Efficacy and Impact of Some Insecticides Used to Control Aphids, Aphis gossypii Glover (Homopters: Aphididae) on Cotton in Uganda, on Predators

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ABSTRACT

Representatives of the main insecticide groups currently being used by farmers for the control of the cotton aphid, Aphis gossypii Glover were evaluated . The four insecticides tested were carbosulfan 35 STD (Marshall), cypermethrin 5% E.C. (Ambush), dimethoate 222g/L + chlorpyrifos 278g/L E.C (Salut) and Monocrotophos (Azodrin E.C.). The three foliarly applied insecticides were applied at 5,7,9 and 11weeks after plant emergence (WAE). The fourth insecticide, carbosulfan (Marshall 35) was applied as a seed treatment. Before and after each spray, aphid infestation was assessed and abundance of the major predator species determined. While the protection by the systemic seed dressing did not last beyond five WAE, the most efficacious organophosphorous insecticide (dimethoate 222g/L + chlorpyrifos 278 g/L E.C.) caused the greatest reduction in predator activity. The relative ineffectiveness of cypermethrin 5% against aphids could be due to development of resistance oresulting from its long use. The controversy in insecticide choice for controlling aphids calls for an integrated approach, including cultural and other management options.

Introduction

Cotton (*Gossypium hirsutum* L.) is the most important fiber crop in Uganda. The current major growing areas in the country lie mostly within the mid-altitude-dry (>1,000 metres above sea level) including districts in Eastern and Northern Uganda and some areas in Western and North Eastern regions.

Over the last century the crop has been cultivated in Uganda, various workers have identified insect pests as a major production constraint of cotton (Pearson, 1958; Reed, 1972; Serunjogi, 1983; Sekamatte 1994). The major pests of cotton in Uganda include American bollworm, *Helicoverpa armigera* Hübner, spiny bollworm, *Earias insulana* Boisd, and *E. biplaga*, false codling moth, *Cryptophlebia leucotreta* Meyer, red bollworm, *Diparopsis castanea* Roths, cotton lygus, *Taylorilygus vossereli* pop; cotton Jassid, *Empoasca lybica* de Berg and stainers, *Dysdercus* spp. (Sekamatte, 1994). Although a serious pest in the past, cotton jassid has been effectively controlled by host plant resistance. Control of all the other pests, however requires the use of chemicals (Reed, 1972; Sekamatte, 1994). Recently, cotton aphid, *Aphis gossypii* Glover has attained increased importance in Uganda and its control is an issue that has occupied attention of government officials, extension agents, researchers and farmers. Many possible reasons have been published as being responsible for the change in pest status of aphids (Rodriquez *et al.*, 1960; Oka and Pimentel, 1974; Slosser *et al.*, 1989).

Despite the recent introduction of integrated pest management (IPM), insecticides continue to dominate control measures against pests of cotton in Uganda and many chemicals have been tested over the last decade (Sekamatte, 1994; Anon., 1993). Various insecticides have been used by farmers to control aphids and other pests in Uganda. Among the organophosphates (OP) dimethoate and chloripyrifos are very common, while the main carbamate insecticides include carbosulfan, flucythrinate, primicarb, aldicarb, methomyl and menazon. Sythetic pyrethroids are probably the most widely and long used insecticide group among Uganda farmers. Insecticides in this group include cypermethrin 5% under different trade names (e.g. Ambush, Sherpa, Agrocytrin), labdacyhalothrin and bifenthrin. These insecticides are commonly applied on a calendar basis that commences at five weeks after seedling emergence with up to six sprays per growing season, applied at two-week intervals.

Complaints about ineffectiveness of applications of many of these insecticides particularly foliar applications of cypermethrin against aphids have been widespread (Sekamatte and Ogenga-Latigo, 1990) and have attracted research attention. Therefore, an experiment was designed to establish the effectiveness of some of the commonly used insecticides. Foliar sprays however, are known to be highly hazardous to non-target insects of agricultural importance, especially natural enemies (Way *et al.*, 1954; Butler, 1988; Ifner and Hall, 1983; King *et al.*, 1987). An additional objective of the experiments therefore, was to assess the influence of these insecticides on abundance of the common generalist predators in cotton.

Material and Methods

Proceedings of the World Cotton Research Conference-2. Athens, Greece, September 6-12, 1998. pp.724-728.

Field experiments were established at Namulonge Agricultural and Animal Research Institute (NAARI) located 27 km North of Kampala during the 1991 and 1992 cotton seasons. In each season, cotton (Var. BPA 89) was planted in plots measuring 20 x 6.3m with a 2.0m space between adjacent plots. Planting was on August 3 and June 23 during the 2 seasons respectively in a randomized complete block design with four replications. The planting seed was dressed with a fungicide (cuprous oxide/Nordox) to ensure uniform germination.

Three insecticides, cypermethrin 5% (Ambush), dimethoate 222g/L + chlorpyrifos 278g/L E.C (Salut) and Monocrotophos, (Azodrin) widely used by farmers in Uganda and a new seed dressing, carbosulfan 35 (Marshall) were tested. Each chemical except carbosulfan 35 that was applied as a seed treatment before planting, was applied four times per season. The foliar applications commenced five weeks after plant emergence and continued at two week interval at 7, 9 and 11 weeks after emergence (WAE). All foliar insecticides were applied using a knapsack sprayer.

Before and after each spray, all plants in the five middle rows of every plot were inspected. The following data were taken from each plot: (1) On each sampling occasion, the incidence of aphid infestation was determined by taking all plants with >10 aphids as infested. The level of aphid infestation was determined by counting colonies of aphids found on the under surface of 30 leaves taken from 10 infested plants per plot 7 days after each chemical application. Ten infested plants were selected randomly in each plot and three leaves each from the top, middle and bottom sections of plants collected in a paper bag. They were taken to the laboratory where the aphids were counted: (2) the abundance of coccinellid, syrphid and lacewing predators was assessed by inspecting plants in the sample rows identified in (1) one day before sampling for aphids. Records were taken of the number of larvae and adult coccinellids and lacewings. The numbers of syrphid larvae found on the 30 leaves sampled for aphid counts were recorded. The data for aphid predator at the different sampling periods were pooled for an analysis of variance.

Results

Aphid incidence and severity on cotton

Aphid infestation build-up in plots sprayed with various insecticides is presented in Figure I. All insecticide-treated cotton plots had lower infestation by *Aphis gossypii* compared to unsprayed (control) plots. The pattern of infestation during the two seasons was fairly consistent. In most of the plots, aphid infestation continued building up following the first insecticide applications made at 5WAE. Aphid counts however diminished steadily after the 2nd spray at 7WAE especially during the second season until after 11WAE when aphid populations again increased. Analysis of peak infestation data revealed that all insecticide treatments significantly (P=0.05) suppressed aphid population build up on cotton (Table 1). Dimethoate 222g/L + chlorpyrifos 278 g/L E.C. was the most effective insecticide and led to significantly (P=0.01) lower levels of A. gossypii infestation of cotton compared to the other treatments (Table 1).

Significant differences in levels of aphid infestation were observed during the first five weeks of cotton growth when carbosulfan greatly suppressed cotton aphid infestation. After the 5th WAE however, the effect of Carbosulfan diminished while Cypermethrin 5%, Dimethoate 222g/L + chlorpyrifos 278 g/L E.C. and Monocrotophos showed higher levels of aphid control. In the 1991/92 season, aphid numbers/plant on cotton treated with marshal were lower at 5WAE compared to that on Cypermethrin 5% and Monocrotophos treated plants. The average number of aphids/plant found on carbosulfan treated cotton was however not significantly different from that on the dimethoate 222g/L + chlorpyrifos 278 g/L E.C. treated crop. Similarly, in the 1992/93 season, Dimethoate 222g/L + chlorpyrifos 278 g/L E.C. effected better control of A.gossypii than Carbosulfan, and there were almost similar numbers of aphids found on Monocrotophos, Cypermethrin 5% and Marshal treated plots at 5WAE (Figure 2).

Following the 2nd, 3rd and 4th insecticide applications, at 7, 9 and 11 WAE, Cypermethrin 5% and Monocrotophos effected better control of the aphid than Marshal as a seed dressing only but the two insecticides did not perform distinctly better than dimethoate 222g/L + chlorpyrifos 278 g/L E.C. during the same period (Figure 2).

Abundance of aphid predators

The common predator genera found were *Cheilomenes* and *Scymnus* (Coleoptoa:coccinellidae), *Chrysopa* (Neuroptera: Chrysopidae), and *Syrphus* (Diptera: Syrphidae). There was significant (P=0.05) variation in the number of predators among plots treated with different insecticides (Table 2). In both seasons, *Carbosulfan* treated cotton had higher numbers of predators than Cypermethrin 5%, Dimethoate 222g/L + chlorpyrifos 278 g/L E.C. and Monocrotophos treated cotton. Those sprayed with Dimethoate 222g/L + chlorpyrifos 278 g/L E.C. during the two seasons also had significantly (P=0.05) more predators than cotton sprayed with Cypermethrin 5% and Monocrotophos. The abundance of aphid predators, therefore, was adversely affected by application of insecticides.

Discussion

The level of control of *A. gossypii* and activity of aphid predators were greatly influenced by the type of insecticide used. Seed dressing with Carbosulfan 35STD suppressed aphid infestation of cotton during

the first 5 weeks of the growing season, but its effect did not persist beyond 35 days after crop emergence.

Several reasons have been put forward to account for the increase in aphid infestation of cotton worldwide (Matthews, 1994). Among the reasons, elimination of pests natural enemies and resistance following prolonged-use or inappropriate use of insecticides (especially organophosphate compounds and pyrethroids) seem to be ranked high (Leclant and Deguine, 1994). Seed dressing has been variously proposed as possible remedy to the destruction of natural enemies by direct insecticide sprays (Elbert *et al.*, 1990; Halloin, 1986). Nevertheless, protection achieved through seed-dressing with the common systemic chemicals such as disulfaton, monocrotophos, phorate, acephate and imidacroprid. (Elbert *et al.*, 1990), rarely provides season-long protection. The short activity period exhibited by carbosulfan 35STD as seed treatment compares well with persistence of many other common seed dressing chemicals (Parecia *et al.*, 1983). Our sturdy therefore suggests the need to superimpose foliar sprays on carbosulfan treated cotton for a more effective control of the aphid.

Among the foliar insecticides, dimethoate 222g/L + chlorpyrifos 278 g/L E.C. exhibited higher efficacy than cypermethrin 5% and monocrotophos. This wide variation in efficacy seems to emphasize the importance of careful selection of insecticides in aphid management.

During the 1991/92 season when severe aphid infestation occurred, the pest population built-up rapidly following chemical application even on cotton sprayed with cypermethrin 5%. Similar observations were made during the 1990/91 season (Sekamatte and Latigo, 1990) on cotton and on potatoes (Kakwenzire, personal comm.).

Lack of effective control of aphids by cypermethrin 5% in this study and other reported observations could be due to aphids developing resistance the insecticide especially as the chemical has been in continuous use for nearly 20 years.

The incidence of aphid predators on cotton sprayed with different insecticides showed that some protection of natural enemies could be achieved by seed treatment as relatively high number of predators were recorded on carbosulfan treated plots. This is a valuable aspect since it could help farmers avoid foliar sprays early in the season when populations of natural enemies are known to build-up rapidly.

The insecticide dimethoate 222g/L + chlorpyrifos 278 g/L E.C. with highest efficacy also caused the greatest suppression of aphid predators, although cypermethrin 5% and monocrotophos led to similar low level of predator activity. While it is possible that the low incidence of predators in dimethoate 222g/L + chlorpyrifos 278 g/L E.C. treated plots was related to low aphid numbers in the plots, previous studies, way *et al.* (1954) and Butler *et al.* (1989) showed that foliar sprays are a major factor causing mortality of pollinators, parasitoids and predators. This study clearly emphasizes the importance of careful selection of insecticides for chemical control programmes. It also confirms the need for judicious use of chemicals since the most highly effective insecticides can also affect non-target species (Dettrich *et al.*, 1985).

A large number of predators appear to exist in cotton fields together with other aphid natural enemies. Predators often impose significant control of insect pests (Frisbie, 1983). In Uganda therefore, attention should be directed at the development of a control programme that will conserve these natural enemies through careful choice of insecticide to be used.

Conclusions

The choice of insecticides for aphid control seems to be complex. The most effective organophorous insecticides (dimethoate 222g/L + chlorpyrifos 278 g/L E.C.) cause greatest damage to predators and seed-dressing with carbosulfan offers short-lived (<5 weeks) protection. In addition to careful choice of the insecticides, their timing, method of application, and integration with other control strategies such as cultural practices need to be carefully studied.

Acknowledgments

The paper is part of an M.Sc Thesis of the principal author. We thank the United States Agency for International Development (USAID) MFAD project and National Agricultural Research Organization

(NARO) who sponsored the study and Drs. A.H. Heneidy and V.A.O. Okoth for technical assistance.

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Table 1. Aphid infestation (%) at peak incidence on untreated and treated cotton with Salut, Azodrin and Marshall 35STD four times at 2-week interval starting 5 weeks after emergence during the 1991 and 1992 seasons.

Season	Control	Chemical name			
		Marshall	Ambush	Azodrin	Salut
1991	93.0a	87.2a	45.0b	38.0b	18.5c
1992	41.0b	63.0a	31.0c	35.0c	11.0d

L.S.D: Between insecticide means, 1991: (P=0.01) =19.6; 1992: (P=0.01) = 6.8; (P=0.01) = 11.9.
Means for rows followed by the same letter are not significantly different; Tukey's test (P=0.01).

Table 2. Mean number of aphid predators/10 plants per plot in cotton sprayed with aphicides 1991/92 and 1992/93 seasons.

Aphicide	Aphid predators per plot		
1991/92 season	Coccinellids	Syrphid larvae	Lacewings
Control	24.24a	13.81a	20.45a
Marshall	23.46a	6.45b	29.85a
Azodrin	12.00b	2.45c	6.00b
Ambush			
Salut	4.02c	8.00b	6.52b
L.S.D (P=0.05)	4.53	2.32	0.27
1992/93 season			
Control	15.24a	10.30a	3.78a
Marshall	13.24ab	7.47b	2.92b
Salut	5.24c	3.32c	0.71d
Ambush	12.54b	3.32c	2.00c
Azodrin	12.73ab	4.58c	1.58c
L.S.D (P=0.05)	0.76	2.25	2.25

Means within a column followed by the same letter are not significantly different. Tukey's test (P=0.05)

Figure 1. Percent aphid infestation in untreated control and treated cotton during the 1991/92 and 1992/93 seasons.

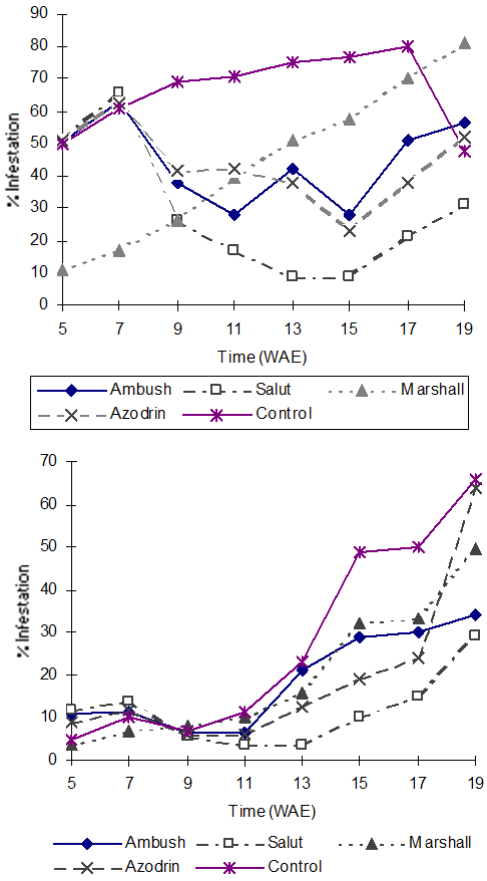
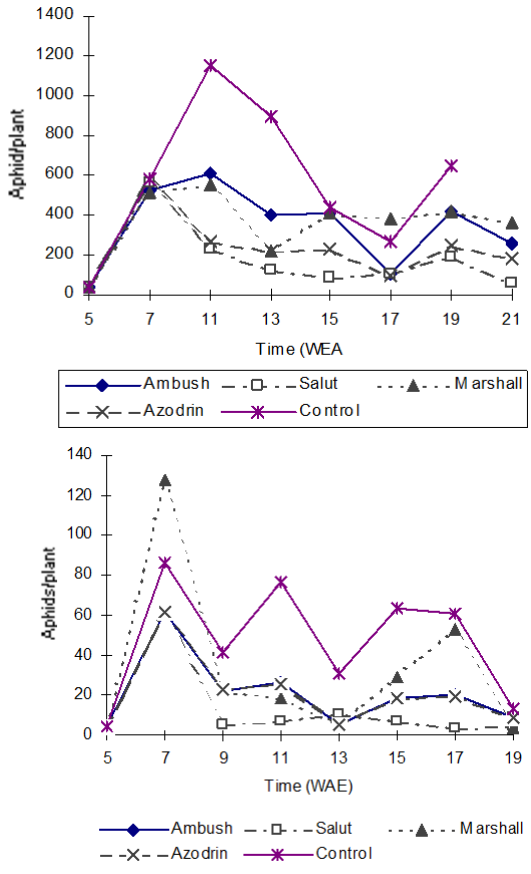


Figure 2. Number of aphids per plant found in untreated control and treated cotton during the 1991/92 and 1992/93 seasons.



Note in all graphs:
Ambush = cypermethrin 5%
Salut = dimethoate 222g/L + chlorpyrifos 278 g/L
Marshall = carbosulfan 35 STD

Azodrin = monocrotophos