A METHOD TO BIOASSAY ONION THRIPS, *THRIPS TABACI* LINDEMAN (THYSANOPTERA: THRIPIDAE) FOR PESTICIDE RESPONSE

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Summary

Onion thrips, *Thrips tabaci* Lindeman, is a major pest of Australian field onion with chemical control limited to organophosphate insecticides. Following grower complaints of field failure we aimed to establish a bioassay capability for onion thrips and develop a method that could accurately measure small differences in response to insecticides with a view to resistance detection. LC_{99.9} extrapolation indicated a discriminating concentration of 1.25 g ai L^{-1} for diazinon, 0.40 g ai L^{-1} for dimethoate, 0.40 g ai L^{-1} for methidathion, 0.11 g ai L^{-1} for omethoate and 3.50 g ai L^{-1} for malathion.

Keywords: Insecticide resistant, *Thrips tabaci*

INTRODUCTION

Onion thrips, *Thrips tabaci* Lindeman, is the most important insect pest of onion in Australia and if uncontrolled can reduce yield by as much as 75 percent (Hely 1946). Growers are limited to a handful of organophosphate insecticides; namely a generic registration for omethoate and dimethoate and species specific registration for malathion, methidathion and diazinon (Infopest 2004).

It is desirable to broaden the chemical groups used to control onion thrips because organophosphates are currently under review by the Australian Pesticides and Veterinary Medicines Authority and reliance on a single chemical group is not conducive to sustainable resistance management (Roush and Daly 1990). Some growers complain of inadequate control and suspect insecticide resistance but a bioassay method to diagnose resistance is currently not available in Australia. Insecticide resistance in onion thrips should be of serious concern in Australia because it has been detected overseas to pyrethroid (Martin et al. 2003, Shelton et al. 2003) and organophosphate (Martin et al. 2003) insecticides.

This paper reports our attempts to rear onion thrips and adapt an existing method to establish a bioassay capability.

MATERIALS AND METHODS

Thrrips

Three populations were collected that included ‘Colleambly’ (New South Wales (NSW)) from an organic grower on the 27 October 2003, strain ‘Yanco’ (NSW) from an unsprayed vegetable block on the 22 October 2004 and strain ‘Mypolonga’ (South Australia) from a conventionally sprayed onion crop on the 3 December 2004. Populations were sent by overnight courier to the Elizabeth Macarthur Agricultural Institute (EMAI) in NSW for culturing. Species identity was confirmed by Laurence Mound, CSIRO, Canberra after laboratory cultures had been successfully established.

Culturing

‘Colleambly’ was initially cultured on French bean (*Phaseolus vulgaris* L.) with honey and Gumbungi (*Typha domingensis* Pers.) pollen as supplementary food sources (Herron and Gullick 2001). On the 27 November 2003 the host plant was changed to broad bean (*Vicia faba* L) with split broad bean seed with honey and tea pollen (*Camellia sinensis* (L.)) as the supplementary food source (Mauri and Loomans 2001). Finally, on the 29 July 2004 culturing was modified to include sprouted whole bulb onion in 150 mm soil filled pots surrounded by vermiculite where nymphs could pupate with supplementary Gumbungi and tea pollen, split broad bean seed and honey. Populations were maintained in an insectary at 24 ± 4.0°C under natural light and isolated in thrips proof cages. Populations ‘Yanco’ and ‘Myolonga’ were cultured using the latter method only.

Chemicals

Chemicals tested included diazinon 800 g ai L^{-1} EC (Diazinon®, Insecticide, Barmac Industries Pty. Ltd.); dimethoate 400 g ai L^{-1} EC (Dimethoate®, Nufarm Australia Limited); malathion 1150 g ai L^{-1} emulsifiable concentrate (EC) (HY-MAL Insecticide®, Crop Care Australasia Pty. Ltd.); methidathion 400 g ai L^{-1} EC (Supracide®, 400, Syngenta Crop Protection Pty. Ltd.), and omethoate 800 g ai L^{-1} soluble concentrate (SL) (Folimat® 800 SL, Bayer CropScience Pty. Ltd.).

Bioassay

The bioassay method is an adaptation of that described
for western flower thrips, *Frankliniella occidentalis* Pergande (Herron and Gullick 2001) except that broad bean leaf discs were substituted for French bean discs. In addition, broad bean leaf discs were set on a previously cooled agar bed with minimal molten hot agar to seal the leaf disc. Briefly the method required 10-15 CO₂ anesthetised adult female *T. tabaci* to be placed on a cooled leaf disc in a Petri dish. The Petri dish with immobilised thrips in place was then sprayed with 4 mL of a serially diluted emulsion of insecticide or water via a Potter spray tower. Four to seven serial insecticide concentrations were tested per replicate and each replicate included a water only sprayed control in which mortality did not exceed 15 percent. All tests were replicated three times producing three lots of 10-15 thrips at each insecticide concentration per completed test. Sprayed Petri dishes were covered with a clear plastic film containing approximately 50 small ventilation holes and maintained at 25 ± 0.1 °C under 16:8 L: D for 48 h until mortality was assessed.

**Statistical analysis**

Probit regressions including control correction (Abbott 1925) were calculated using a program written in GENSTAT 5 statistical software (Barchia 2001).

LC99.9 values with overlapping 95% fiducial limits were considered similar.

Slope was not considered significant if its ratio by standard error was less than 1.96 (Robertson and Preisler 1992). For each insecticide, the lowest concentration tested that killed all the test insects (the minimum effective concentration, MEC) was also recorded.

**RESULTS**

Against diazinon, populations ‘Colleambly’, ‘Yanco’ and ‘Mypolonga’ showed no variation in the MEC (1.0 g ai L⁻¹) or significant difference in the LC₉₉.₉ to kill all of them (Figure 1). In contrast, MECs of dimethoate, methidathion, omethoate and malathion varied 2.0 fold between populations but their was no significant difference between LC₉₉.₉ values (Figures 2, 3, 4 and 5).

Interestingly, the log-concentration probit mortality line for population ‘Mypolonga’ against malathion showed a distinct inflection in its 84 to 98 percent range. Moreover, the large standard error of the slope of the concentration-response line indicated excessive heterogeneity to malathion (Figure 5).

![Figure 1 Dose-response against diazinon for field collected populations ‘Colleambly’, ‘Yanco’ and ‘Mypolonga’ relative to the high volume field rate.](image-url)
Figure 2 Dose-response against dimethoate for field collected populations ‘Colleambly’, ‘Yanco’ and ‘Mypolonga’ relative to the field rate.

Figure 3 Dose-response against methidathion for field collected populations ‘Colleambly’, ‘Yanco’ and ‘Mypolonga’ relative to the high volume field rate.
Figure 4 Dose-response against omethoate for field collected populations ‘Colleambly’, ‘Yanco’ and ‘Mypolonga’ relative to the field rate.

Figure 5 Dose-response against malathion for field collected populations ‘Colleambly’, ‘Yanco’ and ‘Mypolonga’ relative to the high volume field rate.
DISCUSSION
The bioassay method developed in this current study was an adaptation of that used for western flower thrips (Herron and Gullick 2001). Results indicate the method can produce acceptable bioassay data for T. tabaci with moderate slope values. This allows meaningful extrapolation to the LC₉₉₉ level and is particularly important if future routine resistance monitoring is to be by a discriminating dose technique. The bioassay method described by Shelton et al. (2003) used insecticide treated microcentrifuge tubes while Martin et al (2003) used leaf dip. We consider our method superior because both the insect and its holding surface were treated. Such pesticide application ought to better represent field application of product and should prove robust if used in conjunction with newer chemistries with unique modes of action. Currently, extrapolation of the LC₉₉₉ to the most tolerant population suggests a discriminating concentration of 1.25 g ai L⁻¹ for diazinon (Colleambly), 0.40 g ai L⁻¹ for dimethoate (Mypolonga), 0.40 g ai L⁻¹ for methidathion (Colleambly), 0.11 g ai L⁻¹ for omethoate (Colleambly) and 3.50 g ai L⁻¹ for malathion (Colleambly).

Little has been published on resistance or bioassay of T. tabaci but recently Shelton et al. (2003) detected very high pyrethroid resistance while Martin et al. (2003) detected 40-fold diazinon resistance in addition to high-level pyrethroid resistance. There were no such differences between populations reported here and it is likely that the variation between population responses reflects normal variation between susceptible phenotypes and the sensitivity of the bioassay method. The response to malathion of one population in this current study is characterised by high heterogeneity; a trait usually associated with resistance (Tsukamoto 1963). Whether this result heralds the imminent emergence of malathion resistance is unknown, however, comparison with the field rate for malathion, suggests control of populations like ‘Colleambly’ and ‘Mypolonga’ may be compromised irrespective of resistance. Such comparison suggests reported control problems may be due to the registered label rate being too low to achieve effective control rather than insecticide resistance.

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REFERENCES
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