Talstar resistance in two-spotted mite increasing in level and abundance

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Abstract

Talstar (bifenthrin) was registered at the beginning of the 1993/94 season for control of *Helicoverpa* spp. and two-spotted mite in Australian cotton. Resistance to this compound in two-spotted mite was monitored following registration. Incipient Talstar resistance was detected in one strain of two-spotted mite during the 1996/97 cotton season. Resistance increased progressively both in level and abundance over the following two seasons. Resistance in two-spotted mite has now reduced the reliability of Talstar for two-spotted mite control in Australian cotton.

Introduction

Overseas there are 33 species of spider mites recorded attacking cotton with two-spotted mite a pest of cotton in temperate and semitropical areas (Leigh 1985). In Australia, *T. urticae* is a persistent secondary pest of cotton with potential to cause significant loss of yield and fibre quality (Wilson 1993).

Two-spotted mite is notorious world-wide for developing resistance to chemicals used for its control (Cranham and Helle 1985), with Australian researchers infamously publishing many first citations (Edge and James 1982, Herron *et al.* 1993, Herron and Rophail 1998). In Australian cotton, resistance in *T. urticae* to the older organophosphates, such as dimethoate, was high (>100x) by 1976. Resistance rendered all older organophosphates ineffective by 1980 (Herron *et al.* 1998). However the newer organophosphates, profenofos and monocrotophos survived, but with reduced efficacy, until 1995. By 1995 resistance to profenofos and monocrotophos was also high (Herron *et al.* 1998).

Organophosphates in Australian cotton were replaced by the specific acaricides propargite (Comite) and dicofol (Kelthane, Mitifol) in the early 1990's (Wilson *et al.* 1995). Those two acaricides have subsequently been augmented with abamectin (Agrimec, Wizard), chlorfenapyr (Intrepid), diafenthiuron (Pegasus) and bifenthrin. The latter was used experimentally in cotton on a small scale for several years before full registration at the beginning of the 1993/94 cotton season. Bifenthrin was primarily used for control of *Helicoverpa* and has been a popular option when both *Helicoverpa* and spider mites require control. All the newer chemicals are used in cotton according to a management strategy designed to minimise resistance. The strategy is based around limited use, ie a maximum of two applications of any product, and rotation, ie non-consecutive use of the same product. Monitoring is an integral part of the effective management of resistance in two-spotted mite. Results of annual monitoring have chronicled the demise of the organophosphates and anticipated the need for newer chemistry. Unfortunately, monitoring

has recently confirmed bifenthrin resistance in two-spotted mite from cotton.

Materials and Method

Chemicals Tested

A proprietary commercial formulation of Talstar (bifenthrin) was tested.

Bioassay

The bioassay procedure used has been described in detail by Edge and James (1982). Briefly, the method requires young adult female mites to be transferred from culture to French bean leaf discs. Mites and leaf disc are then sprayed with insecticide with the aid of a Potter spray tower. Each test is replicated three times and includes a water-only sprayed control. Preliminary experimentation in 1994 using a susceptible reference strain indicated that a discriminating dose of 0.02% ai bifenthrin was appropriate and this was used throughout.

Analysis

Discriminating-dose tests were corrected for control mortality using Abbott's formula (Abbott 1925). Probit regressions, including control correction, were calculated using Probit 5 for Windows (Gillespie 1995) and LC_{50} values estimated.

Results

Resistance factors (RF) were calculated for each strain by dividing the LC_{50} of the tested strain by that of the susceptible reference strain. Resistance was first detected in season 1996/97 with resistance frequency, as indicated by the number of strains with survivors, and level of resistance, as indicated by the RF values, increasing in each subsequent year (Table 1).

Table 1 Monitoring data for bifenthrin tested against strains of two-spotted mite from cotton.

Season	No. strains tested	No. resistant strains#	RF* range
1993/94	5	0	0.9 – 1.8
1994/95	6	0	0.5 – 0.8
1995/96	7	0	0.3 – 1.1
1996/97	5	1	0.6 – 1.2
1997/98	6	4	1.6 – 2.9
1998/99	6	5	1.2 – 8.1

#As indicated by survivors at the theoretical discriminating dose of 0.02% ai bifenthrin

*RF = Resistance factor: LC_{50} of a field collected strain / LC_{50} of a laboratory susceptible strain

Discussion

For the first three seasons monitoring resistance was not detected in any strain of two-spotted mite collected from cotton. However, during the 1996/97 season testing we noted a small number of survivors (2%) in one strain (Cudgewa - Field 14, Narrabri) at the discriminating dose. The RF for the Cudgewa strain was a low at 1.2x, indicating that resistance was still in the incipient stage. Resistance was subsequently confirmed by limited pressuring of this strain in the laboratory, which quickly increased the response of the strain to Talstar by an order of magnitude.

In 1997/98 six strains were evaluated for resistance of which only two were completely susceptible. The four resistant stains had 1 to 10% of mites surviving at the discriminating dose, indicating resistance was still relatively subtle. The frequency of Talstar resistant two-spotted mite was still relatively low which was in turn reflected in low resistance levels. However, the proportion of populations with resistant individuals had increasing from 1 in 5 in 1996/97 to 4 in 6 in 1997/98. We now speculated that if Talstar continued to be used, as it has been used in the past, resistance would continue to increase. This was communicated to the cotton industry as a matter of urgency. Unfortunately, Talstar was a key product for *Helicoverpa* control and severe limitation in its use was unacceptable to industry at that time.

By the 1998/99 season Talstar was fast becoming unreliable for two-spotted mite control in cotton. Resistance was detected in five out of the six strains tested with survivors at the discriminating dose ranging from 8 – 33%. RF values were still relatively low at 8.1x at the LC50 level but some strains contained a small proportion of highly resistant individuals. In a strain from Auscott Warren, a dose of 12.80 g ai Talstar / L would not kill all the two-spotted mites in the field-collected population. Resistance had gone from first detection to control failures in three years despite the implementation of resistance management.

However, we do not consider the manifestation of Talstar resistance in two-spotted mite from cotton to indicate a flaw in our management strategy. For comparison, Goodwin *et al.* (1995) detected resistance in two-spotted mite to the pyrethroid Mavrik (fluvalinate) at levels causing control failure the year after the chemical was released. Without resistance management, Talstar resistance in two-spotted mite from cotton would have evolved much faster than it did.

However, the development of resistance to Talstar flags a key problem, that of products that are targeted against more than one pest. Most of the other acaricides also have other targets, ie propargite as a pyrethroid synergist, abamectin against *Helicoverpa punctigera*, diafenthiuron against aphids, chlorfenapyr against *Helicoverpa* spp. Use against other pests will also select for resistance in coincident mite populations, whether these are at economic levels or not. For the mectins this situation will become more critical with the registration of emamectin-benzoate (Affirm), which is closely related to abamectin and is also an acaricide. Growers and consultant need to take this into account and as far as possible to avoid repeated selection with any acaricide when there are mites present in the field.

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