since the numbers of all pests and natural enemies were relatively low throughout the period of the trial, this trial will need to be repeated in a high-pressure season. Furthermore because heliothis pressure is unpredictable, glasshouse experiments will be undertaken to better understand the role of sowing into stubble on heliothis oviposition and survival.

References

Scholz, B. C. G., Cleary, A. J., Lloyd, R. (2001). **Sheet unbeatable for sampling predators in cotton**. *The Australian Cotton Grower*. **22:** 14-17.

Waters, D. and R. Sequeira (2000). **Cereal stubble and trap crops in heliothis management**. *10th Australian Cotton Conference*, Brisbane. Australian Cotton Growers' Research Association Inc. Orange, New South Wales.

Acknowledgements

The authors thank Wade, Jeff, Marilyn, and Sallyanne Bidstrup for the help and cooperation in this trial; Brad Scholz, Richard Lloyd, Scott Foster and David Waters for their assistance and support; Sue Maclean for providing heliothis eggs; Kym McVeigh, Michael Thompson and Brett Bidstrup for their assistance in the field; and the Cotton Research and Development Corporation for funding this project.