Comparing Sorghum and Wheat Stubble as an Integrated Pest Management Tool

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Introduction

Cotton planted into cereal stubble has numerous benefits over conventional planting methods, such as reducing soil erosion, reducing pesticide and nutrient movement, and improving soil condition (Waters and Sequeira 2000).

The main focus of the current research is to identify the potential benefits of stubble in insect pest management and determine if different types of cereal stubble have an impact on pests and natural enemy numbers.

Methods

The effect of different types of cereal stubble on pest management was investigated in a trial conducted at the Department of Primary Industries Kingsthorpe farm on the Darling Downs.

Wheat stubble was already present in the field. Sorghum variety DK35 (Pacific Seeds) was planted (14th Dec 2001) and sprayed with Roundup® (4th Feb 2002) at the pre flowering stage to create stubble. The average height of the wheat and sorghum stubble was 29 cm and 81 cm respectively.

Conventional Delta TOPAZ cotton was planted on the 18th Feb 2002 in a single skip configuration into standing wheat stubble, standing sorghum stubble and bare ground. The trial design was a 3 x 3 Latin Square, and plots were 60 m long and 16 m wide each containing 6 pair rows.

For the purpose of this trial the main period of interest was when the cotton plants were shorter than the standing stubble. This was considered to be the period when stubble effects would be most pronounced. The sorghum stubble provided a longer time period to work as it took 90 days after sowing (DAS) for the cotton to reach the top of the stubble.

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

A Stihl BG72 suction machine was used to sample cotton plants for pests and natural enemies. Two random 10 m lengths in each plot were sampled; the contents of each sample were placed into sealable plastic containers containing 70% ethanol. Their contents were recorded in the laboratory. This was undertaken weekly until the plants reached 7 nodes (39 DAS).

Visual inspections of five consecutive plants at four randomly selected sites per plot were examined for pests and natural enemies. All eggs, larvae/nymphs and adults were recorded. This was completed twice a week until 50 DAS.

Subsequent to 50 DAS, the method used to sample the cotton plants for pests and natural enemies was changed. Instead, three 1 m rows of cotton plants were randomly selected in each plot and visually inspected. All eggs, larvae/nymphs and adults were recorded. These plants were then used for the beat sheet sample. The beat sheet was made from a 1.5 m by 2 m yellow piece of Canvacon. A 1.5 m piece of timber dowel 25 mm in diameter was fixed at each end of the sheet. The sheet was laid flat on the ground under the cotton plants to be sampled. The end of the sheet was placed against the base of the plants.

A 1 m long piece of plastic conduit was used to knock the insects from the plants onto the yellow sheet. The cotton plants were struck with the stick 10 times gradually moving from the base of the plants to the top, as in accordance with the method described by Scholz *et al.* (2001). The insects landing on the sheet were then recorded and added to the visual count data. This was completed twice a week.

Conduit sleeves (41 mm diameter x 150 mm) were placed in the soil next to cotton plants within the row using a soil auger, ensuring that the top of the sleeve was level with the surface of surrounding soil. Ten tubes were placed in each plot, with five in the outside of row pairs 3 and 4. Each sleeve was 10 m apart. Each week pitfall tubes (120 x 40 mm) were $^1/_3$ filled with 70% ethanol and placed in the conduit sleeves and collected after 48 hours. Each pitfall tube was examined in the laboratory and the contents 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.

In the final week of the trial (89 DAS), ten cotton plants from each plot were removed, labelled and placed into eskies. They were transported to the laboratory where root length, shoot length, number of leaves, number of squares, number of nodes and the distance between nodes were recorded.

The leaves from each plant were removed and placed into individual trays. These leaves were then placed into an Area Measurement System Conveyor Belt Unit. A MK2 Area Meter, television and an Ernite 12 mm F1.2 TV lens was used to calculate the leaf area of each plant. The machine was calibrated using a piece of graph paper with a know area. The calibration of the machine was checked every 5 samples. Data were analysed by analysis of variance (ANOVA), and means were compared using Fisher's LSD technique.

Results

Low heliothis activity throughout the trial meant that we could not investigate stubble effects on egg-laying heliothis moths. However, large infestations of cotton aphid (*Aphis gossypii*) allowed us to compare their development and control under different stubble regimes.

Visual inspections of the cotton up to 50 DAS established that cotton planted conventionally and into wheat stubble had significantly more aphids than cotton planted into sorghum stubble (Table 1). Cotton planted conventionally had significantly more predatory bugs than cotton planted into stubble. While spiders were the predominant species of natural enemy, there was no significant difference between treatments. Cotton into wheat stubble had more natural enemies than other treatments although the difference was not significant difference.

Table 1: Collective visual counts of pests and natural enemies per 108 row metres from 1-50 DAS.

Treatment	Heliothis Eggs	Whitefly	Aphid	Jassids	Thrips
C	10.2	2.4	567.0_a	3.8	3.3
CWS	18	1.5	1162.2_a	2.1	2.4
CSS	4.7	8.6	54.2_b	2.5	9.8
P value	0.473	0.222	0.048	0.166	0.466

Treatment	Predatory Bugs	Spiders	Ant	Total Natural Enemies
C	4.9_a	7.2	1.2	14.2
CWS	4.8_b	2.6	9.0	20.0
CSS	0.0_c	4.7	13.2	17.8
P value	<0.001	0.299	0.156	0.854

Means followed by the same subscript are not significantly different at the 5% level. Key: C= cotton planted into bare ground; CWS= cotton planted into standing wheat stubble; CSS= cotton planted into standing sorghum stubble.

Suction samples were only taken 18, 25, 33 and 39 DAS. Cotton planted into sorghum stubble had significantly more spiders than cotton planted conventionally or into wheat stubble (Table 2). Spiders were the most abundant predator in all treatments. Total numbers of natural enemies were greatest in the cotton planted into sorghum stubble, however there was no significant difference between treatments. Numbers of green mirids and heliothis larvae were too few to analyse.

Table 2: Collective suction sample of pests and natural enemies per 240 row metres from 1-50 DAS.

Treatment	Aphid	Jassids	Predatory Beetles	Spiders	Ants	Total Natural Enemies
C	64.5	24.3	2.4	7.9_a	3.4	40.7
CWS	167.0	29.4	5.9	8.0_a	6.1	35.3
CSS	21.4	18.3	2.4	12.3_b	6.8	60.6
P value	0.140	0.808	0.933	0.017	0.910	0.360

Means followed by the same subscript are not significantly different at the 5% level. Key: C= cotton planted into bare ground; CWS= cotton planted into standing wheat stubble; CSS= cotton planted into standing sorghum stubble.

Based on beat sheet samples, cotton planted into bare ground and wheat stubble had significantly more aphids than cotton planted into sorghum stubble (Table 3). Subsequently there were significantly more mummified aphids in these treatments. Cotton planted into wheat stubble had significantly more loopers.

While predatory beetles were the most abundant predator group (Table 3), (45.2% variable ladybird; 33.3% amber spotted ladybird; 10.1% minute two spotted ladybird; 5.9% striped ladybird; 5.5% red and blue beetle) differences between treatments were not significant. *Lysephlebus testaceipes* parasitised 15.5%; 13.1% and 53.3% of aphids in cotton planted conventionally, cotton planted into wheat stubble and cotton planted into sorghum stubble respectively.

There were more spiders in cotton planted into sorghum stubble compared to cotton planted conventionally or into wheat stubble, however the difference was not significant (Table 3).

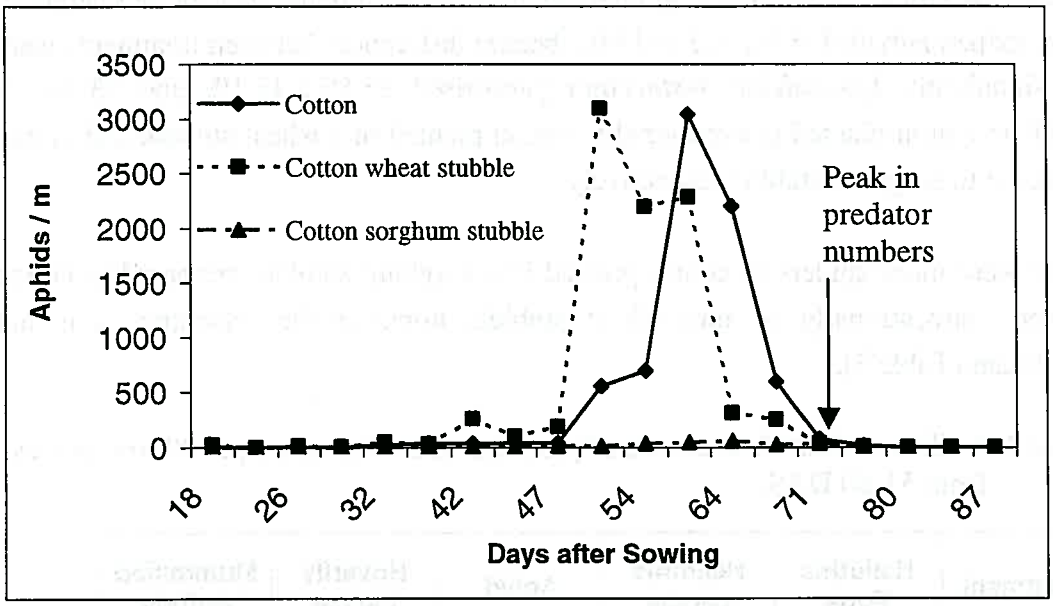
Table 3: Collective beat sheet counts of pests and natural enemies per 90 row metres from 51-90 DAS.

Treatment	Heliothis Eggs	Heliothis Larvae	Aphid	Hoverfly Larvae	Mummified Aphids
C	1.4	9.3	22584_a	11.9	2997_a
CWS	2.9	6.0	20054_a	10.0	2124_a
CSS	0.7	0.8	646_b	4.4	316_b
P value	0.749	0.152	0.002	0.274	0.025
Treatment	**Green Mirid**	**Predatory Bug**	**Spiders**	**Predatory Beetles**	**Total Natural Enemies**
C	2.8	36.6	14.9	162.5	225.8
CWS	1.0	23.3	15.3	105.0	115.5
CSS	0.3	5.0	34.6	56.5	100.0
P value	0.569	0.078	0.21	0.333	0.272
Treatment	**Jassids**	**Green Vegetable Bug**	**Looper**		
C	3.7	1.0	22.8_{ab}		
CWS	4.0	2.3	40.7_b		
CSS	2.0	0.6	5.6_a		
P value	0.12	0.538	0.037		

Means followed by the same subscript are not significantly different at the 5% level. Key: C= cotton planted into bare ground; CWS= cotton planted into standing wheat stubble; CSS= cotton planted into standing sorghum stubble.

The aphid population first appeared in the cotton planted into wheat stubble (18 DAS). The number increased rapidly in the conventionally planted cotton and the cotton into wheat stubble 47 DAS and decreased rapidly 71 DAS (Figure 1). Aphid numbers remained low in the cotton planted into sorghum stubble through out the trial. Predator numbers peaked 71 DAS (Figure 1)

Figure 1: Aphid population during trial



There was no significant difference between treatments for soil fauna in the pitfall traps therefore these data is not provided.

Cotton plants were significantly taller when planted into standing sorghum stubble compared to other treatments (Table 4). Average leaf area and number of leaves were greater on cotton planted into sorghum stubble than cotton planted conventionally or into wheat stubble, however the differences were not significant. There were significantly more squares on cotton plants planted into stubble compared to cotton planted conventionally.

Table 4: Plant measurements taken at 15 nodes.

Treatment	Average Root Length (cm)	Average Shoot Length (cm)	Average Number of Squares	Average Number of Leaves	Average Leaf Area cm^2	Average Number of Nodes	Average Node Length (cm)
C	20.2	44.1_a	7.6_a	48.5	1797.9	15	2.3
CWS	26.1	60.2_b	12.0_b	59.2	2768.7	15	3.0
CSS	25.8	65.6_c	14.8_b	54.2	3023.7	16	3.3
LSD		143.5	3.43				

Means followed by the same subscript are not significantly different at the 5% level. Key: C= cotton planted into bare ground; CWS= cotton planted into standing wheat stubble; CSS= cotton planted into standing sorghum stubble.

Discussion and Conclusion

Heliothis numbers were relatively low throughout this trial. As a result, this trial was inconclusive in determining if cotton planted into wheat and sorghum stubble effects oviposition behaviour of female heliothis moths.

The abundance of aphids throughout the trial enabled us to examine the effect of different stubble types on their population development. Aphids first appeared in the cotton planted into wheat stubble and quickly infested the conventionally planted cotton' eventually peaking at 52 and 59 DAS respectively.

The impact of aphids on the plants was evident with heavy infestation affecting plant growth and development. Lower plant height and poor average leaf area in cotton planted conventionally and cotton planted into wheat stubble was a direct result of high aphid infestation.

Aphids were reduced to low levels 82 DAS by a combination of predators and parasitoids. Numbers of parasitised aphids were highest in conventionally planted cotton, however in proportion to the number of aphids, cotton planted into sorghum stubble had a higher parasitism level.

Plant height and node length was affected when cotton was grown into stubble. This may be a result of limited sunlight reaching the plants when they are young, therefore requiring the plants to grow taller faster to reach the light. This continues until the cotton plants reach the height of the stubble. There were fewer pest numbers in cotton planted into stubble compared to conventionally planted cotton. This resulted in significantly more squares, which is a positive outcome.

Root (1973) suggests that differences in the physical conditions prevailing in the crop could have some influence on the herbivore fauna. This may be a reason why there were less heliothis, green mirids, aphids, jassids, loopers and green vegetable bugs in the cotton planted into standing sorghum stubble compared to the other treatments as the plants were less exposed.

This is the second in a series of trials over three years. Since the numbers of heliothis 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 cotton into stubble on heliothis oviposition and survival.

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This trial demonstrated the reduced impact of cotton aphids on cotton sown into cereal stubble. This aspect will be further investigated throughout the project.

References

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Acknowledgements

The authors thank Richard Lloyd, Peter Horne and Graham Pauli for the help and cooperation in this trial; Brad Scholz and Bernie Franzmann for their assistance and support; Ian Broad for assistance with the area measurement system. Sue Maclean for providing heliothis eggs; Nathan Slater, Mark Wade and Austin McLennan for their assistance in the field; and the Cotton Research and Development Corporation for funding this project.