An Evaluation of Insecticide Seed Treatments Against Thrips in Southern Australia

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ABSTRACT

Thrips (Thrips tabaci and Frankliniella schultzei) are common seedling pests of Australian cotton crops. They are controlled using insecticide seed treatments, soil applied insecticide granules or foliar insecticides. To assess the relative value of these control options, their efficacy was assessed in the field. The yield response of cotton was also assessed to indicate the effect of thrips damage on yield. Cotton protected with thiodicarb, imidacloprid, or a combination of thiodicarb and fipronil, applied as seed treatments was compared with that protected by in-furrow applied aldicarb granules and with untreated seed. Replicated experiments were carried out on commercial cotton farms at 14 sites throughout Australia over 2 seasons. Experiments were unsprayed through the early season, when thrips were present, but after that, insect pests were managed according to best commercial practice. Varieties expressing the Cry 1Ac protein were used to minimize potential confounding effects due to damage by Helicoverpa spp. Aldicarb provided the best control of thrips, followed by imidacloprid, fipronil and thiodicarb. Yield increases were recorded at only 4 of the 13 sites harvested. The magnitude of the yield increase from thrip control appeared to be related to the seasonal abundance of thrips, the growing conditions and treatment efficacy.

Introduction

Thrips are regarded as key early season pests of cotton in Australia (Wilson and Bauer, 1993), though their true pest status has been questioned (Sadras and Wilson, 1998). Thrips cause damage to cotton during the four to eight week period from emergence until the plants have about eight true leaves, after which they are no longer regarded as damaging. Feeding damage by thrips causes distorted growth of leaves, leading to reduced leaf area, and severe infestations may kill the growing terminal, known as 'tipping out', causing a delay in plant development as a new terminal is produced. Heavy damage can result in excessive tipping out throughout a cotton field, resulting in delayed maturity and/or yield loss (Sadras and Wilson, 1998). Thrips may also feed on young cotton buds (squares) causing them to shed, although this is not common. Despite this array of symptoms, the pest status of thrips in cotton remains controversial. Some authors have reported that thrips cause significant effects on cotton yield or maturity while others reported that thrip damage was mainly cosmetic, with little effect on the economic value of the crop (Hawkins *et al.*, 1966; Rummel *et al.*, 1988; Terry, 1992).

Seed treatments have been used as a convenient method of protecting seedling cotton plants against thrips in Australia for the last 20 years. Thiodicarb (Semevin®) is currently the standard seed treatment used and is applied to over 50% of the cotton seed used for planting in Australia. During the last 5 years, however, there has been a substantial increase in the use of granular insecticides such a aldicarb (Temik®) and phorate (Thimet®). These compounds are applied with the seed at planting and are taken up systemically by the seedling. Additionally, a new seed treatment, imidacloprid (Gaucho®) became commercially available in Australia for the first time in 1997 and a combination seed treatment, thiodicarb plus fipronil (Semevin Super®), is being developed to provide control of both thrips and wireworm and may have replaced Semevin in 1999. The aim of this study, therefore, was firstly, to compare the range of seed treatments against one of the granular insecticides (aldicarb) in terms of efficacy against thrips and secondly, to evaluate the yield responses of cotton to protection from thrips.

Methods

A total of fourteen large-scale trials were established on commercial farms in southern Queensland and northern NSW in 1996 and 1997. In each experiment a randomized block design was used with four replications. Plots sizes ranged from 8 m x 400 m to 12 m x 1000 m, depending on the planting equipment used and the field length.

The experimental plots were not sprayed with insecticides during the first 6 weeks after emergence to allow natural thrip infestations to develop, especially in the untreated plots. Transgenic cotton varieties (Ingard ®) containing the Cry 1A(c) gene were used at each location to reduce the potential confounding effect of damage by *Helicoverpa* spp during the unsprayed period. The varieties used were Sicala V-2*i* and Exp944*i*, both normal leaf varieties and Siokra V-15*i*, which was okra leaf.

In experiments in 1996 there were four treatments; three seed treatments and aldicarb. In experiments in 1997 there were five treatments; an untreated control, three seed treatments and aldicarb. The seed treatments were applied using a large cement mixer to agitate the seed while the required rate of insecticide was added to ensure consistent and even coverage. A polymer called Peridium® was applied to all seed, as was a standard fungicide mix containing Apron® and Quintazine®. Thiodicarb was applied at a rate of 450 g ai / 100 kg of seed, imidacloprid at 525 g ai / 100kg of seed and the mixture of thiodicarb plus fipronil at 250 and 50 g ai / 100 kg of seed respectively. Aldicarb was applied in the furrow with the seed at planting, using the growers' equipment, calibrated to apply aldicarb at the rate of 450 g ai /ha. The seed was planted using the farmer's equipment at rates ranging from 12-16 kg/ha. At most sites, the cotton seed was planted into dry soil and irrigated to ensure germination but some sites, the seed was planted into moist soil or received rain after planting.

Insect and plant assessments began within a week of emergence and continued for 4 weeks on a weekly basis. The abundance of thrips was assessed by collecting 10 to 20 cotton seedlings from each plot into large glass jars containing 100% methanol, to kill and preserve the thrips. Thrips were washed from the plants and counted using a microscope at a later date. Counts of thrips were separated into nymphs and adults. Damage to cotton plants, caused by thrips, was assessed each week after emergence. Damage was rated visually using a 1 to 5 scoring system where 5 = no damage and 1 = severe damage. Plant density was assessed in 5 m of row in each plot in each experiment and assessments were completed 2-3 weeks after emergence.

Yield was assessed by picking the cotton from the central four or eight rows of each plot using a commercial mechanical cotton picker and weighing the picker on a set of portable picker scales. A sample of the seed cotton was taken from the cotton picked from each plot to determine gin turnout and fiber quality.

Analysis

Data from all sites for each year were combined and analyzed using analysis of variance to test for treatment differences. Fisher's protected least significant difference was used to separate treatment means. Thrip counts were transformed (ln + 1) before analysis.

Results

Experiments in 1996

Aldicarb provided the highest level of control of both adult and nymph thrips, compared with all other treatments in both years (Figures 1 and 2). Damage levels were worst on the thiodicarb and thiodicarb plus fipronil seed treatments, significantly less on the imidacloprid seed treatments and least on the aldicarb treatments, mirroring the thrip levels (Figure 3). In 1996, significant differences in lint yield were found between treatments at three of the seven sites (Table 1). Overall, when all 1996 sites were analyzed together, yield was slightly but significantly higher in the aldicarb treatment than in other treatments except imidopropil (Figure 4).

Experiments in 1997

Aldicarb provided the best control of thrips, both adults and nymphs, compared with other insecticides and the untreated control (Figures 5 and 6). Imidacloprid provided significantly better control of thrips nymphs than thiodicarb but was similar to thiodicarb plus fipronil (Figure 5). Thiodicarb alone was not significantly different from the untreated control. All seed treatments provided significant control of adult thrips (Figure 6). Damage levels were significantly lower in all insecticide treatments than the untreated control. Thiodicarb and thiodicarb plus fipronil had slightly but significantly less damage than the untreated control, imidacloprid less again and aldicarb the least (Figure 6). In 1997, significant differences in lint yield were recorded between treatments at one of the six sites harvested. When all sites were analyzed together, there were no significant differences in yield between treatments.

Discussion

At all trial sites, aldicarb gave the best control of thrips, both nymphs and adults. Aldicarb kept nymph numbers at very low levels for up to 40 days after planting, reducing breeding of thrips. In contrast, the seed treatments did not control thrips as well as aldicarb and control was for a relatively short period. Imidacloprid was the most efficacious seed treatment. These trends occurred over 2 years but some individual sites diverged from the trends.

Observations of plant damage generally correlated positively with nymph numbers. The aldicarb treated cotton showed very little sucking pest damage and appeared to be more vigorous than the other treatments, though the plants in the imidacloprid plots were almost as vigorous as those in the aldicarb treatment. The thiodicarb and thiodicarb plus fipronil seed treatments provided a marginal reduction in damage levels compared with the untreated control.

Overall analysis showed significant differences in yield between treatments only in 1996, when aldicarb treated cotton yielded significantly more than the other treatments. Three of the seven individual sites had significant yield differences between treatments in 1996, while in 1997, only one of the six sites picked had a difference in yield between treatments. Where significant differences occurred, the aldicarb plots produced the highest yield. The 1996 season was relatively cool while 1997 had ideal conditions after planting. The results suggest that cotton seedlings can tolerate quite high levels of thrip, provided seasonal conditions encourage rapid plant growth. These results confirm those of Sadras and Wilson (1998), who found that although thrips could cause significant reduction in leaf area and in the dry weight of cotton seedling, the plants were able to recover from all but the most severe damage with negligible loss of yield.

Conclusion

Aldicarb controlled thrips nymphs and adults for up to 4 weeks after emergence and produced virtually unblemished plants. imidacloprid was the most efficacious seed treatment while thiodicarb and thiodicarb plus fipronil gave only slight control; both in terms of thrips abundance and preventing damage. No consistent yield responses were recorded between treatments, confirming that cotton plants can often compensate for the thrip damage.

Acknowledgements

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Table 1. Mean lint yield (kg / ha) for each treatment at each location in 1996.

Site	Aldicarb	Imidacloprid	Thiodicarb	Thiodicarb + Fipronil
Warren	2152a	2081a	1993b	2026b
Breeza	1519a	1497a	1290b	1334b
Wee Waa	1913a	1902a	1963a	1862a
Moree	2433a	2327a	2478a	2383a
Goondiwindi	2080a	2020b	1962b	1990b
Bongeen	2035a	2052a	1918a	1974a
MacAlister	1721a	1710a	1682a	1665a

At each location means with different letters are significantly different at p = 0.05 using ANOVA, LSD.

Table 2. Mean lint yield (kg / ha) for each treatment at each location in 1997.

Site	Aldicarb	Imidacloprid	Thiodicarb	Thiodicarb + Fipronil	Untreated
Warren	2097a	1990b	1946b	2063a	1962b
Wee Waa	1946a	2040a	1939a	1937a	1921a
Moree	2034a	1975a	1947a	1964a	1923a
Goondiwindi	2129a	2199a	2216a	2142a	2212a
Bongeen	2253a	2161a	2313a	2300a	2273a
MacAlister	1655a	1678a	N/A	1689a	1659a

At each location means with different letters are significantly different at p = 0.05 using ANOVA, LSD.

Figure 1. Cumulative abundance of thrips nymphs on cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.) or thiodicarb (Thio.) across 7 experiments in 1996[1].

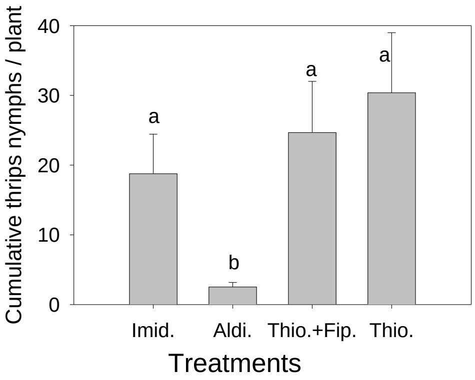


Figure 2. Cumulative abundance of thrips adults on cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.) or thiodicarb (Thio.) across 7 experiments in 1996[1].

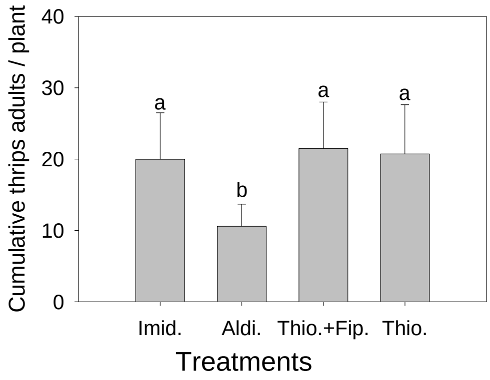


Figure 3. Cumulative thrips damage rating for cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.) or thiodicarb (Thio.) across 7 experiments in 1996[1].

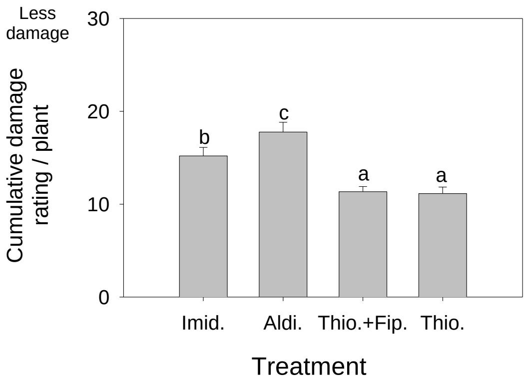


Figure 4. Mean lint yield for cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.) or thiodicarb (Thio.) across 7 experiments in 1996[1].

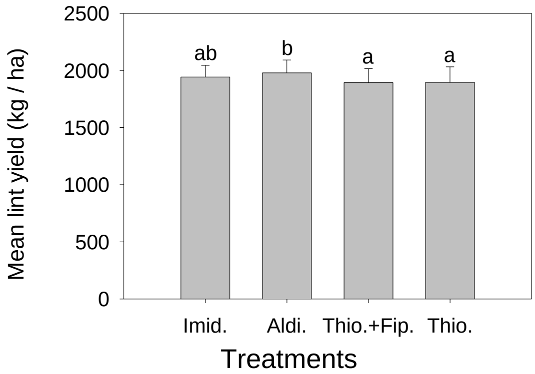


Figure 5. Cumulative abundance of thrips nymphs for cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.), thiodicarb (Thio.) or untreated (UTC) across 7 experiments in 1997[1].

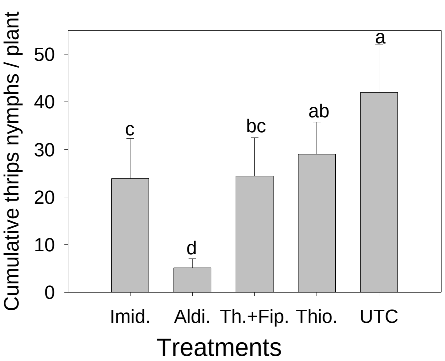


Figure 6. Cumulative abundance of thrips adults for cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.), thiodicarb (Thio.) or untreated (UTC) across 7 experiments in 1997[1].

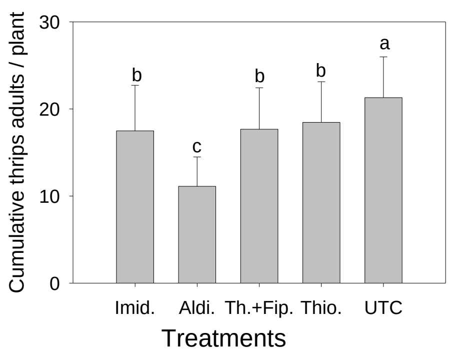


Figure 7. Cumulative thrips damage rating for cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.), thiodicarb (Thio.) or untreated (UTC) across 7 experiments in 1997[1].

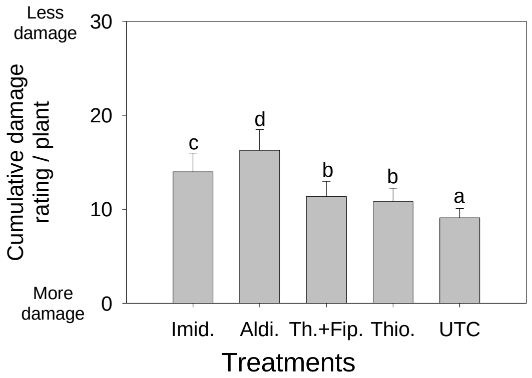
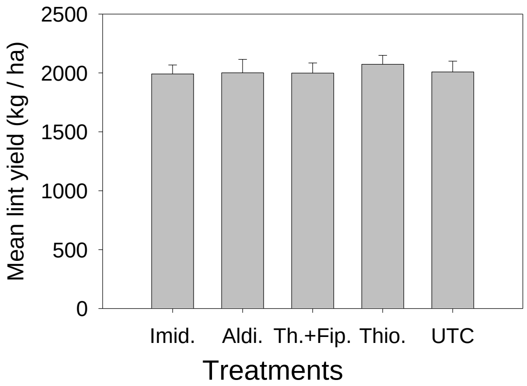


Figure 8. Mean lint yield for cotton treated with imidacloprid (Imid.), aldicarb (Ald.), thiodicarb plus fipronil (Thio.+Fip.), thiodicarb (Thio.) or untreated (UTC) across 7 experiments in 1997[1].



[1] Values are means ± SE. Treatments with different letters are significantly different at p = 0. 05 using ANOVA, LSD.