Pyridine Compounds Increase Thrips (Thysanoptera: Thripidae) Trap Capture in an Onion Crop

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ABSTRACT The effect of the thrips (Thysanoptera: Thripidae) lures ethyl isonicotinate, methyl isonicotinate, and ethyl nicotinate on numbers of thrips captured in white water traps in an onion (Allium spp.) crop, in New Zealand, was examined. Female onion thrips, Thrips tabaci Lindeman (69.0%), and Thrips obscuratus Crawford (27.8%) (males and females) were the most common species found in traps in the onion crop. Ethyl isonicotinate, methyl isonicotinate, and ethyl nicotinate caught 18, 12, and 4 × more onion thrips, respectively, than controls (no-lure). In contrast, traps with ethyl isonicotinate set up in a grass field at the same time as the onion crop trial caught 84 × more onion thrips than traps without this lure. For T. obscuratus, traps with ethyl isonicotinate, methyl isonicotinate, and ethyl nicotinate caught 10, 13, and 12 × more thrips, respectively, than controls in the onion crop.

KEY WORDS onion thrips, Thrips tabaci, Thrips obscuratus, semiochemicals

There is increasing interest in the use of semiochemicals, and other behavior-modifying chemical compounds, in thrips (Thysanoptera: Thripidae) pest management (Hamilton et al. 2005, Koschier 2008). Historically, many compounds derived from plants have been identified as thrips lures for a range of thrips species (Kirk 1985, Teulon et al. 1993, Koschier et al. 2000, Murai et al. 2000). However, pyridine compounds, rarely found or identified from plants, have been shown to increase trap capture of thrips (Teulon et al. 2007b). One such compound, ethyl nicotinate, was found to be a very strong lure for Thrips obscuratus Crawford in stone fruit orchards (Penman et al. 1982, Teulon et al. 1993) and in grass field experiments (Teulon et al. 1993, 2007b). More recently, compounds related to ethyl nicotinate have been identified as thrips lures, including those with distinct chemical structures, such as ethyl and methyl isonicotinate. Ethyl and methyl isonicotinate are the most powerful lures reported for onion thrips, Thrips tabaci Lindeman (Teulon et al. 2007b). Ethyl and methyl isonicotinate also have proved to be effective lures for the Western flower thrips, Frankliniella occidentalis (Perigande), in commercial Capsicum greenhouse crops (Davidson et al. 2007).

Onion thrips pose a serious threat to onion (Allium spp.) crop production (Liu and Chu 2004, MacIntyre-Allen et al. 2005, Trdan et al. 2005). The objective of this experiment was to examine the efficacy of these compounds for the first time in an onion crop in which host plant attributes (such as onion crop odor) might influence the effectiveness of the lures.

Materials and Methods

Trials were conducted in an organically managed commercial onion crop or rye grass field, at Lincoln, Canterbury, New Zealand, over a 23-h period between 31 January and 1 February 2006, when air temperatures were between 15 and 28°C, wind speed was between 2 and 10 km/h, and overall conditions were overcast, but fine. A method similar to that of Teulon et al. (2007b) was used. In brief, white plastic containers (1.5–1.7 liters of water, 0.04 ml of formalin, and 0.08 ml of Tween 20 were placed on top of inverted containers of the same dimensions. A volatile compound or water (1 ml) was added to a 4-ml glass vial containing a wick (4.5 cm²; Whatman no. 1 filter paper), with the vial suspended above the water in the center of the trap using wire (0.5 mm in diameter).

Onion Crop Trial. The field trial was carried out in a 3.8-ha onion crop [variety Canterbury (A1) planted 30 or 31 August 2005], 11 d before lifting. The five treatments included ethyl isonicotinate, methyl isonicotinate, ethyl nicotinate (Sigma-Aldrich, St. Louis, MO), and water (control), plus an additional compound not relevant to the current study, with five replicates per treatment, laid out in a Latin Square design, with ≈10 m between each trap. Traps were placed on bare ground between rows of onion plants (≈0.6 m in height). The upper edge of the water trap was ≈30 cm below the onion crop canopy in the onion crop.
At setup, one ethyl isonicotinate trap was accidently not included; an extra control trap was set up instead, giving four replicates for ethyl isonicotinate, and six control traps. This was taken into account when data were statistically analyzed.

**Grass Field Trial.** A trial was undertaken in a grass field (predominantly ryegrass [Lolium sp.], =0.2 m in height) ~1 km east of the onion crop, on the same day as the onion crop experiment, to assess thrips capture in traps with ethyl isonicotinate compared with water. Traps (five replicates per treatment) were laid out ~10 m apart in a randomized block design, with the upper edge of the traps just above grass level.

**Thrips Sampling and Identification.** In the laboratory, the total number of thrips in each trap was counted and a subsample of thrips was slide-mounted for identification of terebrantian species according to Teulon and Walker (1982). Thrips were randomly subsampled using the following criteria: for <50 thrips per trap, all thrips were mounted; form 50–100 thrips per trap, 25 thrips mounted; for 101–200 thrips per trap, 50 thrips mounted; and for >201 thrips per trap, 100 thrips mounted.

**Data Analysis.** For the onion trial, total thrips numbers were analyzed with a Poisson generalized linear model with a logarithmic link (McCullagh and Nelder 1989). For the grass field trial, variability between the total thrips numbers in the ethyl isonicotinate traps was much greater than would be expected within the Poisson generalized linear model, so these data were analyzed instead with a negative binomial generalized linear model with a logarithmic link, with an estimated aggregation parameter k of 28. For both trials, species numbers from the subsamples were analyzed with a Poisson generalized linear model, but for these analyses, adjustments for the subsampling were made by including the log(number mounted/total thrips numbers) as an offset (McCullagh and Nelder 1989), following the methods described in Teulon et al. (2007a). In all analyses, comparisons between treatments were done in an analysis of deviance using F-tests based on the estimated dispersion. Estimated treatment means and 95% confidence limits (CL) for these were obtained on the logarithmic scale as part of the analyses, and backtransformed to the count scale. All analyses from the onion crop trial included data from an additional compound not relevant to the current study and were therefore not included in the results, but its inclusion in the analysis provides more reliable estimates of variability. All analyses were carried out with GenStat (GenStat Committee 2006), and a level of P = 0.05 was used throughout to determine significance.

### Results and Discussion

In the onion crop trial, onion thrips (females only) and *T. obscuratus* (males and females) were the most common thrips recorded (overall estimate 69.0 and 27.8%, respectively), although this varied with treatment (Table 1). High numbers of OT were expected because this species is a common pest in onion crops (Martin et al. 2005). *T. obscuratus* have not been reported from onion plants (Teulon 1988, Teulon and Pennman 1990), suggesting that trapped individuals probably originated from the above the crop. No onion thrips males were trapped, because is consistent with previous water trapping of flying thrips in New Zealand (Teulon et al. 2007a,b). In the grass field, an estimated 92% of thrips caught were onion thrips (females). *T. obscuratus* females made up <2.4%, and males accounted for <1% of total thrips.

In the onion crop, numbers of onion thrips varied between the treatments (F = 35.59; df = 4, 20; P < 0.001) where all traps with odors caught more onion thrips than traps without (Table 1). Compared with control (no-lure) traps, ethyl isonicotinate increased capture the most (17.6%), followed by methyl isonicotinate (12.1×), and ethyl nicotinate (3.7×). Traps with ethyl nicotinate caught significantly fewer onion thrips (P < 0.001) than traps with ethyl isonicotinate. In the grass field trial, ethyl isonicotinate caught 84 times more onion thrips females than controls (F = 619.8; df = 1, 8; P < 0.001). In a previous study in a grass field, Teulon et al. (2007b) found that water traps with ethyl isonicotinate increased capture of onion thrips by between 21 and 62×, methyl isonicotinate by 19×, and ethyl nicotinate by 3 and 7× compared with a no-lure control.

Traps with ethyl isonicotinate caught nearly twice as many onion thrips in the grass field (479 onion thrips) as traps with this lure in the onion crop (496 onion thrips). Although onion thrips have been found on grasses (Chambers and Sites 1989, Andjus 2004), onions are one of their preferred hosts (Doe derlein and Sites 1993, Mound 1997). Thus, odors from the onion plants may have diluted ethyl isoni-
cotinate, a possible host plant odor mimic (Teulon et al. 2007b), with more thrips landing on onion plants surrounding the traps, whereas in the grass field, more OT landed in the traps than on surrounding vegetation. Alternatively, a larger number of starving OT may have been flying over the grass field, so more landed in the traps with a lure. A previous laboratory study found that hungry western flower thrips females were more responsive to the lure, methyl isonicotinate, in a Y-tube olfactometer, than satiated thrips (Davidson et al. 2006).

In the onion crop, significantly more New Zealand flower thrips ♀ and ♂ were caught in traps with a lure compared with the no-lure control (F = 39.27; df = 4, 20; P < 0.001; Table 1). In the grass field, a mean of 25 ♀ and 10 ♀ New Zealand flower thrips were caught in traps with ethyl isonicotinate (calculated from subsamples), but none were caught in no-lure controls (Table 2).

This study is one of the first to report the use of odors in an onion crop to increase trap capture of onion thrips. Although the increase in onion thrips trap capture with lures was not as great in the grass field as in the grass field, it was substantially greater than in traps without lures. Previous studies using sticky traps (without any olfactory cue) in onion crops to monitor onion thrips have suggested such traps may provide an early detection tool, or possibly even a mass trapping system (MacIntyre-Allen et al. 2005, Trdan et al. 2005, Natwick et al. 2007).

The addition of a volatile lure (olfactory cue) to such traps may improve their use in pest management. However, determining whether such lures increase trap capture at different stages of the crop and how this relates to resident thrips populations, and understanding how volatile lures may affect population distributions in a given crop, will be crucial to understanding how best to optimize the application of such lures for thrips pest management.

Acknowledgments

We thank Melanie Walker, Phillipa Milne, and others in the Plant and Food Research Lincoln Entomology team for assisting with the field trials. We are grateful to the referees and Bruce Chapman for reviewing the manuscript. This work was in part funded by the Foundation for Research Science and Technology, New Zealand (Reduced Insecticides, CO6X0301).

References Cited


Table 2. Mean numbers (95% CL) of total thrips, onion thrips, and T. obscuratus (‘New Zealand flower thrips [NZFT], females and males) caught in water traps, ratios (95% CL, except for total thrips) relative to control traps (water only) in a grass field, and total combined catch from all treatments.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Mean</th>
<th>Ratio</th>
<th>Mean</th>
<th>Ratio</th>
<th>Mean</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>11.8</td>
<td>(8.2, 17.0)</td>
<td>11.2</td>
<td>(6.5, 19.3)</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Ethyl isonicotinate</td>
<td>1,028.2</td>
<td>(841.8, 1,255.8)</td>
<td>945.8</td>
<td>(785.1, 1,139.4)</td>
<td>24.7</td>
<td>10.3</td>
</tr>
<tr>
<td>Total*</td>
<td>1.940</td>
<td>&lt;0.001</td>
<td>957</td>
<td>(92.0%)</td>
<td>24.7</td>
<td>(2.4%)</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>10.3</td>
<td>(1%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Totals estimated using numbers in [sample × (total on trap/total in sample)].

b No NZFT of either sex were captured in water-only traps; therefore, these data could not be analyzed.


Received 23 June 2008; accepted 8 May 2009.