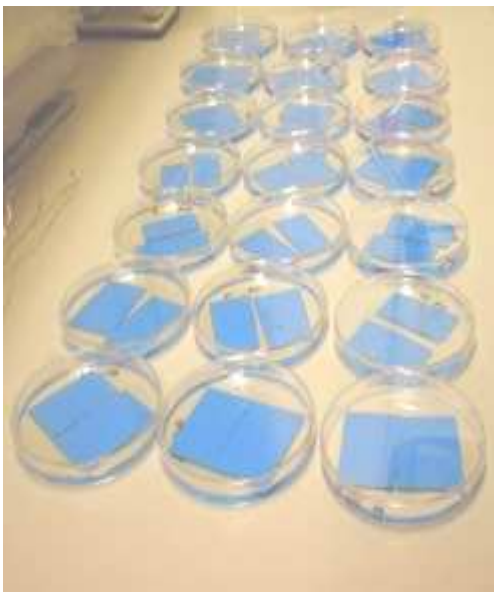
INTERNSHIP

Crop and Food Research
New Zealand



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January – May 2008

Content

1. Crop and Food Research (CFR)

1.1 New Zealand's science history

It all started in 1926 with the Department of Scientific and Industrial Research (DSIR), a government research institute. Due to low investments in science and technology changes were proposed to increase funding, improve prioritisation of funding, enhance private sector investment and improve the overall efficiency. This led to a reformation of DSIR and related government departments in 1992. It was split up into nine government-owned companies called New Zealand Crown Research Institutes (CRIs), of which *Crop & Food Research* was one such CRI. All of them perform research in different important sectors of the economy along with the freedom to operate as commercial organisations. CFR, together with *Scion*, *Agresearch* and *Hortresearch* are specialised in research for land-based industries. Other areas such as environmental and resource management, technology development and environmental health are covered by other CRIs; *Landcare Research*, *GNS Science*, *National institute of Water and Atmospheric Research* (NIWAR), *Industrial research* and *Environmental Science and Research*.

1.2 Crop and Food Research Institute

New Zealand Institute for Crop & Food Research Limited is a biological science company, which focuses on 'developing intellectual properties in areas of expertise and capturing and sharing the value of resulting developments with its partners'. The main areas in which the company gains new knowledge are:

- Sustainable land and water use
- High performance plants
- Personalised foods
- High value marine products
- Biomolecules and biomaterials

The main research centre of CFR is based in Lincoln (fig 1.1), together with several of other research companies (*Agresearch*, *Landcare* and *HortScience)*. The institute is divided into several offices located in different parts of New Zealand (fig 1.2) as well as having one site in Australia (Albury). CFR does both fundamental and applied research for which funding comes from both local and international industry and government sources. The company has a total of around 390 staff and its annual turnover is $55 (€27) million (2007).

Fig. 1.1: C&F, Lincoln

Fig. 1.2: Divisions of C&F

1.3 Organisation

Within CFR, the company structure includes an officer Mark Ward, supported by the executive consisting of a chief scientist and managers responsible for strategy & investments, food, production, finance or corporate services. The research outcomes are delivered by different teams, each concentrating on one of the main areas covered by CFR. The entomology division, at which I am doing my internship, falls under Sustainable Land and Water Use of which Grant Smit is the team leader. Together with the divisions crop physiology and agronomy, crop physiology and modelling, molecular microbiology, plant pathology and soil science they develop innovative solutions that enhance the productivity of land based systems while maintaining environmental quality. The entomology department under the supervision of David Teulon, consists of researchers, lab technicians and once in a

while, one or a few student doing their internship or gaining work experience. A lot of the employees originate from outside of New Zealand, which results in a very diverse and international research group. Furthermore, CFR often works together with other organisations and companies from overseas resulting in visits from overseas collaborators.

The researchers work individually or together on a variety of small to large projects dealing with chemical ecology. The projects deal extensively with researching integrated pest management and sustainable food production, particularly for small insects (e.g. thrips, aphids, whitefly, psyllids) and insect pests of vegetable crops (especially Diamond Back moth) as well as examining insect pollination systems. The higher up you are, the more responsibility you have, including gathering funding for (new) projects. Mostly during the summer period a lot of proposals have to be written for new projects. The chance that a project will be funded is very small (50% or less), but funding is important for the company to be able to exist.

1.4 Publicity

Crop and Food Research has its own webpage to show the general public what kind of company Crop and Food is and more importantly it is a tool to attract (new) clients and gather funding for new projects.

www.crop.cri.co.nz

2. Activities

During my internship I worked mainly on improving identification of thrips collected on sticky traps. Under the supervision of Melanie Davidson, an entomology researcher, we examined different glues and solvents to improve the use of sticky traps as a collection method for thrips.

This small study is part of the large B3 project '*Better Border Biosecurity*'. B3 was set up to develop new approaches and tools to prevent harmful organisms entering New Zealand or, if they do manage to get in, are eradicated before establishing permanent populations. My small research contributes by enhancing surveillance tools (sticky traps) to be able to detect (new) thrips species faster and more accurately.

In the near future we aim to produce a journal article from this study. However, as taxonomists of MAFF in Lincoln and Auckland help in scoring the thrips specimen, it requires more time to obtain all data. Due to this I was not able to write the paper during my internship. The following chapter gives an overview of the experiment and results obtained so far.

In chapter 2.2 other projects in which I took part are briefly described.

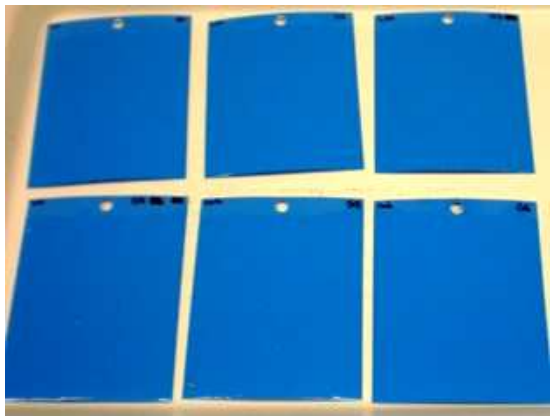

Figure 2.1: Example of coloured plastic covered with different glues

2.1. Main research: Improving identification of thrips from sticky traps; an evaluation of glues and solvents.

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Introduction

There are approximately 100 thrips species found throughout the world described as pests of horticultural and agricultural crops (Moritz et al. 2004). Thrips pests can cause extensive damage and subsequent yield losses through direct feeding or ovipositing damage. A number of species are also able to vector tospoviruses, which can affect a diverse range of food, fibre and ornamental crops causing crop disease epidemics of global economic and social significance (Whitfield et al., 2005). Their small size (<3 mm), cryptic habits, vagility, reproductive biology, broad host range and propensity to evolve resistance to insecticides predispose many species toward an invasive lifestyle (Morse & Hoddle 2006; Riley & Pappu, 2000). While existing pest species pose a biosecurity threat to countries where they are not currently present, there is also the potential for an ever increasing number of thrips species to become pests that will exhibit high invasion potential as novel crops and growing strategies are introduced, quarantine practices are changed, and international trade expands (Morse & Hoddle 2005). Consequently, one of the principle challenges when attempting to manage invasive thrips species is early recognition of a potential incursion, followed by rapid and accurate identification of emergent pests (Morse & Hoddle 2005).

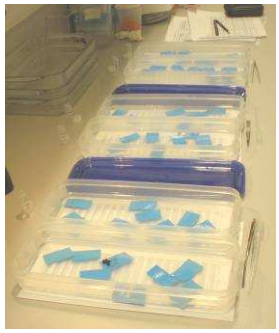
Coloured sticky traps are commonly used as a rapid, simple and economical means of detecting and monitoring thrips (Cornelius, 2002; Lewis, 1997). However, accurate identification of thrips on sticky traps is difficult because many of the key features used to identify species require high magnification (200-400x). Furthermore, removing thrips from commercially available sticky traps is labour intensive and often results in damaged specimens, which makes morphological identification very difficult. As some species are almost identical to one another (Chu et al., 2006) it is important to minimise damage to specimens for accurate identification. For instance, *Frankliniella occidentalis* only differs from *Frankliniella intonsa* by having longer postocullar setae than *F. intonsa*, and two sensilla (small holes) in the metanota, which are not present in *F. intonsa* (Mound & Walker, 1986). The type of glue used on the sticky trap combined with a solvent that efficiently removes thrips may enhance the quality of specimens coming off such traps and thus improve the efficiency of morphological identification. Although a number of studies have reported thrips species caught on sticky traps, most identification was done directly off the traps (Gillespie & Vernon, 1990; MacIntyre-Allen et al., 2005; Steiner et al., 1999; Vernon & Gillespie, 1990). Where thrips have been removed from traps and mounted onto microscope slides for identification the removal method is often not provided (Chu et al., 2006; Davidson et al., 2007; Riley & Pappu, 2000). If the method of removing thrips from sticky traps was described, mostly thrips were removed from only a part of the traps and solvents such as white spirits (cannon et al, 2007) were used which are hazardous to deal with when using it in large quantities.

The aim of this study was to evaluate sticky traps made using coloured plastic and a range of commercially available glues for; 1) their efficacy in capturing thrips, 2) how rapidly thrips can be removed from them using different solvents, and 3) how intact the thrips specimens are after removal from the sticky traps, using the most effective solvent (the solvent to remove all thrips in the shortest time).

Material and methods

Efficacy of glue in capturing thrips. The experiment was undertaken in a commercial greenhouse in Woodend, New Zealand, that grows *Capsicum* (sweet pepper). Two trials were conducted to assess the efficacy of different glues applied to sticky traps to trap thrips within a greenhouse. In the first trial six glues, *Tanglefoot* which is often used for research purposes (Chen et al., 2004; MacIntyre-Allen et al., 2005; Maris, 2004; Van Tol et al., 2007), *Oecotak*, *Stikem Regular*, *Trappit*, *Thripstick II* and *Water-based glue* were analysed for their usability in trapping thrips (see Appendix I for detailed information). They were chosen because most of them were recommended for thrips control and commercially available and therefore relatively easy to obtain. The glues were applied to blue plastic (10 x 20 cm), used for producing commercial thrips traps (Aeroxon Insect Control GmbH, Germany). On 14 February 2008, 5 replicate traps of the six glues were hung in the greenhouse just above the crop canopy with approximately 2 m between the traps. Traps were arranged in an extended Latin square design. After 10 days the traps were individually wrapped in clear plastic and taken to the laboratory where the total number of thrips per trap was counted under a stereomicroscope (63 to 100 x magnifications).

The second trial included a commercially available sticky trap *Horiver-TR* (Koppert B.V., the Netherlands) having the same coloured plastic used in the glue trial. This trap was pre-coated (information of glue kept secret by the supplier), but the plastic was similar as used for the other glues. On 7 March 2008, 5 replicate traps of six glues plus the Horiver traps were hung in the same greenhouse as used in the first trial based on a Latin square design. As for the previous trial after 10 days, wrapped in plastic and transported to the laboratory. In both trials, one or two days prior to putting the traps up a combination of *Match*® and *Success*®[1] had been sprayed by the grower.



Rapid removal of thrips from sticky traps. Three solvents, *De-Solv-it*, mineral oil (recommended by some of the glue manufacturers) and water were tested on their ability to remove thrips from sticky traps. As large numbers of traps had to be analysed these solvents were chosen as being non-toxic, re-useable (3 to 4 times), and environmentally safe. Two replicate traps of each glue were used for analysing the solvent usability. The traps were cut into 6 pieces of similar size without damaging the thrips. Two pieces were taken together (each pair having a similar number of thrips), cut into a further four pieces to maximise exposure to solvent and placed in a 16.5 cm x 26 cm glass Parex dish containing 280 ml in volume of one of the three solvents. Every 10 minutes the trap pieces were turned and agitated gently for 5 seconds. At 10, 30, 60, 120 and 150 minutes the amount of clear plastic wrap and number of thrips coming off the traps was recorded.

Assessing thrips specimens (for morphological identification) from sticky traps. Thrips of the three remaining replicate traps of each glue were used for assessing quality of specimens. Using the most effective solvent De-Solv-it, (1) thrips were floated free from the sticky traps, (2) pipetted into small (75 ml) containers with De-Solv-it, (3) removed from solvent by passing through a fine gauze which had been fastened to a funnel with paper clips, (4) cleaned by adding a drop of dishwashing liquid onto thrips on the gauze and rinsing gently with water, (5) step four was repeated three times and finally (6) transferred into 75% ethanol. This method took 10-18 minutes (from time thrips were removed from solvent). For both trials, 10 thrips of each of the 3 replicates were randomly removed from the ethanol where there were an excess number of thrips, put onto microscope slides using PVA glue (5 min per slide of 10

[1] Match® = Tradename for the chemical Lufenuron; an insect growth regulator. Interferes with chitin synthesis (a part of the insect exoskeleton) (siu.edu, 2008)
Success® = Tradename for the insecticide Spinosad; a fermentation metabolite of the actinomycete *Saccharopolyspora spinosa*. It has both contact and stomach activity against thrips. (ipmworld.umn.edu, 2008)

thrips) and placed in the oven for four weeks to harden and set. This was repeated to obtain two sets of thrips slides; one set to be examined by four, the other by three people[2] (researchers of CFR Lincoln examined both sets). The quality of the thrips, which refers to how intact the specimens are for identification purposes, was quantified by the taxonomists. A scoring table was developed (appendix II; based on characters found in (Moritz et al., 2001; Mound & Walker, 1986) and used by all taxonomists to minimize differences in grading. The thrips were examined under 200-400x magnification using a Leica compound microscope.

Methods of Analysis

Total thrips numbers were analysed with a Poisson generalised linear model (McCullagh & Nelder, 1989). In addition to this analysis, some exploratory analyses were done (not detailed here) to look for any significant spatial patterning in the trial. Some patterning was found, with numbers of thrips per trap generally increasing from the West to East and from the South to North of the greenhouse (trial 1) and numbers of thrips in column a generally lower than for the rest of the greenhouse (trial 2). The main analysis results were therefore adjusted by basing tests and standard errors on the estimated dispersion (rather than the expected value of 1). Comparisons between treatments were made using contrasts within the analysis of deviance done as part of the analysis, using F-tests. Confidence limits and ratios to compare counts for the different treatments were obtained for the data on the transformed (log) scale, and back transformed to counts. The analysis was carried out with GenStat (GenStat Committee).

Results

Efficacy of glue in capturing thrips. The total numbers of thrips caught by the different glue traps are shown in figure 1. For the first trial mean numbers caught on traps varied ($p=0.003$) from 56 per trap for the *Water-based glue* to 299 for *Stikem Regular* ($p<0.001$). Numbers on the *Oecotak* and *Stikem Regular* traps were significantly greater than the numbers on the *Water-based glue* trap ($p<0.01$). Thrips numbers on *Stikem Regular* traps also differed significantly from those with *Thripstick II* and *Tanglefoot* glue ($p=0.017$), with more than twice as many thrips on the former.

In trial 2, fewer numbers of thrips were caught, but mean counts for the six glues in trial 1 correlate very strongly with those from the second trial (fig 2), with only the numbers for the *Thripstick II* trap not falling on an approximately straight line. Numbers in trial 1 were approximately 8.7x those in trial 2 apart for *Thripstick II*. The mean numbers caught on traps in trial 2 varied ($p<0.001$) from 4.2 per trap for the *Water-based glue* to 50.8 for the *Horiver* trap. Numbers on all traps other than *Tanglefoot* traps were significantly greater than the numbers on the *Water-based glue* trap ($p<0.04$ or smaller).

Thripstick II did not cover plastic uniformly.

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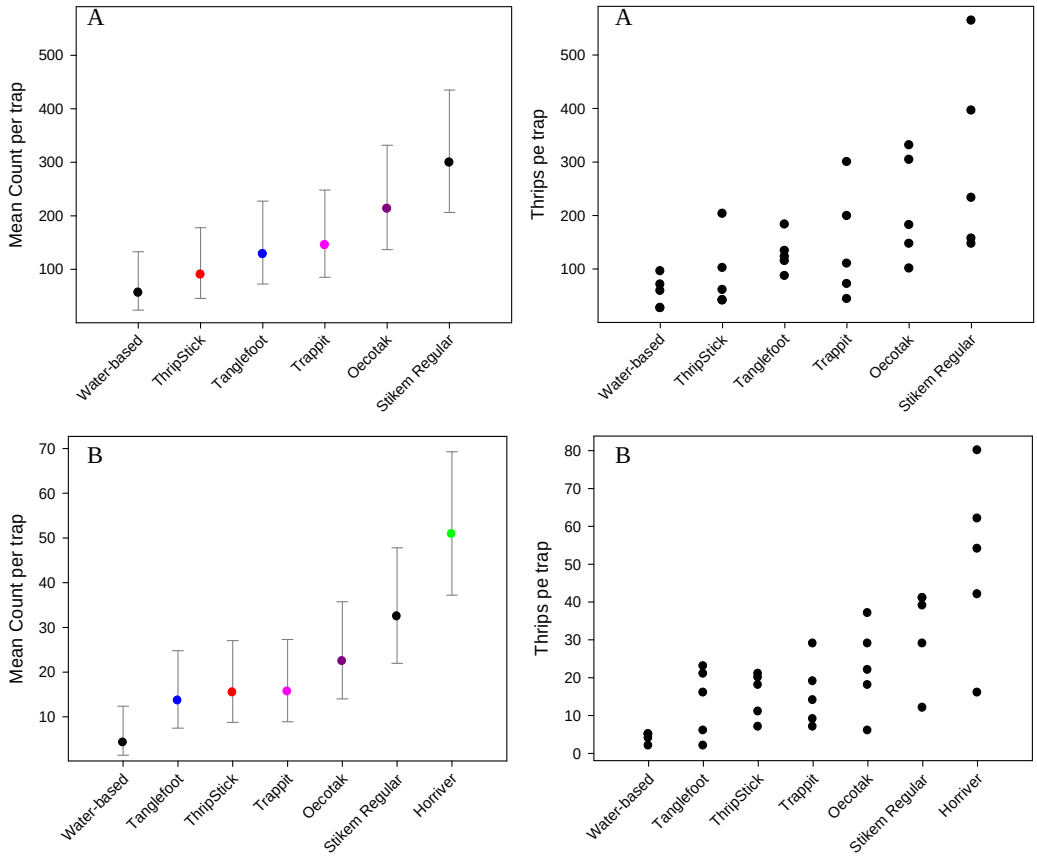

Fig. 1. Total number of thrips caught by different glue traps in trial 1 (A) and 2 (B). Left: Estimated Counts per trap for each glue (bars are 95% confidence limits). Right: Counts for individual traps for each glue.

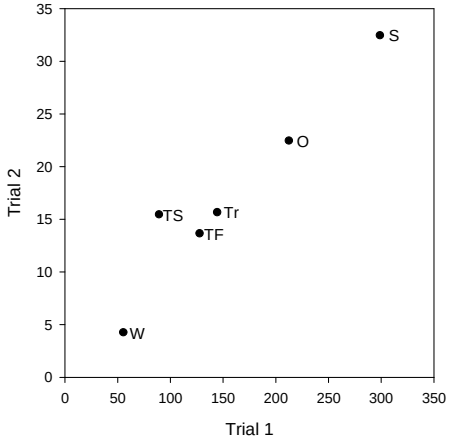

Fig. 2. Comparison of thrips numbers caught by the different glues in trial 1 and 2.

Efficiency of solvents. Regarding the time to remove thrips from sticky traps, similar results were obtained with traps from trial 1 and 2 (high versus low numbers of thrips respectively). Only a small difference of less than 15 minutes for *Trappit* was noticeable. The efficacy of the three solvents on removing the thrips from sticky traps containing different glues is shown in table 2. *De-Solv-it* was able to remove all thrips from each glue trap. Thrips came off the traps with *Thripstick II* most rapidly (30 min) followed by *Trappit* (between 30-60 min), *Stikem Regular* (60 min), *Oecotak* and *Tanglefoot* (both 120 min). It took 150 minutes to remove the thrips from *Horiver* traps or traps with the *Water-based glue* using De-Solv-it.

Table 2. Number of thrips and time taken to flat off sticky plates, using different solvents. Numbers are an average of 2 samples. Glues ordered by time to remove thrips. (TF = Tanglefoot, O = Oecotak, S = Stikem Regular, Tr = Trappit, TS = Thripstick II, H = Horiver, W = Water-based glue). **Stickiness of glue on plates after 10 days in greenhouse. Between 1 (barely sticky) to 4 (extremely sticky).*

Solvent	Glue						
	TS	Tr	S	O	TF	W	H
DiSolv-it							
No. thrips trial 1	37	39	102	92	79	22	-
No. thrips trial 2	9	11	21	12	4	3	28
Thrips removed (min)	30	30-45	60	120	120	150	150
Mineral oil							
No. thrips trial 1	25	40	100	77	63	18	-
No. thrips trial 2	9	5	20	12	4	3	30
Thrips removed (min)	30	>150	>150	-	-	-	-
Water							
No. thrips trial 1	11	9	51	40	30	7	
Thrips removed (min)	-	-	-	-	-	-	
Stickiness glue*	1	2	2	3	2	4	3

Water on the contrary did not result in thrips floating free from the traps with any of the different glues after 150 minutes and was consequently not repeated with traps from the second trial. Mineral oil removed thrips from *Trappit*, *Stikem regular* and *Thripstick* II traps, but acted slower than *De-Solv-it* in all cases.

Assessing thrips specimens (for morphological identification) from sticky traps. Scoring of the thrips specimens is still ongoing, but preliminary results from 2 of the 5 people examining them are shown in the figure 3.

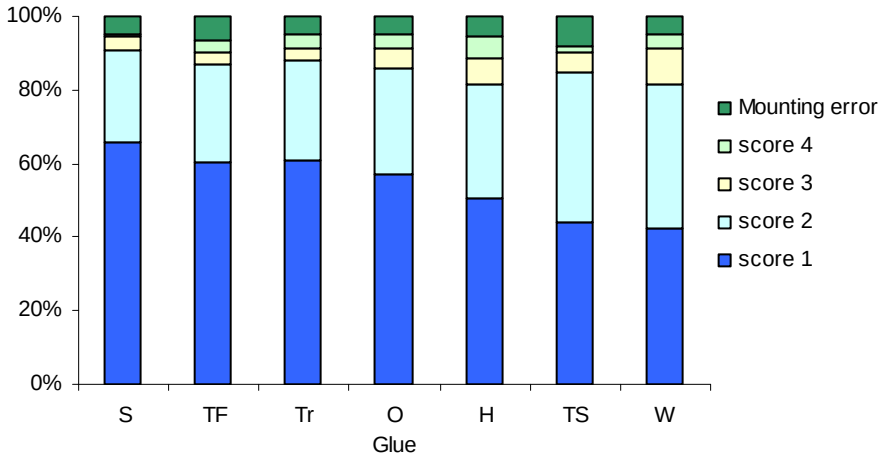

Fig. 3. The percentage of each scoring category for a given glue. Seven morphological features (Antennae, Head, Mesonotum, Pronotum, Forewings, Forelegs and Abdomen) of each thrips specimen were given a score between 1-4: (1) Specimen intact/complete, (2) some damage, but able to see character for identification, (3) morphological feature not clearly visible or damaged, (4) feature absent. If the feature was present but not visible it was given an M (mounting error). Bars indicate the average percentage of the scores given for thrips specimens of both trials examined by two people (max. of 60 thrips p. glue). Glues ordered by highest percentages with a score of 1. (TF = Tanglefoot, O = Oecotak, S = Stikem Regular, Tr = Trappit, TS = Thripstick II, H = Horiver, W = Water-based glue)

A score of 1 was mostly given to (features of) thrips specimens removed from sticky traps with the glue *Stikem Regular*. Only a small percentage of thrips of the traps with water-based glues, *Thripstick II* and *water-based glue*, got a score of 1; indicating the morphological feature being scored was intact. The glues *Oecotak*, *Horiver* and *water-based glue* had the highest number of thrips given a score of 3 and 4; indicating the feature was damaged to such an extent it could no long be used for identification or the feature was completely absent..

Discussion

Efficacy in capturing thrips.

The seven glues tested in this study for trapping purposes differed considerably in thrips capture. The *Horiver* traps showed the highest thrips catch, followed by the glue *Stikem Regular*. The two water-based glues, *Thripstick II* and *Water-based glue*, resulted in extremely low numbers of thrips on the traps in both trials. The remaining glues *Oecotak*, *Trappit* and *Tanglefoot* also caught fewer thrips than *Stikem Regular* although it was not significantly different. Maximising the number of thrips caught is important since it is presumed that if large numbers of thrips are caught, there is a greater chance of catching potential invasive thrips. This would be of critical importance for detecting and preventing establishment of new species. The costs and effort for early, accurate detection are far less then when outbreaks occur. For example, *Thrips palmi* (Thysanoptera, Thripidae), a widespread pest species causing up to 100% crop loss, has been detected in Western Europe, but was prevented from establishing through a successful eradication program (Cannon et al., 2007). MacLeod et al. (2004) depicted the benefit:cost ratio of preventing *Thrips palmi* establishment, to be between 4:1 to 19:1 (no loss of exports) and from 95:1 to 110:1 (when export losses results from the establishment) (MacLeod et al., 2004).

Efficiency of solvents.

Using sticky traps for surveillance of potential incurions coiuld mean the number of thrips on a trap and number of traps for processing may be large. Therefore the ideal solvent will be safe to use in large volumes. In the present study mineral oil and *De-Solv-it* could be used safely in large volumes. *De-Solv-it* showed more potential as, unlike mineral oil, this solvent was effective for all glues, suggesting it might be effective for a large range of glues. Secondly, it removed thrips more quickly than mineral oil which helps reduce the time to process sticky traps. *De-Solv-it* is considered safe to use, not hazardous to the environment, relatively cheap, can be recycled (3 x 4 times) and can be used in large quantities acting similarly when high or low numbers of thrips are on the traps.

Getting thrips off sticky traps can be enhanced by choosing the right glue-solvent combination. Using *De-Solv-it* the time taken to remove thrips from sticky traps differed between the glues. It took a long time to get thrips off the *Horiver* traps in comparison with other glues. The faster the thrips can be taken off the sticky traps, the sooner identification can be done and control methods can be applied to prevent thrips outbreaks. If the standard *Horiver* traps would be replaced by traps containing *Tanglefoot, Oecotak, Stikem Regular, Trappit* or *Thripstick II* the time taken to remove thrips from sticky traps can be reduced considerably (30- 120 minutes). However, the difference in thrips catch was large and glues such as *Trappit, Tanglefoot, Water-based glue* and *Thripstick II* resulted in a much lower number of thrips. *Oecotak* and especially *Stikem Regular* on the other hand showed promising results in both thrips catch and time to remove thrips from sticky traps (30 to 90 minutes respectively).

Quality of thrips (for morphological identification) of sticky traps.

From the results obtained so far, thrips specimens off traps with *Stikem Regular* seem to be of better quality than thrips removed from other glues traps. Thrips seem to be more damaged from traps with the *Horiver* glue and the *water-based glue*. Although *Horiver* resulted in a high thrips catch, it seems to fail both in time to remove thrips from the sticky trap and obtaining quality specimens. The *Water-based glue* was considerably low in thrips numbers, it took long to remove thrips from sticky traps and seemed to lead to low quality thrips

specimens, suggesting it would not be useful for detecting thrips. *Stikem Regular* showed promise in maximising thrips capture and specimen quality for morphological identification, and minimizing time to remove thrips from sticky traps.

Conclusions

Detection of thrips using sticky traps can be improved, enhanced and accelerated by the type of glue used on the sticky trap. Thrips capture can be maximized and time to remove thrips from the traps minimised to be able to correctly identify the specimen by finding an effective glue-solvent combination. Furthermore, large numbers of traps can be processed easily, safe and fast making use of the solvent *De-Solv-it.* The glue *Stikem Regular* in combination with *De-Solv-it* proved to be such effective combination in the present study. From the preliminary results of scoring the thrips on quality for morphological identification, it seems that *Stikem Regular* is also less damaging to thrips specimens, increasing accuracy of morphological identification.

Acknowledgments

We thank the grower (Canterbury, New Zealand) who allowed us to undertake the experiments in his greenhouse. This work was in part by the Foundation for Research Science and Technology programme *Better Border Security.*

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2.2. Other activities

As the research study with sticky traps did not take all of my time I was also able to take part in other projects, each described briefly below.

Semiochemical study thrips.
The second project was about thrips and odour attraction. Thrips use olfactory and visual cues to find host plants (Lewis, 1997). *Crop & Food Research* has developed a thrips lure, together with *Plant Research International*, the Netherlands, and Koppert BV, *Lurem-TR* which is now commercially available. This study was undertaken to gain more knowledge of this lure, by attempting to answer to the following questions:

- Is the odour effective and if so for how long?
- Does *Lurem-TR* work better than a prototype lure?
- Does a trap with *Lurem-TR* results in more thrips in the surrounding roses?
- Does *Lurem-TR* also attract thrips from outside the greenhouse (i.e. pull thrips from surrounding vegetation into greenhouses). In New Zealand, onion thrips (*T. tabaci*) are more apparent outside greenhouses and western flower thrips (*F. occidentalis*) are mostly found in greenhouses only. If there are more onion thrips found inside the greenhouse when the odour is used, the lure may be attracting thrips from outside.

This study was undertaken at a rose company. Over four sample periods during 2007/2008 traps with/without lure were hung up in the greenhouse and collected and replaced each week (a sample period consisted out of 4 weeks). The number of thrips was counted and identified to know how many thrips were captured and which species were caught. My contribution in the project was to get the thrips off the rose flowers (question 3) by rinsing the flowers and putting them on glass slides (mounting) for identification. Furthermore, I helped in the March trial, hanging up and collecting sticky traps with/without odour in the greenhouse, counting the thrips and getting the thrips off sticky traps. This project is ongoing.

Aphids in New Zealand.
New Zealand is known for its unique fauna and flora. However, due to the increasing international trade the possibility of introducing other insects and plants is increasing. This also holds for a small group of insects, the aphids. One of the projects running at *Crop and Food Research* at the moment is to make a collection of all aphids present in New Zealand (180 species in total). Secondly, it has been found that some native aphids are parasitized by introduced parasitoids. To protect these native aphids against extinction, one has to obtain more knowledge on this interaction to be able to find out how to protect these aphids. In both cases I helped collecting aphids from different areas such as the botanical gardens, environs of Lincoln, Porters pass, Lewis pass and Akaroa. Collecting was done (1) by visually examining a particular or all sorts of plant species, or (2) making use of a wooden stick, hitting the tree and catching all small insects present on a white tray which was held underneath. The collected aphids were taken to the lab and identified. This project is ongoing.

3. Personal experience

3.1 Learning goals

At the start of my internship I had set up some learning goals, hoping to improve them during my stay in New Zealand.

Interests: Crop protection (entomology) versus crop production (greenhouses). During my study I always struggled with my interests as I could not choose between the specialisations horticulture and entomology. I choose to specialise in horticulture, but later on I had my doubts. This internship, dealing more with entomology, gave me a great opportunity to find out what suits me better. Now, at the end of my internship, I really know that I am more interested in the entomology part and hope to use my last months at the university in specializing myself further in this area.

Furthermore, I got the opportunity to see if working in a research environment (like CFR) suits me better than working in the greenhouse industry. I really enjoyed working at a research company like Crop & Food where I was both in contact with local companies and doing laboratory work. After my graduation I hope to work in such a company, being able to do both research and being in close contact with industry/local companies.

Gaining more knowledge in Entomology. Working daily on insect-related topics definitely increased my knowledge in this area. Dealing a lot with thrips, I know a lot more about these small insects.

Improving research skills. I worked on a small project for which I had to write a proposal, carrying out experiments, analyse the results and (in the future) to write a journal article. This helped to improve my research skills.

Learning more about horticulture in New Zealand. During my internship I was able to see two greenhouse companies, one growing sweet pepper, and the other growing roses. As there was some greenhouse work in both companies, I was able to see how growers manage their produce and how it differs from Dutch growers. As expected, the greenhouse industry in New Zealand is much smaller than in the Netherlands. Furthermore, technology and new developments are far behind. Prices of flowers in the supermarket are minimally 3 times higher as in the Netherlands, but the quality is much lower. This is mainly caused by the high export rate of first quality products. Some of the New Zealand flowers and vegetables which are sold over here, would not have been sold in The Netherlands but thrown away. The people here accept a lower quality. In the Netherlands competition between growers is so high that quality is of major importance.

Improving language skills. During my stay in New Zealand, I hope to have improved both my English writing and oral skills.

3.2 Overall experience

My time at Crop and Food Research in New Zealand was great. Especially as the activities were so diverse. I got the freedom to help in different projects, giving me the opportunity to know what kind of research is done at a company like CFR. I was able to give my own input and ideas in certain projects and I got a small project of my own. By helping collecting aphids in different areas of New Zealand, I was also able to see more of the country.

Next to working in research projects I got the opportunity to attend the 57th annual conference of the Entomological Society of New Zealand, which was held at the University of Canterbury. Short presentations were given by researchers and PhD students about topics such as invasions, climate change, biosystematics and biosecurity. It was really interesting to

see New Zealand copes with aspects that we in the Netherlands do not have to. Principally as New Zealand has a unique fauna and flora.

Furthermore, I was allowed to attend meetings of the B3 programme (Better Border Biosecurity), giving me the opportunity to know how my small project is connected to other projects and what the overall goal is of this programme. When schoolchildren were visiting the entomology lab, I show them a small part of the research done at CFR.

I really did not expect that CFR would be so internationally orientated. Not only by having many connections with companies from overseas, but also the employees of CFR originate from different countries. The working atmosphere is great as everyone is very social, friendly, cooperative and always willing to help you.

All in all I can say that it was an amazing learning experience and I really would like to thank Crop and Food Research staff, in particular all people of the Entomology department for the opportunity to do this internship.

It was great, thanks!!!

Appendix I:
Detailed information about glues used

Glue	Symbol	Product Description	Manufacturer	Company recommendations/ purpose	Stickiness*
Tanglefoot	TF	Trapping adhesive	The Tanglefoot Company	Especially formulated to adhere to virtually any trapping surface	2
Horiver-TR	H	Glue on commercial sticky traps Glue based on artificial resins	Koppert *Biological systems.*	For monitoring purposes. Targets: Thrips and Sciarids.	3
Oecotak	O	Polybutene based glue	Oecos	Can be used on plastic traps. Oecotak sticky traps readily available.	3
Stikem Regular	S	Insect Trapping Adhesive	Seabright Laboratories	Can be applied on any surface, under which plastic traps (also readily available). Traps a variety of insects (including thrips)	3
Trappit	Tr	Insect barrier glue	Garrick Distributors Limited	Apply to the trunk of a tree or rose stem to prevent insects from travelling up into the canopy. Also trappit® yellow sticky traps available.	3
Thripstick II	TS	Water-based glue	Aquaspersions, UK	-	1
Water-based glue	W	Water-based glue			4

*Note: * Stickiness ranging from 1 (easy) to 3 (difficult). The stickier the more difficult to apply on traps.*

Appendix II:
Scoring criteria for assessing thrips specimens for morphological identification

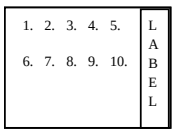
QUALITY JUDGEMENT THRIPS SPECIMEN *TRIAL I: February 2008*
Set of thrips: A

DATE:
TAXONOMIST:
TREATMENT: O

TREATMENT	SAMPLE	MORPHOLOGICAL FEATURES						
		Antennae	Head	Pronotum	Mesonotum	Forewings	Forelegs	Abdomen
O 1	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
O 2	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							
O 3	1							
	2							
	3							
	4							
	5							
	6							
	7							
	8							
	9							
	10							

Explanation
Each morphological feature in the table must be given a number between 1 - 4.
The definition of the numbers are outlined below.

Slide:



Grading	*Description*	Example: Antennae
1	Intact / complete	Both intact/complete
2	Some damage, but able to see character for identification.	One damaged or missing, but other fully intact so able to count number of segments, and/or see sense cones
3	Morphological feature not clearly visible or damaged	Both damaged or some antennal segments missing from both, so unable to count number of segments, and/or see sense
4	Absent	Both absent

Note: The quality varies between 1 (high quality) to 4 (low quality)

The individual scores for each feature for each thrips, and total number (sum of scores over all features for each thrips) will be analysed

The thrips are numbered 1-10 (see slide figure). Please use this order to fill in the form. If it is not possible to identify all 10 thrips on each slide, indicate which thrips you analysed.