Development of a New Semiochemical (Plant X extract) for the Management of Cotton Pests

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Introduction

In Australia, about 85% of cotton farmers grows transgenic (Bt) cotton. Bt cotton controls only Lepidopteran pests but is not effective against sucking pests. Control of these pests and also b *Helicoverpa* spp. in conventional and Helicoverpa survivors on transgenic cotton crops relies extensively on the use of synthetic insecticides. The issues of cost, efficacy, resistance and environmental impacts have led to the increased implementation of Integrated Pest Management (IPM) programs. Crop plants including cotton can produce secondary plant compounds (SPCs) to protect the plants against pest predation. The SPCs can modify pest behaviour by acting as feeding and oviposition deterrents, attractants or repellents to reduce pest damage. Toxicity of SPCs are not as high as synthetic insecticides but when this toxicity is added to the other effect of SPCs their combined efficacy against the pest is high. For the past 6 years, research by NSWDPI has identified a plant codenamed Plant X. Fractionated extracts from the plant in Hexane and oil has been found to deter pest feeding, egg lay and cause toxicity to larvae and nymphs of cotton pests. Generally, Plant X has intuitive appeal because the product can be used in IPM as a stand alone or reduced label rates of synthetic insecticides to reduce Synthetic insecticide sprays.

Materials and methods

Refuge crops

Field trial was conducted with different refuge crops i.e. lucerne, pigeon pea, sorghum, sweet corn and plant X .

Extracts

Solid Phase extraction (SPE) procedures were employed to fractionate crude homogenized solvent extract of Plant X and G. nelsonii. Six fractions of each plant were provided for bioassay and oviposition studies against *H. armigera*.

Feeding response Trials

Cotton leaf discs 20mm in diameter were treated with the equivalent of 1 ml of extract spread evenly on the lower and upper leaf surfaces and left to dry for one hour. One H. armigera second instar larva was enclosed in each Petrie dish and then sealed. Each treatment was placed in a Labec incubator with a temperature of 25^{0}C (±2^{0}C) for 48 hours.

Oviposition Trials with Plant X extract in Methanol

Small plot field trials was conducted in ACRI using 10, 15 and 20%v/v rates against Helicoverpa spp. on cotton. Number of eggs and larvae per metre were recorded and compared with plots that were left unsprayed (control).

Oviposition trials with Plant X in Oil

Small plot field trials was conducted in ACRI using 1 and 2% v/v rates against *Helicoverpa* spp. and green mirids on cotton. Number of Helicoverpa eggs, larvae and green mirids per metre were recorded and compared with plots that were left unsprayed (control).

Results

Table 1 shows Plant X had the lowest number of eggs than all the refuge crops tested.

Crops	Total no. Eggs/metre
Cotton (MHR 11)	812 bc
Cotton (OGF)	119 cd
Cotton (Lumein)	168 c
Plant X	18 f
Maize	1680 a
Sorghum	1886 ab
Chickpea	1388 ab
Lucerne	214 c

Table 1. Oviposition preference of *Helicoverpa* spp. to refuge crops in commercial cotton field, Norwood

Plant X in Methanol

Figures 2 shows that significantly lower number of eggs and larvae were recorded on cotton plants treated with Plant X extracts in Methanol. and Oil. However, higher rates are required to achieve efficacy when Plant X was formulated in Methanol

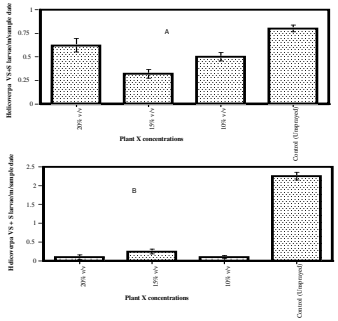

Figure 2. Efficacy of Plant X in methanol on survival of Helicoverpa spp. very small and small larvae on commercial conventional cotton crops at ACRI in Narrabri, January 2008.

Plant X in Oil

Formulation of Plant X in Oil reduced the quantity required to control Helicoverpa spp. eggs and green mirids (Table 2 and 4).

Treatments	Pre-trt	3DAT	5 DAT
1%v/v Plt X in Oil	0.17a	0 a	0.17 a
2%v/v Plt X in Oil	0.33 a	0 a	0.17 a
Unsprayed	0.17 a	0.33 b	0.50 b

Table 2. Efficacy of Plant X in Oil against green mirids adults and nymphs/metre on cotton, ACRI, 2008

Feeding Response of *H. armigera* larvae to Plant X extracts.

The bioassay results of Plant X fraction showed that fractions 2 and 4 contain chemical compounds which can deter larval feeding based on weight of leaf consumed (Fig.4.). Trial is continuing to identify the compounds involved.

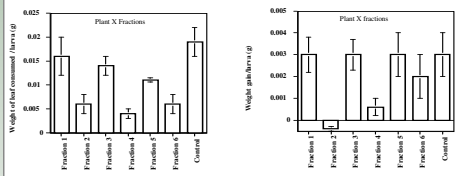

Fig.4 Feeding response of H. armigera 3rd instar on cotton leaves treated with Plant X.

Discussion

The study showed that fractions of Plant X contain compounds that can be used to deter *H. armigera* egg lay. In addition Plant X fractions 2 and 4 may also contain feeding deterrent compounds. Formulation of Plant X fractions in oil resulted in a product that was more stable and efficacious even at a low rate against Helicoverpa spp. and green mirids. Oviposition deterrent compounds identified in Plant X are regarded as very important for the cotton industry in terms of pest management because oviposition or egg lay is an important step in an insect's reproductive process particularly *Helicoverpa spp.* The application of an oviposition deterrent compound to the cotton leaf surface will make the plant seem a non-host for *Helicoverpa* females, hence attracting fewer egg lays. In addition the application of a feeding deterrent chemical reduces insect feeding. Thus the presence of a feeding deterrent at the surface of leaves plays a major role in discriminatory feeding behaviour of the larvae of insects particularly *Helicoverpa* spp. There is a general view that the efficacy of a deterrent based method may be increased if used in combination with another method that attracts the pest to a non-valued resource in a stimulo-deterrent diversion system (SDDS) (Miller and Cowles, 1990) or push-pull (Pyke et al., 1987) strategy. By combining some of the compounds identified as being active and including them in the SDDS (Pyke *et al* 1987; Miller & Cowles 1990; Pickett *et al* 1997) and IPM strategy it may be possible to manipulate *H. armigera* to the point where the damage to crop is reduced and / or the population itself decline. So by applying an oviposition deterrent to the desirable crop (cotton) and / or an attractant to a "trap" crop area of Plant X if oviposition occurs then larvae face the possibility of inhibited development, starvation or possible mortality from naturally occurring toxic compounds.

Conclusion

This study is an initial step in developing new and environmentally benign pest control tools to complement IPM program against *Helicoverpa* spp. in cotton.

Literature cited

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Acknowledgments

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