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Short communication

The effect of adhesives and solvents on the capture and specimen quality of pest thrips on coloured traps

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ABSTRACT

The present study compared different adhesives for trapping efficacy, ease of removing specimens and the subsequent quality of specimens for identification of thrips pests captured on blue plastic boards in a commercial capsicum glasshouse. The mean total number of thrips caught on sticky boards differed significantly with different adhesives. Blue boards covered with a water-based adhesive caught the least total number of thrips in the two experiments (56 thrips per trap, experiment 1; 4 thrips per trap, experiment 2). Traps covered with Stikem Special® caught the greatest number of total thrips (299 per trap, experiment 1; 32 per trap, experiment 2). De-Solv-it® was the most effective solvent to remove thrips from sticky boards compared with water and mineral oil, with all thrips detached from boards for all adhesive treatments within 150 min. Damage to or absence of key morphological features due to removal of specimens with De-Solv-it that would prevent species identification was recorded in only 10 of the 720 specimens removed from traps across all adhesives. The majority of thrips (70–92%) identified were *Thrips tabaci* Lindeman or *Frankliniella occidentalis* (Pergande). The type of adhesive used is an important factor to consider when developing traps for insect pest monitoring and management.

1. Introduction

Sticky traps, often made from coloured boards to exploit an insect's response to particular light wavelengths, are widely used for catching small winged insects such as those found in the Coleoptera, Diptera, Hemiptera and Thysanoptera (Augustin et al., 2012; Kaloostian, 1961; Muirhead-Thomson, 1991; Murphy, 1985). The exposed surface of the coloured board or panel is coated with an adhesive substance that will not wash off with rainfall or irrigation, so that traps can be left outside for weeks or months. Insects become immobilized in the adhesive where they may be counted *in situ* or, in many cases, may be removed for further identification (Augustin et al., 2012; Lewis, 1973).

In many situations, such as detecting quarantine pests, or where populations are at low densities (e.g. soon after crop invasion), or for managing pest populations (e.g. mass trapping), it is often important to maximize the trapping efficiency (number of individuals caught) of sticky traps. There are numerous reports of attempts to achieve maximum trap capture through the positioning of the trap in an optimal location (e.g. crop edge), or increasing the size of the trap, or using attractive colours or semiochemicals (Davidson et al., 2007; Lewis, 1973; Muirhead-Thomson, 1991; Pinto-Zevallos and Vänninen, 2013; Taylor et al., 2014).

The type of adhesive used on a trap can also be an important factor influencing trap capture of insects. Relatively few studies examine this, but those that do indicate that different adhesives can catch different numbers of insects, for example Cicadellidae (Kaloostian, 1961), Diptera (Chin et al., 2008; Kaloostian, 1961; Ryan and Molyneux, 1981), and Aleyrodidae (Webb et al., 1985). Conversely, trapping efficiency of the psyllid *Diaphorina citri* Kuwayama or the tephritid fly *Rhagoletis indifferens* Curran was not

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affected by adhesives (Hall and Hentz, 2010; Yee, 2011).

In addition to ensuring maximum trap capture, accurate identification of insect specimens caught on traps is often critical, and for smaller winged species this can require high magnification (Augustin et al., 2012; Lewis, 1973). Accurate identification may be especially critical in surveillance or eradication programs of new incursive species where it is important to accurately identify these invaders at low relative density with respect to similar looking related species. For identification under high magnification, specimens need to be removed from the sticky trap and this may require special solvents (Augustin et al., 2012). Ideally an adhesive would allow specimens to be removed easily and with little damage to important morphological characters. Yee (2011) found that intact *R. indifferens* could be removed from traps made from non-drying adhesive without using a solvent, but a solvent was needed to remove individuals from traps made with hot-melted pressure sensitive adhesive.

The effect of adhesives on the capture and subsequent quality of specimens for identification has not been reported for thrips. Yet thrips are important pests of agriculture, horticulture and forestry crops (Lewis, 1997; Morse and Hoddle, 2006; Mound and Teulon, 1995; Whitfield et al., 2005). Sticky traps are used for thrips monitoring (Lewis, 1997), mass trapping (Sampson and Kirk, 2013), border surveillance (Augustin et al., 2012) and in eradication programmes (Cannon et al., 2007). Several thrips species are often found in the same agricultural system and found together on the same sticky trap (Teulon and Penman, 1992; Teulon et al., 1999). Thrips being small (<2 mm body length) need to be removed from the sticky boards for identification under high power magnification, especially when few characters differentiate species (e.g. Teulon and Nielsen, 2005). A number of species have considerable quarantine importance and are subject to border surveillance and eradication (Cannon et al., 2007; MacLeod et al., 2004; Mehle and Trdan, 2012; Vierbergen, 2001). The ability to rapidly identify quarantine species by specialists is a critical factor that will determine the success of any campaign to prevent its establishment (Walsh et al., 2005).

The purpose of this study was to evaluate: (1) the efficacy of a range of adhesives in capturing thrips on blue plastic boards selected to minimize bycatch of non-thrips species, (2) the ease of removing specimens using non- or low-hazardous solvents and (3) the quality of the specimens after removal for morphological identification by experts.

2. Materials and methods

Experiments were undertaken in a commercial *Capsicum annuum* crop in greenhouses near Christchurch, New Zealand. In an initial experiment (February 2008, experiment 1), six adhesives (Table 1) were applied to both sides of blue plastic boards (10 cm × 25 cm) (Aeroxon Insect Control Stuttgart, Germany) using a standard decorators' paint brush (40 mm brush width). Every effort was made to provide a consistent thickness and area of coverage for each adhesive on each board. The plastic boards were the same as those used for producing Horiver-TR commercial traps (Koppert Biological Systems, The Netherlands) at the time of the experiment. In a second experiment (March 2008, experiment 2), the same six adhesives were tested with the commercially available blue sticky trap (Horiver-TR blue, Koppert Biological Systems, the Netherlands) as an additional treatment. The adhesives chosen for this study were all commercially available in early 2008, except one (water-based adhesive) obtained from the Swedish University of Agricultural Sciences. However, not all were designed to capture insects using sticky traps, but were chosen for this study because they were either widely used (e.g. Tangle-Trap®) or would reportedly be easy to remove with the solvents tested (Table 1). Due to commercial sensitivity, we were unable to obtain information regarding the constituents of the adhesives tested in the present study.

In experiments 1 (14–24 February 2008) and 2 (7–17 March 2008) five sticky boards for each adhesive treatment were hung in a greenhouse (30 m × 40 m) just above the crop canopy, approximately 2 m apart, with the flat surfaces facing north/south. Traps were arranged in an extended Latin square design. The traps were removed after 10 days and individually wrapped in clear plastic and transported to the laboratory. The total number of adult thrips caught (female and male) per trap was counted using a stereo microscope (>100× magnification).

The efficacy of water, mineral oil (Sigma-Aldrich, New Zealand) or De-Solv-it® (RCR International P/L, Australia and commercially available in several countries) to remove thrips from the sticky boards was evaluated. All three solvents were used in experiment 1, while only mineral oil and De-Solv-it were used in experiment 2, since water failed to remove the thrips from the different adhesives in the first experiment. Two out of the five boards from each treatment were cut into six evenly sized pieces, ensuring no insects were damaged in this process. Two of these pieces, with a similar number of insects on them, and cut into four smaller evenly sized pieces to increase the surface area, were suspended in a given solvent (280 ml) held in a glass dish (16.5 × 26 cm). Every 10 min the pieces were turned and agitated gently for 5 s. The plastic pieces in the different solvents were checked after 10, 30, 60, 120 and 150 min to determine whether any or all of the insects had separated from the plastic.

The quality of specimens removed from the boards for identification was evaluated using the three remaining intact boards from each adhesive treatment. Using the method described above and the most effective solvent (De-Solv-it), insects were removed from

Table 1
Details of the adhesives applied to blue plastic boards to make sticky traps in the present study.

Adhesive	Manufacturer	Recommendations for use	Recommended solvents	Information source
Water-based adhesive	Experimental formulation (Swedish University of Agricultural Sciences)	Prototype adhesive, not commercially available.	Not specified	Dr Rob van Tol, Plant Research International
Thripstick II	Aquaspersions	Physical trap for ground pupating and weak flying insects such as thrips, sciarids, leaf miners and spider mites	Not specified	www.aquaspersions.co.uk
Tangle-Trap®	Contech Enterprises Inc. (previously The Tanglefoot Company)	Effective in trapping and monitoring flies, ants and other flying and crawling insects.	Mineral spirits, waterless cleaners or baby oil	Product label
Trappit® Barrier Glue	Garrick Distributors Limited	Apply to vertical surfaces (e.g. poles tree trunks, rose stems) to prevent insects (e.g. ants, codling moths).	Not specified	No longer available
Oecotak A5	Oecos	Insect trapping adhesive.	White spirits	Product label
Stikem Special®	Seabright Laboratories	For trapping of flying insects; aphids, whiteflies, thrips, leafhoppers, froghoppers, moths.	Not specified	Product label www.seabrightlabs.com