Cottonseed Treatment in Addition to Chemical Control of Sporadic Pests for the Small Scale Farmer

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ABSTRACT

Cottonseed treatment trials over two to three seasons showed that phorate and terbufos have potential as seed dressings to protect young cotton plants against pests. Bio-assays indicated that germinating cotton plants are capable of absorbing and transporting sufficient insecticide to produce satisfactory mortality in pests such as Syagrus rugifrons Baly the black cotton beetle, and other ground insects, e.g. crickets, that damage cotton seedlings. The black cotton beetle is a pest on cotton seedlings and ratoon cotton on the Springbok Flats in the Northern Province. Soil treatment and seed treatment with terbufos effectively prevented root damage early in the season, while follow-up applications of monocrotophos or abamectin in combination with endosulfan (Thioflo), controlled plant damage above the soil. Endosulfan in combination with profenofos and carbaryl resulted in significant yield increases. Monocrotophos simultaneously controls the American bollworm (Helicoverpa armigera Hübner), the main pest of cotton. Monocrotophos also shows potential to control the cotton stem weevil, Apion soleatum Wagner (Apionidae: Coleoptera), a relatively new pest in the lowveld areas of KwaZulu-Natal and Mpumalanga, where many small-scale farmers produce cotton. An integrated pest management programme that includes seed treatment and limited use of insecticides that control a number of pest species at the same time, is suggested for small-scale farmers.

Introduction

Syagrus rugifrons Baly (Chrysomelidae: Coleoptera), is one of the important sporadic pests in the northern parts of the cotton-producing area, specifically Northern Province and the Springbok Flats. This pest distribution has widened to include the Northern parts of KwaZulu-Natal (Makhathini flats), where it has not been recorded before. Broodryk (1961) completed a detailed study on the morphology, biology and control of this pest. It has since become a large problem for the cotton producer and the small-scale farmer. The beetle has consistently occurred in large numbers in the three seasons prior to 1988, is currently receiving higher pest status than sporadic pests normally do. It used to be mainly a pest on ratoon cotton, but populations have increased to such an extent that adults are now a pest on seedlings. Larvae cause extensive root damage, while adult feeding leaves holes in the leaves. Normal plant growth is disturbed and the plant wilts and eventually dies. Carbaryl is currently registered against the pest, but it does not give cotton producers effective control. Other insects that normally occur early in the season are leafhoppers and aphids. These insects have been observed to occur whenever *S. rugifrons* is present in low numbers. The incorrect application of insecticides to control *S. rugifrons* can result in an increase in the numbers of aphids and leafhoppers. Endosulfan (Thioflo) is used under normal control programmes for the American bollworm (*Helicoverpa armigera*), red bollworm (*Diparopsis castanea*) and spiny bollworm (*Earias insulana* and *Earias biplaga*) is not effective against pests other than bollworms. *Apion soleatum* Wagner (Coleoptera: Apionidae) is a pest on ratoon cotton as well as newly planted cotton in the area with the highest number of small-scale cotton producers, i.e. KwaZulu- Natal (Bennett, 1992,1993). No insecticide is at present registered against this pest although chemical trials have been under way for several seasons (Bennett and Harding, 1993). Monocrotophos has been evaluated in combination with other softer insecticides as a potential control measure. Its effect on leafhoppers and aphids was also taken into consideration.

Material and Methods

Field trials were conducted to evaluate the effect of seed treatment on S. *rugifrons*, and *A. soleatum*. In 1996/97, a greenhouse pot experiment with five replications was carried out in which acid delinted, fungicide treated seed and fuzzy seed of the same variety, Tetra, were used. Each plot comprised one pot, was sown with six to ten seeds of either the acid delinted or fuzzy seed. The cotton was left to grow to a height of approximately 15 centimetres before some of the leaves were harvested from each pot and placed in plastic containers in which two *Syagrus* beetles were placed. The following day, the beetles were assessed for survival. The same procedure was repeated two and four days later. The same experiment was repeated a week later, with one *Syagrus* beetle and one cricket in each container. Data of the surviving insects were recorded and an analysis of variance computed with Genstat for Windows 97.

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Insecticides that performed best in the greenhouse trial, as well as carbosulfan and a coded compound, TS 200, made up the treatments for the field trials (Table 1). Phorate and terbufos were identified as potential seed dressings. The efficacy of seed treatment was compared over 2 seasons. Field trials were planted in Vaalharts (Northern Cape) and Loskop (Northern Province). All the seed was initially treated with a strong sugar (sucrose) solution comprising 500 ml water and 500 grams of sugar, used as an adhesive. After immersion, the seed was removed and allowed to dry. The sugar treated seed was then treated with various insecticides as seed dressings (Table 1). Plants were rated for damage by early season cotton pests. Seven treatments and five replications were used. Trials were assessed for plant stand (i.e. germination) and insect damage.

Field trials relating to *S. rugifrons* were carried out in the Northern Province while those relating to *A. soleatum* were carried out in KwaZulu-Natal. For all the field trials, the layout was a randomized block design. The effects of seven treatments on *S. rugifrons*, were evaluated in greenhouse trials at Steelpoort (Table 2). Similar treatments were repeated on ratoon cotton in field trials at Potgietersrus (Table 4) and ten treatments were carried out on cultivars Tetra and Sicala in Potgietersrus (Table 3). Plots consisted of six rows, five m long. Ten random plants per plot were rated for root damage in all field trials. Leaves were analyzed for feeding damage. A rating system of 0 = no damage to 3 = extensive damage was used for roots and leaves. The number of damaged plants was expressed as a percentage infestation of the original plant population. Yields of five rows per plot (0.01 ha) were compared between treatments.

Adult beetles *Syagrus* were monitored on five ratoon cotton treatments in trial plots of seven rows, four m long (0.0112ha) in Potgietersrus. Plots were sprayed with insecticide. Ten random plants per plot were monitored for adult beetle and leaf damage. This seems to be a problem specific to ratoon cotton where adult beetles over winter (Broodryk, 1961). Treatment yields were compared.

The biology and control of *A. soleatum* were studied on transgenic cotton over several seasons on the Makhathini Flats. The field trial included treatment combinations of two insecticides, at different times during the season. An untreated control was added. The following insecticides were applied (given as product/ha): monocrotophos 1.5 l/ha (Azodrin® EC 250 g/l a.i.) and endosulfan at 1 l/ha (Thioflo® SC 475 g/l a.i.). The insecticides were applied on the 4, 6, 8,10, 12 and 14 weeks after emergence. Seven random plants from each plot were monitored and four consecutive counts of *Apion* larvae, pupae and beetles, plant lesions and larvae in the stems were recorded. All results were analyzed using Bonferroni t-test (p=0.05) to compare treatments.

Results and Discussion

Bio-assays indicated that germinating cotton plants were capable of absorbing and transporting sufficient quantities of both products to produce satisfactory mortalities in crickets and *Syagrus* six weeks after plant emergence. Results from a greenhouse trial, (Table 2) show the mean number of surviving *Syagrus* that had been fed on the leaves of seed-treated cotton plants for three days. Results show that phorate and imidacloprid gave the highest mortality. Experiments done on the *Syagrus* beetle and the experiments done on crickets the previous season showed that these two insecticides were the most promising potential seed dressings for early-season insects. Results obtained with thiodicarb did not differ significantly from those of the control. Seeds treated with dimethoate did not germinate and were rejected. Results also showed no significant difference ($p \leq 0.05$) between acid delinted and fuzzy seed. The field trial and greenhouse results corresponded.

None of the seedlings were left unharmed by adult *Syagrus* beetles in Steelpoort. Terbufos (Counter®) gave the best results, while aldicarb (Temik®) also proved to be effective. When root damage was compared over time, the pattern was similar to that of leaf damage. Very few beetles were found on the terbufos (66g) treatment.

Terbufos (66g) and aldicarb seem to be the best soil treatments to protect roots and leaves against *Syagrus* damage in ratoon cotton. These chemicals gave the highest plant populations and compared well with the control treatment. Plant stands were more or less the same between treatments and did not decrease over time. The most living beetles was found early in the season in the carbofuran treatment, while no living beetles were found in the phorate treatment. Abamectin had the least plant damage. Yield comparisons on ratoon cotton were not statistically significant.

In newly planted cultivar Tetra in Potgietersrus, the abamectin (treatment 6) abamectin/endosulfan combination (treatment 7), phorate/carbaryl combination (treatment 3) and the monocrotophos treatment (treatment 8) had least plants with root damage (Figure 1) by the second to the third week. When comparing damage to the upper plant parts (Figure 2), the seed treated plants (treatments 1-3) and the abamectin, endosulfan / abamectin and monocrotophos treated plants seemed to have many plants with little damage (lowest plant damage rating). Most of the plants in treatments 4 and 5 were damaged by the third week, while plant damage was less obvious amongst treatments 6, 8 and 9. The control also had few badly damaged plants at the end of the observation period, confirming the uneven distribution of the pest in a field. There is often a cluster-effect of the pest in the field (*pers obs.*, A. Bennett), resulting in low insect numbers in the control. No plants with either new root or leaf *Syagrus* damage were observed for the 6th week in any treatments. Evaluation of plant damage between treatments showed that profenophos and the terbufos/carbaryl combination had more wilted plants than the control. Phorate, carbaryl and monocrotophos treatments had no wilted plants.

In the case of Sicala, when root damage was compared (Figure 3), the phorate, endosulfan and monocrotophos treatments, showed the least plants with root damage (rating 1) during the first week. All other treatments showed a higher degree of root damage. After two weeks, the terbufos treatments (treatment 1), the abamectin, endosulfan/ abamectin and monocrotophos treatments gave effective protection against root damage. No further root damage was noticed near the end of the season. It seemed that terbufos, phorate/carbaryl combination, and endosulfan with a follow-up of abamectin effectively prevented root damage. A comparison of leaf damage (Figure 4), indicated that the endosulfan/abamectin combination had no plants with leaf damage, while monocrotophos and profenophos showed few plants with leaf damage during the first week. By the third week, the terbufos/carbaryl (treatment 2), the carbaryl and the monocrotophos and profenophos treatments prevented leaf damage. After 6 weeks, all the treatments except phorate and profenophos gave a high number of plants with a low degree of leaf damage. Abamectin with or without the addition of endosulfan effectively prevented leaf damage in the beginning of the season, while the registered product, carbaryl seems to be most effective later in the season.

Yield comparisons with both the cultivar Sicala and Tetra in the Potgietersrus trials, indicated that the profenophos treatment differed significantly from the phorate/carbaryl abamectin-, abamectin/endosulfan-, monocrotophos and terbufos/carbaryl treatments ($P<0.05$) (Table 3). The yields of the other treatments and the control treatment were not significantly lower than that of the sprayed treatments. This result could be attributed to high bollworm infestations and not directly to other pest infestations. Control of the pest could, in this instance, not be related directly to yield. The use of transgenic cotton (Bollgard™), now commercially available in South Africa, will probably be effective in determining the impact of secondary pests on yield, by suppressing bollworms and thereby minimizing the impact of the bollworm complex on yield. Yield differences could then be ascribed to damage resulting from secondary pest, such as, in this case, *Syagrus rugifrons*.

In ratoon cotton, the least plant damage was in the monocrotophos treatment. There were no differences between treatments that could be related to *Syagrus* (Table 4). This could probably be due to the effect of bollworm, mainly red bollworm, a major pest of ratoon cotton, on yield. None of the treatments controlled the bollworm complex effectively.

The number of *Apion* adults and larvae on the control and the endosulfan (s,s,s) treatments, did not differ significantly in field trials on the Makhathini Flats but differed significantly from the monocrotophos treatment in greenhouse trials (h,h,h) (Table 5). When spraying a combination of "soft" and "harder" insecticides, varied control was achieved, but this was not significantly different from the results using endosulfan alone, although significantly better than the control. Fewer beetles were found in combinations where a hard insecticide was used early in the season (Figure 5). Yields in control plots were significantly lower than those from other treatments. Endosulfan sprayed alone (normal bollworm control) gave the lowest yields of all the treatments. Treatment combinations of monocrotophos / endosulfan / monocrotophos gave the highest yield, but this was not statistically significant. Sticky traps showed increased leafhopper numbers at the end of the season. It is suggested that monocrotophos should be sprayed for early insect control, followed by endosulfan for bollworm control, then monocrotophos for leafhopper control near the end of the season. The fact that the yields of the monocrotophos plots were higher than those in the endosulfan plots, indicates that *Apion* damage exceeds bollworm damage and emphasizes the importance of *Apion* control. It is, therefore, important that the small-scale farmer should control this pest.

Conclusions

From these results, it is clear that phorate, terbufos and imidacloprid have the potential to control *S. rugifrons* when applied as seed dressings, while spraying with monocrotophos or abamectin in combination with endosulfan is effective against *S. rugifrons* and *A. soleatum*. The extent of *S. rugifrons* root and leaf damage should be assessed and stem damage in the case of *A. soleatum*. Seed treatment could play an important role in an IPM system for the small-scale farmer, since it is easy to perform and eliminates the need for other insecticides during the first six weeks of the season.

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Table 1. Seed treatments and dosage rates for the greenhouse and field trials.

Treatment	Formulation	Trade name	Dosage per 50 gm seed	
			Greenhouse Trials	Field Trials
Thiodicarb	FS	Semevin	2.00 ml	
Carbofuran	GR	Curaterr	123.00 gram	123.00 gram
Terbufos	GR	Counter	62.50 gram	62.50 gram
Phorate	GR	Thimet	41.30 gram	41.30 gram
Imidacloprid	WS	Gaucho	3.60 gram	3.60 gram
Carbosulfan	EC	Marshall	2.00 ml	0.5 ml
*TS 200				n.a.
Monocrotophos	SL	Monostem	7.00 ml	
Dimethoate	EC	Dimet	13.00 ml	
Sugar			50.00 gram	50.00 gram

* not known - unregistered

Table 2. Mean numbers of surviving Syagrus beetles. [1]

Treatment	day 1	day 2	day 3	Mean
8. Control (sugar)	2.0	2.0	2.0	2.00a
1. Thiodicarb	2.0	1.9	1.9	1.93a
6. Carbosulfan	1.8	1.4	1.2	1.47 b
7. Monocrotophos	1.4	1.0	0.6	1.00 c
3. Terbufos	1.3	0.9	0.4	0.87 c
2. Carbofuran	0.7	0.6	0.5	0.60 c
5. Imidacloprid	0.6	0.5	0.5	0.53 d
4. Phorate	0.4	0.0	0.0	0.13 d
LSD Bonf				0.46

Table 5. Transformed number of *Apion* beetles and yield, with different combinations of insecticides (hard and soft insecticides) at different intervals.[1]

Treatment[b] Combination	Number beetles[a]	Yield (kg/ha)[a]
Control	1.802a	428 c
s,s,s	1.621ab	1629 b
s,h,h	1.154abc	2428a
h,h,s	.997 abc	2091ab
s,s,h	.954 bc	2495a
s,h,s	.952 bc	2196ab
h,s,h	.899 bc	2577a
h,s,s	.822 bc	1894ab
h,h,h	.390 c	2471a
$LSD_{Bonferroni}$	.816	731

s = soft insecticide (endosulfan).
h = hard insecticide (monocrotophos).

Table 3. Yields of *Syagrus* field trial of Sicala and Tetra (Potgietersrus). [1]

Treatments	Sicala	Tetra
	(kg/ha)	
1. Terbufos/Carbaryl	115.7 b	211.4 b
2. ½ Terbufos/Carbaryl	140.6ab	191.9 b
3. Phorate/Carbaryl	123.6 b	250.3ab
4. Carbaryl	156.3ab	222.0 b
5. Endosulfan	166.9ab	276.1ab
6. Abamectin	119.4 b	208.6 b
7. Endosulfan/abamectin	116.8 b	207.5 b
8. Monocrotophos	117.1 b	188.9 b
9. Profenophos	216.9a	330.6a
10. Control	139.6ab	256.3ab
$LSD_{Bonf(p<0.05)}$	78.6.	98.0.

Table 4. Yields of ratoon cotton in Potgietersrus. [1]

Treatments	Sicala	Tetra
	(kg/ha)	
6. Abamectin	300.3 a	238.2 a
8. Monocrotophos	17.0 b	274.1 a
9. Profenophos	308.0 a	274.7 a
4. Carbaryl	297.1 a	254.5 a
10. Control	292.7 a	269.1 a
$LSD_{Bonf(p<0.05)}$	81.7.	49.9

[1]Means sharing the same letter do not differ significantly. (p<0.05)

Figure 1. The mean number of plants (Tetra) with root damage on newly planted cotton in Potgietersrus.

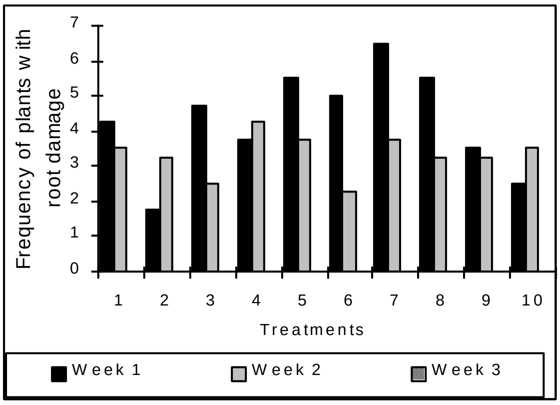


Figure 2. The mean number of plants (Tetra) with little leaf damage on newly planted cotton in Potgietersrus.

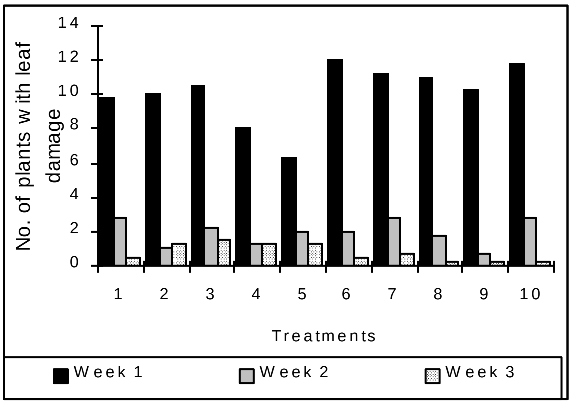


Figure 3. The mean number of plants (Sicala) with root damage on newly planted cotton in Potgietersrus.

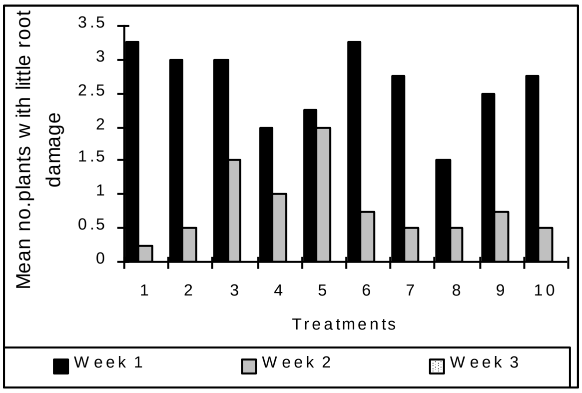


Figure 4. The mean number of plants (Sicala) with little leaf damage on newly planted cotton in Potgietersrus.

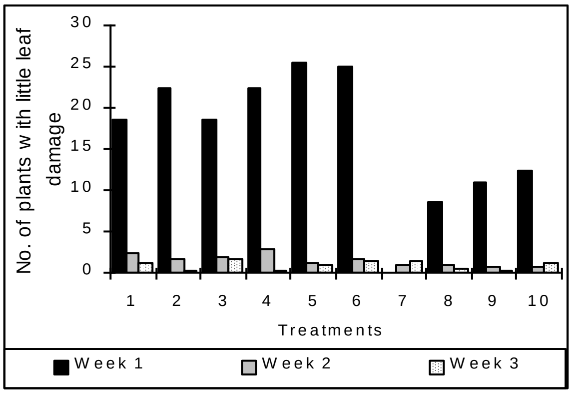
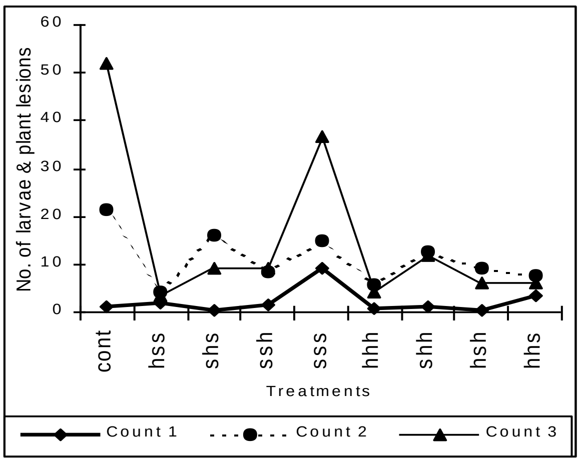


Figure 5. The number of *Apion* larvae and plant lesions at different time intervals (Lesions refer to damage in the plant stem/or pupation site).



(s = soft insecticide, endosulfan;) (h = hard insecticide; monocrotophos)
(e.g. hhs = combination and sequence of hard and soft insecticides sprayed)