New Spray Adjuvant Increases the Efficacy of Cotton Insecticides

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ABSTRACT

Vicchem EOP was evaluated with several insecticides for control of crickets and aphids. In laboratory studies, EOP enhanced the efficacy of betacyfluthrin and deltamethrin three-fold against crickets compared to dimethoate and carbaryl. In field studies, EOP increased the activity of imidacloprid on aphids in cotton but no enhancement was seen with dimethoate against aphids on peas. The enhanced activity may be due to EOP extending the liquid state of certain insecticides in the spray deposit that would increase contact with the insects and possibly enhance cuticular penetration.

Introduction

The use of spray adjuvants to increase the efficacy of herbicides is well established (Nalewaja *et al.*, 1986). The recently patented ethyl esterified seed oils, such as Vicchem EOP, have been shown to provide superior herbicidal efficacy to the methylated seed oils and the emulsifiable crop oil concentrates in the USA and Australia (Killick *et al.*, 1998). A series of laboratory and field studies were conducted to investigate the potential use of Vicchem EOP as an adjuvant to increase the efficacy of several insecticides used in cotton production.

Materials and Methods

Vichem EOP consists of ethyl oleate emulsified with non-ionic surfactants including esters of fatty acids derived primarily from canola oil. The following insecticides were used with the adjuvant EOP: *Betacyfluthrin* a-cyano-4-fluoro-3-phenoxybenzyl-3-(2,2-dichlorovinyl) - 2, 2 - dimethylcyclopropane-carboxylate; *Deltamethrin* (*S*)-a- cyano - 3-phenoxybenzyl (1R,3R) - 3 - (2, 2 - dibromo vinyl) - 2, 2 - dimethylcyclopropane - carboxylate; *Carbaryl* 1-naphthyl methylcarbamate; *Dimethoate O, O* - dimethyl *S* - methylcarbam - oylmethyl phosphorodithioate; *Imidacloprid* 1-(6-chloro-3-pyridinyl)methyl) - *N* - Nitro - 2 - imidaz - olinidin - 2 - ylideneamine. Both chewing and sucking insects were selected for the laboratory studies.

The black field cricket (*Teleogryllus commodus*) was chosen as a chewing insect, using first instars from a laboratory culture maintained at 25°C for testing purposes. The adults were reared from nymphs in ventilated plastic containers (Decor TM, 30 x 25 cm). Equal numbers of males and females were placed into containers with sand-trays (Townson, 9 cm diam.) for breeding. The females oviposit into the sand-trays and newly emerged crickets (first instars) were removed daily for bioassays.

For the bioassays, cabbage leaves were sprayed using a Potter Tower (Burkard) set at 40 kPa to deliver 50 micron VMD spray droplets. Betacyfluthrin, deltamelthrin, dimethoate and carbaryl were sprayed at various log dose concentrations and then air dried for 20 minutes. Three discs were cut from the treated leaf and placed into a petri dish. A fine brush was used to transfer 10 first instar crickets into the dish before closing the lid. Five replicates were prepared and maintained at 25°C for 24 hours at which time mortality assessments were conducted.

The Green Peach Aphid (*Myzus persicae*) was selected as the sucking insect and first instar nymphs were used for the bioassays. Petri dishes (Johns; 5 cm diam.) were filled with nutrient agar (Oxoid; 1.0% agar) and then cooled. As above, cabbage leaves were sprayed with dimethoate singly and in combination with EOP and air-dried for 20 minutes. Controls were sprayed with the EOP adjuvant or water only. Five replicates were prepared for each dose. Discs were cut from the treated leaves and placed onto filter paper (Whatman) in the lid of a glass petri dish (35 mm; diam.) to absorb any excess moisture from the cabbage disc and lessen the risk of aphids drowning. Ten (10) instars were transferred to the test substance by using a fine camel-hair brush. The base of the petri dish was firmly pressed against the cabbage discs in the lid and held in place with rubber bands. The dishes were inverted and incubated at 25°C and assessed for mortality after 24 hours. The dose-mortality data were interpreted with probit analysis (POLO-Le Ora Software, 1987) for both the cricket and aphid studies.

A field study was conducted in California where imidacloprid was applied by airplane singly and in combination with 1.3% v/v EOP to control green peach aphid. Efficacy evaluations were made 24 hours after application. A second replicated field study was conducted by Washington State University (Bragg, personnel communication) to determine the effect of dimethoate applied singly and in combination with EOP at 1.25% v/v EOP by ground application to control aphid in peas. Efficacy was determined 24 hours after application.

Results and Discussion

No cricket or aphid mortality was recorded when leaf discs were sprayed with the adjuvant EOP at 0.5% or 2.0% v/v concentration in the laboratory trials. Usually there is some mortality when EOP is applied directly to the insects, however, the EOP may have penetrated into the cabbage leaf tissue and not been available for contact with the insect. The adjuvant EOP at 2% v/v of the spray solution shifted the position of the dose-response curve towards greater toxicity to crickets for the synthetic pyrethroids betacyfluthrin and deltamethrin (Fig 1a and Fig 1b). Probit analysis revealed that the LC_{50} for betacyfluthrin was reduced when applied with EOP at 2.0% from 110 ppm to 50 ppm and from 130 ppm to 40 ppm for deltamethrin (Table 1). At the 0.5% v/v concentration the LC_{50} for crickets was reduced with both pyrethroids but it was not significant.

These results are in agreement with the work conducted by Ford and Loveridge (1995) in which EOP was combined with alpha-cypermethrin and lambda-cyhalothtrin, significantly increasing their efficacy against the black field cricket. The increase in activity of pyrethroids may be attributed the ability of EOP to maintain the active ingredient in a liquid state on the leaf surface for a longer period of time. This effect would increase the transfer of the pyrethroid to the target insect following contact with the residual deposits on the leaf surface. Also, the possibility that EOP increases the rate of cuticular penetration cannot be entirely discounted.

Carbaryl, like the pyrethroids, is active against chewing insects but the LC_{50} for carbaryl was much higher at 3,511 ppm. Although there was a reduction in the LC_{50} from 3,511 ppm to 2,600 when EOP was applied at 2.0% v/v, it was not significant.

Surprisingly, the laboratory aphid study resulted in a dramatic reduction in the efficacy of dimethoate. Aphid mortality using dimethoate was comparable to betacyfluthrin with LC_{50}s of 1.140 ppm and 1.141ppm respectively. However, the EOP adjuvant at both the 2.0% and 0.5% v/v concentration inhibited all insecticidal activity of dimethoate. The reasons for this ineffectiveness are being further investigated. It has been suggested that the adjuvant may have chemically masked the insecticide or inhibited the penetration of the systemic insecticide into the leaf surface, leaving the aphids unaffected.

In the Washington State University field study dimethoate was applied alone and in combination with EOP against aphids in a pea field (Table 2). After 24 hours there was no significant difference in the efficacy between dimethoate applied alone or in combination with EOP at 1.25% v/v. Both cabbage and pea plants have very waxy leaf surfaces so the difference in activity between the laboratory and field study may not be due to leaf surface chemistry. In contrast to the laboratory study in which EOP inhibited the insecticidal activity of dimethoate, there was no indication of antagonism as dimethoate and EOP gave good control of aphids in the field study. Currently, there is no explanation for the contradictory results. Additional studies are planned.

Aphids are becoming increasingly difficult to control in the cotton fields of California while attempting to maintain high populations of beneficial insects. Imidacloprid is a very effective product to use to control aphids and it has a minimal effect on beneficials but it is slow in acting, taking as much as 3 days to achieve control. The addition of 1.3% v/v of EOP to the imidacloprid application demonstrated complete aphid control within 24 hours of application as compared to 72 hours in its absence. It is postulated that the EOP accelerates the uptake of imidacloprid into the plants so that it is less susceptible to degradation by ultra violet light.

Conclusion

EOP at 2.0% v/v significantly increases the efficacy of betacyfluthrin and deltamethrin against black field crickets, but not when combined with carbaryl. In the laboratory, EOP inhibited the activity of dimethoate against aphids but a field study demonstrated no antagonism when EOP was applied with dimethoate. EOP significantly increased the rate of control of aphids in cotton fields when imidacloprid was applied in combination with EOP. The increase of activity of EOP is thought to be associated with its ability to maintain certain active ingredients in the liquid state for a longer period of time. This would increase the probability of transferring the toxin to the target insect and may increase cuticular penetration.

References

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Table 1. Probit analysis of log dose-response for cricket bioassays for various insecticides applied singly and in combination with the adjuvant, EOP.

Insecticide	Adjuvant concentration	LC_{50} ppm	LCL-UCL[a]	Slope[b]	± S.E.[c]
Betacyfluthrin	-	110	77.9 – 159.8	1.7	0.1
Betacyfluthrin	2.0%	50	33.3 – 77.6	1.3	0.1
Betacyfluthrin	0.5%	70	50.0 – 100.7	2.0	0.3
Deltamethrin	-	130	101.4 – 185.2	1.7	0.2
Deltamethrin	2.0%	40	22.8 – 70.0	2.1	0.2
Deltamethrin	0.5%	70	n/a	1.8	0.2
Carbaryl	-	3511	2690 – 4726	1.6	0.15
Carbaryl	2.0%	2600	1363-5798	1.4	0.14

[a]Lower {L} and Upper {U} 95% Confidence {c} Limits {L}.
[b]Slope of the line of best fit.
[c]Standard error of the slope.

Table 2. The effect of dimethoate applied singly and in combination with EOP on the control of aphids in cotton and pea fields.

Insecticide	Adjuvant Conc.	Insect	Level of Control[1] 24 hrs
Imidacloprid	--------	Aphid	3.5
Imidacloprid	1.2%	Aphid	5.0
Dimethoate	------	Aphid	4.5
Dimethoate	1.2%	Aphid	4.5

[1] (a) Control reported as: 0 - No Control to 5.0 - Complete Control

Figure 1a. Dose mortality relationship for crickets exposed to betacyfluthrin in different doses, with and without 2.0% EOP adjuvant on cabbage leaf discs.

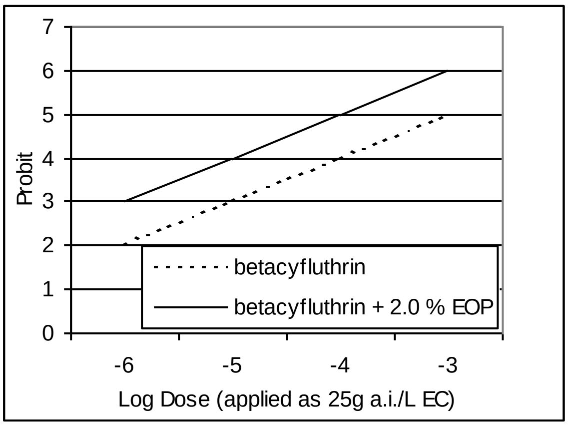

Figure 1b. Dose mortality relationship for crickets exposed to deltamethrin in different doses, with and without 2.0% EOP adjuvant on cabbage leaf disc