



Mana Kai Rangahau

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**Onion thrips breeding dispersal in stores  
Milestone 4, projects 2.4 and 2.5**

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*Copy 20 of 20*

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# 1 *Executive summary*

If onion thrips fly from bins of heavily thrips infested bulbs to thrips-free bulbs and breed in them they lower their quality, reducing their value when they reach overseas markets. Dispersal and breeding of onions in stores is a significant concern for the onion industry.

A trial was set up to measure thrips movement in all parts of onion bins and stores, and to measure infestation of onion bulbs from migrating thrips. In each of the onion stores monitored we used five bins with two lines of onions – one with a 'high' level of infestation and one with a 'low' infestation. Yellow sticky traps were placed in 10 bins, on top of onions in bins, on the outside of bins, suspended between the two groups of bins, and suspended elsewhere in the store. The traps were replaced weekly for eight weeks. A sample of onions was taken from each bin at the start and end of the eight weeks.

The trial was run in three stores:

Onion store	Location	Monitoring dates
A S Wilcox & Sons Ltd	Patumahoe	14 February to 11 April 2001
RPD	Koraro Road, Mercer	28 February to 24 April 2001
May & Ryan	Pook Road, Pukekohe	28 March to 24 May 2001

The mean number of thrips per onion bulb and the percentage of infested onions declined during eight weeks' storage in four of the six lines in the trial. One line, ('May & Ryan, high thrips') in which thrips numbers increased, was a hybrid. This line had the highest incidence of infestation at the start and finish of the trial, 36 and 71%, respectively. This contrasts with 'Wilcox, high thrips' where there was an equally high initial incidence of infestation, which declined substantially during the eight weeks. In one line of late PLK ('RPD, low thrips') onion thrips populations also increased slightly during eight weeks' storage. Most live thrips were found near the base of the neck of each bulb between the first five live scales. Very few were deeper in the onion bulbs.

Thrips were found in all places where traps were placed. Some traps could not be read because they were thickly covered by flies. The downward trend in numbers of thrips trapped at the A S Wilcox store and slight upward trend at the RPD store were reflected in the changes in thrips numbers found in onion bulbs. Yellow sticky traps placed on top of onions within bins could be used as an effective method for monitoring thrips populations in onion stores. There was no evidence

***Results from this study suggest that onion thrips do not readily establish on and breed in Pukekohe Long Keeper onions.***

***Further research is required to test the relationship between trap catches and thrips infestation of onion bulbs in bins. They appear to be a practical option for monitoring thrips populations in onion stores.***

of significant cross infestation of onion bulbs from thrips flying from heavily infested bins to 'clean' onion bulbs in bins held in the same store.

## 1.1 *Recommendation*

That the practicality of using yellow sticky traps to monitor onion thrips populations in bins of onions be tested in the 2001-2002 growing season.

## 2 *Introduction*

After harvest, onions are kept under cover in stores before being graded and packed in bags, bins or containers for export or use within New Zealand. Onions may arrive in stores at various stages of maturity, and are kept prior to or after grading for varying periods of time. Some lines of onions arriving in the stores may be infested with onion thrips. There is concern that onion thrips may spread from bins of infested onions to lines of thrips-free onions, and that these new infestations can cause a loss of onion quality when the onions reach overseas markets.

This report describes a study designed to measure thrips movement over eight weeks within bins, on top of onions within a bin, on the outside of bins, between groups of bins and within onion stores. To measure contamination of onions, low and high thrips-infested lines were used within each of three onion stores, and thrips populations were assessed at the start and end of each eight week experiment.

## 3 *Methods*

### 3.1 *Onion stores and source of onions and assessment of thrips populations*

The following stores were used:

Onion store	Location	Monitoring dates
A S Wilcox & Sons Ltd	Patumahoe	14 February to 11 April 2001
RPD	Koraro Road, Mercer	28 February to 24 April 2001
May & Ryan	Pook Road, Pukekohe	28 March to 24 May 2001

The lines of onions used at each store are noted below. The decision on the categories of high and low levels of infestation was made by the store managers.

- A S Wilcox – high thrips: Kiwi gold, sown 17 June 2000, Karaka, hand clipped, harvested 28 January 2001

- A S Wilcox – low thrips: Kiwi gold, sown 17 June 2000, Karaka, hand clipped, harvested 24 January 2001
- RPD – high thrips: Early PLK (Cream gold) Weirs Block, Matamata, harvested 1 Feb 2001, mown before harvest, picked up by harvester with topper
- RPD – low thrips: Late PLK (cream gold) Wesley Road, Arapuni, near Cambridge, lifted with tops on, harvested 27 February, with long tops, still green and pipes present
- May & Ryan – high thrips: Hybrid (67/24) grown Pukekohe, hand clipped, harvested 17 March 2001
- May & Ryan – low thrips: ELK grown Pukekohe, hand clipped, harvested 20 January 2001.

In each onion store we used five bins of each of the two lines of onions. At the start of each experiment we took 20 onion bulbs from near the top of each bin. At the end of each experiment we took two lots of 20 onion bulbs from each bin. The onions were placed in labelled paper bags and 20 onions per bin were examined in the laboratory within a few days of collection. If thrips numbers were low a second sample of 20 onions was also examined.

The following was recorded from each onion:

1. the length of the onion neck,
2. the presence of live thrips from three locations (under the dead skin and on the first live scale, between the five outermost live scales and between the inner live scale), and
3. the amount of thrips feeding damage.

The data were summarised using a spreadsheet and tabulated.

### 3.2 *Sticky traps for measuring dispersal*

In each onion store yellow sticky traps were placed within bins, on top of onions in a bin, on the outside of bins, suspended between bins and suspended elsewhere within the store. A trap was placed inside plastic hydroponic tubing (150 x 75 mm) 0.8 or 1.0 m long, which was placed horizontally in each onion bin so that one end opened against a gap between the horizontal bin boards and the other end opened near the middle of the bin (Fig. 1). This end of the tube was cut on an angle so that the shorter bottom gave greater exposure of the trap to the onions. Onions were dug out of the bins so that the tube could be inserted and then the onions were put back. The tube was level with the second gap between bin planks from the top of the bin.

When all of the plastic tubes were in place and initial onion samples taken, the bins were arranged for the trial. The arrangement varied slightly between stores, but the five bins of each line were arranged together as in Figure 2, for example. The two onion lines studied were either parallel with enough space to walk between them or in the same row. In one store the 10 observation bins were moved from one part of a store room to another, and in

two stores other bins of onions were moved in and out of the store room during the eight week trial.

The yellow plastic traps were 240 x 200 mm. Both sides were covered with waxed paper which could be removed to expose the sticky surface. Either one or both of the sticky surfaces could be exposed. The traps were cut in half, 120 x 200 mm, for placement inside plastic tubes within the onion bins. Most traps had only one sticky surface exposed, but traps freely suspended between bins or away from shed walls had two sticky surfaces exposed. Where necessary, extra holes were punched along the edge of traps to aid attachment of string.

The traps inside the tubes and those lying on top of onions had strings attached that were tied to a map pin on the outside of the bins. The strings were used to recover the traps. The traps inside the tubes were initially pushed in place with a bamboo stake, but if they were sharply tapped they slid to the end of the tube. The traps on the outside of bins were held by map pins. String lines between bins were used to hang traps between bins while other suspension points were used to hang traps within the store. The traps were replaced weekly. The traps were covered with Gladwrap or put in clear plastic bags for transport to the laboratory.

To aid in the counting, parallel lines were drawn on the clear plastic covering the sticky surface(s) of each trap. Each trap was searched for thrips using a stereomicroscope. The total numbers of thrips per trap were recorded. All thrips were assumed to be onion thrips, but other species were present on the traps at May & Ryan where the bins were exposed to the outdoors on three sides. Some traps were densely covered with flies. Thrips could not be counted on these traps.

The data were entered into a spreadsheet, tabulated and graphed.



*Figure 1: A partly emptied bin of onions showing the plastic tube used to house the sticky trap sampling thrips inside the bin. The bottom of the tube is level with a gap between the planks forming the walls of the bin. After the photo was taken, onions were put back on top of the tube.*





Figure 2: A group of five bins with the yellow sticky traps used to catch onion thrips. Note the dark coloured traps are covered in flies.

## 4 Results and discussion

### 4.1 Thrips populations within onion bulbs

The mean number of thrips per onion bulb and the percentage of infested onions declined during eight weeks' storage in four of the six lines in the trial (Table 1). One line ('May & Ryan, high thrips'), in which thrips numbers increased, was a hybrid. This line had the highest incidence of infestation in bulbs at the start and finish of the trial, 36 and 71%, respectively. This contrasts with 'Wilcox, high thrips' where there was an equally high initial incidence of infestation, which declined substantially during the eight weeks of the trial.

The 'RPD' low thrips' line, which showed a small increase in thrips infestation during eight weeks in storage, was a late PLK crop. From the trial data it is not possible to tell if this increase was due to infestation from the high numbers of thrips in adjacent bins or to better survival and multiplication of the thrips already in the onions.

Table 1: Mean numbers of thrips per bulb, percentage infestation and numbers of thrips per infested bulb in six lines of onions before and after eight weeks' storage in commercial stores. Thrips infestations that increased during storage are highlighted with an asterisk and are in **bold\***.

Property	Line	Date in 2001	Mean number of thrips per bulb	Percentage of bulbs infested	Thrips per infested bulb
A S Wilcox & Sons	High thrips	14 Feb	1.09	45	2.42
		11 Apr	0.08	7	1.14
	Low thrips	14 Feb	0.31	14	2.21
		11 Apr	0.21	5	<b>4.20*</b>
RPD	High thrips	28 Feb	0.54	11	4.91
		24 Apr	0.31	11	2.91
	Low thrips	28 Feb	0.03	3	1.00
		24 Apr	<b>0.38*</b>	<b>10*</b>	<b>4.06*</b>
May & Ryan	High thrips	28 Mar	2.14	36	5.94
		23 May	<b>3.54*</b>	<b>71*</b>	4.99
	Low thrips	28 Mar	0.5	26	1.92
		23 May	0.04	4	1.00

Juvenile thrips (larvae and pupal stages) were present on onions after eight weeks in store showing that the thrips were able to breed in the bulbs (Table 2). Most thrips were found at the base of the neck of each bulb between the first five live scales (Table 3). Very few were found deeper within the onion. Some thrips were found under the dead skins on the first live scale of each bulb and this was the commonest site for the 'RPD, high thrips' onions.



## 4.2 *Thrips damage to bulbs*

*Table 2: The mean numbers of different life stages of thrips present on onion bulbs before and after storage for eight weeks.*

Property	Line	Date in 2001	Juvenile thrips	Adult thrips	Total thrips
A S Wilcox & Sons	High thrips	14 Feb	0.61	0.48	1.09
		11 Apr	0.04	0.04	0.08
	Low thrips	14 Feb	0.09	0.22	0.31
		11 Apr	0.04	0.17	0.21
RPD	High thrips	28 Feb	0.32	0.22	0.54
		24 Apr	0.03	0.50	0.30
	Low thrips	28 Feb	0.02	0.01	0.03
		24 Apr	0.22	0.16	0.38
May & Ryan	High thrips	28 Mar	1.98	0.16	2.14
		23 May	1.09	2.45	3.54
	Low thrips	28 Mar	0.15	0.35	0.5
		23 May	0	0.04	0.04

Table 3: Mean numbers of thrips found on different positions within the onion bulbs before and after eight weeks' storage.

Property	Line	Date in 2001	Under dead skins	Between 5 outer scale	Between 5 inner scale
A S Wilcox & Sons	High thrips	14 Feb	0.33	0.73	0.03
		11 Apr	0	0.08	0
	Low thrips	14 Feb	0.1	0.21	0
		11 Apr	0	0.14	0.07
RPD	High thrips	28 Feb	0.39	0.37	0.03
		24 Apr	0.20	0.10	0
	Low thrips	28 Feb	0	0.02	0.01
		24 Apr	0.12	0.26	0
May & Ryan	High thrips	28 Mar	0.01	1.88	0.25
		23 May	Nd	Nd	Nd
	Low thrips	28 Mar	0.01	0.48	0.01
		23 May	Nd	Nd	Nd

#### 4.3

### *Thrips dispersal*

Thrips were found on traps in all positions (Appendix I) (Figs 3-5). It is not possible to compare the data on thrips numbers between stores because of their different layout, the positioning of the 10 monitored bins, the different temperature regimes and the contamination in one store by other species of thrips.

The sticky trap data from A S Wilcox's onion store show a strong downward trend in catches (Fig. 3), which is reflected in the decline in the numbers of thrips found in the onions after eight weeks' storage (Table 1). More thrips were found on the traps associated with the high thrips line than the low thrips line except for 'on top, low thrips', which had the highest counts for most dates.

The numbers of thrips caught on sticky traps in the RPD store remained similar over the eight weeks or showed a slight upward trend (Fig. 4). This is reflected in the similar thrips population (high thrips line) or increased numbers of thrips (low thrips line) found after eight weeks' storage. A relatively high proportion of traps in this store were thickly covered in flies and so thrips could not be counted.

It is difficult to interpret the May & Ryan data because, unlike the other stores, the bins were exposed to the outside and strong winds. Because of this, traps were contaminated with other species of thrips and so trap catches may not closely reflect the group of bins with which they are associated. However, during the last few weeks, more thrips were caught on the traps on top of high thrips bins than on the low thrips bins (Fig. 5).

Some traps were covered thickly with flies and so thrips could not be counted. This tended to be associated with particular bins or positions within the store. If more bins had been available it would have been better to monitor bins with fewer flies. The process of putting out the traps and reading them was relatively quick. The most convenient place for traps was on top of onions within the bins. In this trial, three out of five traps in this position were exposed to the onion store and the catch could be influenced by other sources of thrips in the store. In a stack of bins in a typical onion store traps on top of onions in bins would be covered by the next bin in the stack and catches should be more representative of the bins.

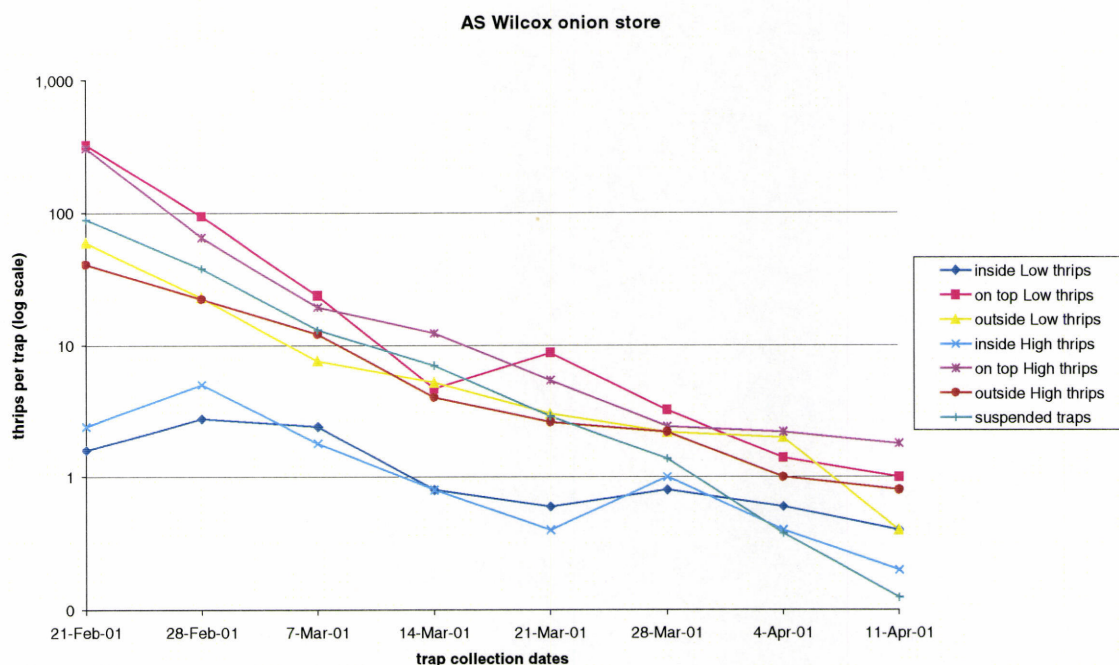


Figure 3: Mean number of onion thrips caught each week on yellow sticky traps at different locations in the onion store, A S Wilcox and Sons, Patumahoe.

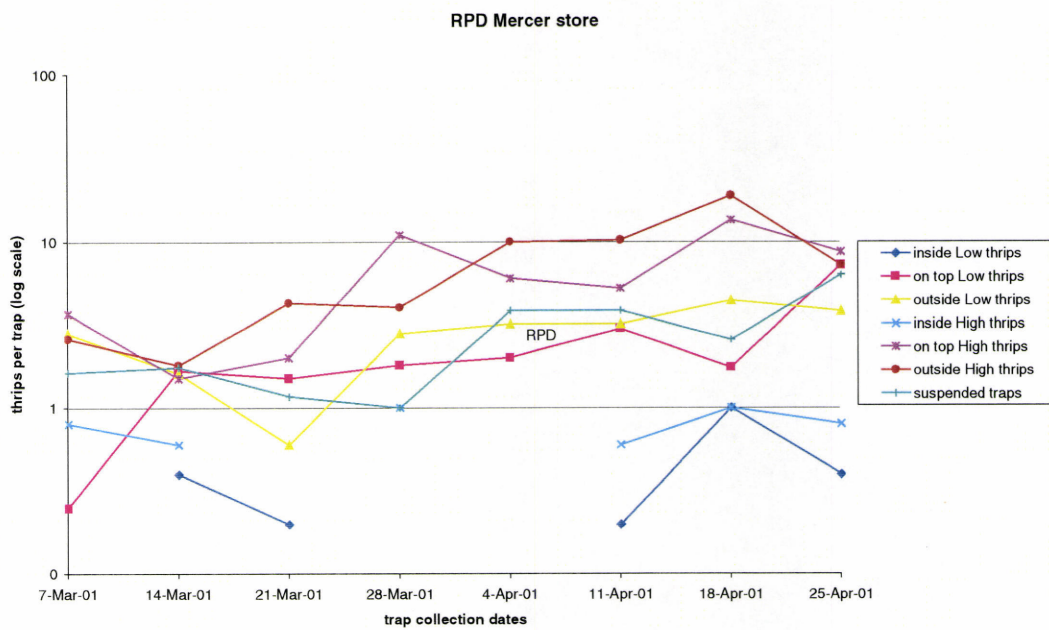


Figure 4: Mean number of onion thrips caught each week on yellow sticky traps at different locations in the onion store, RPD, Mercer.

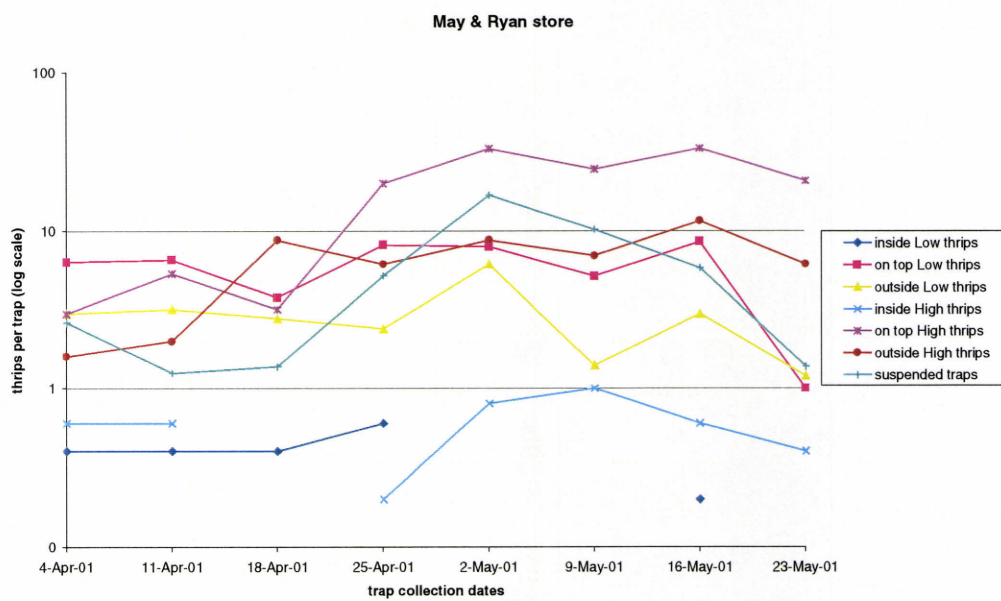


Figure 5: Mean number of onion thrips caught each week on yellow sticky traps at different locations in the onion store, May & Ryan, Pook Road, Pukekohe.

## 5 *Discussion and conclusions*

### 5.1 *Movement of thrips and infestations of onion in the store*

This project has shown that live onion thrips were found in all parts of an onion store containing bins of onions. In general, the thrips infestation in PLK onions declined during storage, though not to levels that made detection difficult. Increased populations were found in two lines of onions: one was a late PLK type and the other was a hybrid. The small increase in the PLK population could have been due to either infestation from the adjacent high thrips line or to multiplication of thrips already in the bulbs. On the other hand, the increased population of thrips in the hybrid line must be due to the hybrid being a more favoured host for the thrips.

While it is a sensible precaution to keep heavily infested onion away from 'clean' lines, this study and other projects this summer indicate that onion thrips do not readily establish on and breed in PLK onions.

### 5.2 *Potential for sticky traps as a monitoring tool*

It would be useful to identify lines of onions with high numbers of thrips prior to storage or before grading. It is also important to know the levels of thrips infestation prior to shipment. Ideally, onions should be sampled for onion thrips infestation prior to harvest or arrival in the onion store, after grading and before shipping. However, it is time consuming to cut up and inspect 100 onion bulbs, let alone the 500 to 600 needed to show a 'nil' infestation. This year's research with yellow sticky traps in onion stores indicated that these traps may be a useful tool for detecting bins/lines of onions with high levels of thrips infestation and could also be used to show if thrips infestations are declining or increasing during storage.

This project has demonstrated that thrips were caught on traps placed in the middle of bins, on top of onions in bins and on the outside of bins. The most convenient place to sample thrips is on traps placed on top of onions in the bins. By using traps with a length of string attached it is easy to push traps through the gaps used by fork lifts and to recover the traps after a week. Further research is required to test the relationship between trap catches and thrips infestation of onion bulbs in the bins. However, use of sticky traps appears to be a practical option. Several bins in a stack can be monitored continuously; we recommend at least 10 traps per line per week, and avoiding bins with many flies. The traps are quick to replace and inspect for thrips; only one species is present and it is easy to train staff to recognise thrips. A low power stereo microscope is required and can be used to examine other pest or plant samples.



### 5.3 *Recommendation*

- That the practicality of using yellow sticky traps to monitor onion thrips in onion bins be tested during the 2001-2002 growing season

## 6 *Acknowledgements*

We thank John Thacker and Richard Wood for organising the onion stores; staff of A S Wilcox & Sons (Brent Wilcox, Paul Kopeck, Andrew Tomkins), RPD (Jamie Chapman) and May & Ryan (Grant Ryan) for assistance with setting up the trials, and accommodating our requirements and the disruption they caused to normal store management; Lydia Huggard and Jan Elliot for technical assistance.

# *Appendices*

## *Appendix I*

**Summary of onion store data**

Onion store trials  
pre trial sample

20 onions per bins  
5 bins per line  
2 lines of onions

Total number of onions per line  
total number of onions per shed

100  
200

a = adult thrips  
j = juvenile thrips (larvae and pupae)

Store AS Wilcox

11-Apr-01

Mean number of thrips per bulb

High thrips	Bin	neck length (mm)	under dead		between outer 5		inner 5		all thrips stages		Total Thrips infestation	bulb infestation	thrips per infested bulb
			skin	j	a	j	a	under dead skin	between outer 5 scale	inner 5 scale			
mean per bin	1	46.75	0	0	0	0.05	0	0	0	0	0.05	0.05	1
	2	41.8	0	0	0	0	0	0	0	0	0.05	0.05	1
	3	48	0	0	0	0.05	0	0	0	0	0.1	0.1	1
	4	44	0	0	0	0	0	0	0	0	0	0	#DIV/0!
	5	32	0	0	0	0.1	0	0	0	0.1	0.2	0.15	1.33
mean per line		42.51	0	0	0	0.04	0	0	0	0.04	0.08	0.07	1.14

low thrips

low thrips	Bin	neck length (mm)	under dead		between outer 5		inner 5		Total thrips		Total Thrips infestation	bulb infestation	thrips per infested bulb
			skin	j	a	j	a	under dead skin	between outer 5 scale	inner 5 scale			
mean per bin	1	55	0	0	0	0.2	0	0	0.35	0	0.75	0.15	6.33
	2	64	0	0	0	0	0	0	0	0	0.1	0.1	1
	3	73.5	0	0	0	0	0	0	0	0	0	0	#DIV/0!
	4	63	0	0	0	0	0	0	0	0	0	0	#DIV/0!
	5	52.65	0	0	0	0	0	0	0	0	0	0	#DIV/0!
mean per line		61.63	0	0	0	0.04	0	0	0.07	0	0.17	0.05	4.2



C h r e a s e r p o o f t h e i d q p e n u a s s

Onion store trials Post trial sample	20 onions per bins 5 bins per line 2 lines of onions		Total number of onions per line total number of onions per shed		100 200												
	Store	RPD Mercer	24-Apr-01	Mean number of thrips per bulb	neck length (mm)	under dead skin	between outer 5 scale	a	inner 5 scale	j	a	all thrips stages under dead skin	between outer 5 scale	inner 5 scale	adults	Total Thrips infestation	bulb infestation
mean per bin	1	72	0.05	0.15	0.05	0.15	0	0	0.2	0.2	0.2	0.2	0	0.3	0.4	0.15	2.67
	2	103.5	0	0.7	0	0.05	0	0	0.7	0.05	0.7	0.05	0	0.75	0.75	0.1	7.5
	3	110.75	0	0.05	0	0	0	0	0.05	0	0.05	0	0	0.05	0.05	0.05	1
	4	108.5	0	0	0.05	0	0	0	0	0.05	0	0	0	0.05	0.05	0.05	1
	5	85.5	0	0.15	0	0.1	0	0	0.15	0.1	0.15	0.15	0	0.25	0.25	0.15	1.67
mean per line		96.05	0.01	0.21	0.02	0.06	0	0	0.22	0.08	0.22	0.08	0	0.27	0.3	0.1	3

low thrips	under dead skin		between outer 5 scale		inner 5 scale		Total thrips under dead skin		between outer 5 scale		inner 5 scale		adults		Total Thrips infestation		thrips per infested bulb	
	Bin	neck length (mm)	a	j	a	j	a	j	a	j	a	j	a	j	juveniles	Thrips infestation	bulb infestation	thrips per infested bulb
mean per bin	1	120	0	0.6	0	0.05	0	0	0.6	0.05	0	0	0.65	0	0.65	0.15	4.33	
	2	108	0.05	0.1	0.15	0	0	0.15	0.15	0.15	0	0	0.1	0.2	0.3	0.1	3	
	3	120	0	0	0.2	0.05	0	0	0.25	0.25	0	0	0.05	0.2	0.25	0.2	1.25	
	4	101.25	0	0.15	0.25	0.05	0	0.15	0.3	0.3	0	0	0.2	0.25	0.45	0.15	3	
	5	126	0	0	0	0	0	0	0	0	0	0	0	0	0	0	#DIV/0!	
mean per line		115.05	0.01	0.17	0.12	0.03	0	0.18	0.15	0.15	0	0	0.2	0.13	0.33	0.12	2.75	



u r e s e r p o o f t u i d t q p e u a s s

Onion store trials Post trial sample	20 onions per bins 5 bins per line 2 lines of onions	Total number of onions per line total number of onions per shed	100 200											
			a = adult thrips	j = juvenile thrips (larvae and pupae)										
Store RPD Mercer sample date 24-Apr-01	Second sample examined Mean number of thrips per bulb	7-8 May 2001												
High thrips	neck length (mm)	under dead skin	between outer 5 scale	inner 5 scale	all thrips stages under dead skin	a	j	between outer 5 scale	inner 5 scale	adults	juveniles	bulb infestation	bulb	thrips per infested bulb
mean per bin	1	0	0.2	0.05	0	0.2	0	0.25	0	0.4	0.05	0.2	0	2.25
	2	0	0	0	0	0	0	0	0	0	0	0	0	#DIV/0!
	3	0	0.3	0.1	0.25	0	0.3	0.35	0	0.55	0.1	0.25	0	2.6
	4	0	0	0.05	0	0	0	0.05	0	0	0.05	0.05	0	1
	5	0	0.4	0	0	0.4	0	0	0	0.4	0	0.05	0	8
mean per line		0	0.18	0.04	0.09	0	0.18	0.13	0	0.27	0.04	0.11	0	2.82

low thrips	neck length (mm)	under dead skin	between outer 5 scale	inner 5 scale	Total thrips under dead skin	a	j	between outer 5 scale	inner 5 scale	adults	juveniles	bulb infestation	bulb	thrips per infested bulb
mean per bin	1	0	0.15	0	0.15	0	0	0	0	0.15	0	0.1	0.1	1.5
	2	0	0	1.45	0	0.15	0	1.6	0	0.15	1.45	0.1	0.1	16
	3	0	0	0.05	0	0.15	0	0.15	0	0.15	0	0.05	0.05	4
	4	0	0.05	0.05	0.1	0	0.05	0.15	0	0.15	0.05	0.15	0.15	1.33
	5	0	0	0	0	0	0	0	0	0	0	0	0	#DIV/0!
mean per line		0	0.04	0.3	0.08	0	0	0.38	0	0.12	0.31	0.08	0.08	5.38

C O U R S E R P O O F Ø T U E I D A Q P E U N S

Onion store trials pre trial sample		20 onions per bins 5 bins per line 2 lines of onions		Total number of onions per line total number of onions per shed		100 200										
Store May & Ryan sample date 28-Mar-01		Mean number of thrips per bulb		a = adult thrips		j = juvenile thrips (larvae and pupae)										
High thrips	Bin	neck length (mm)	under dead skin		between outer 5 scale		inner 5 scale		all thrips stages		Total Thrips infestation	bulb	thrips per infested bulb			
			a	j	a	j	a	j	adults	juveniles				inner 5 scale	bulb	
mean per bin	1	11.15	0	0.05	0	4.25	0.35	0.05	0	0	0.05	0.35	4.65	0.05	0.4	11.75
	2	13.4	0	0	0	0.9	0.25	0.25	0	0	1.15	0.25	1.15	0.25	0.45	3.11
	3	17.35	0	0	0	0.95	0.05	0.25	0	0	1.2	0.05	1	0.25	0.3	4.17
	4	12.75	0	0	0	1.5	0.5	0.15	0	0	1.65	0.5	2	0.15	0.5	4.3
	5	15.75	0	0	0	1	0.1	0.1	0	0	1.1	0.1	1.1	0.1	0.15	8
mean per line		14.08	0.01	0	0	1.72	0.25	0.16	0	0	1.88	0.25	1.98	0.16	0.36	5.94

low thrips		Total thrips per bulb		100 200												
mean per bin	Bin	neck length (mm)	under dead skin		between outer 5 scale		inner 5 scale		all thrips stages		Total Thrips infestation	bulb	thrips per infested bulb			
			a	j	a	j	a	j	adults	juveniles				inner 5 scale	bulb	
	1	22	0	0	0	0.1	0	0.1	0	0	0.2	0	0.1	0.1	0.15	1.33
	2	22	0	0	0	0.25	0	0.35	0	0	0.6	0	0.25	0.35	0.2	3
	3	22.25	0	0	0	0.1	0	0.4	0	0	0.5	0	0.1	0.4	0.3	1.67
	4	29.75	0.05	0	0	0.1	0	0.8	0	0.05	0.9	0.05	0.15	0.85	0.5	2
	5	15.7	0	0	0	0.15	0	0.05	0	0	0.2	0	0.15	0.05	0.15	1.33
mean per line		22.34	0.01	0	0	0.14	0	0.34	0	0	0.48	0.01	0.15	0.35	0.26	1.92

Onion store trials pre trial sample		20 onions per bins 5 bins per line 2 lines of onions		Total number of onions per line total number of onions per shed		100 200						
Store May & Ryan sample date		23-May-01		a = adult thrips j = juvenile thrips (larvae and pupae)								
High thrips		Mean number of thrips per bulb		all thrips stages								
Bin	neck length (mm)	under dead skin	j	between outer 5 scale	inner 5 scale	between outer 5 scale	inner 5 scale	juveniles	adults	Total Thrips infestation	bulb infestation	thrips per infested bulb
mean per bin	1 15	3.05	6.85	0	0	0	0	3.05	6.85	9.9	1	9.9
	2 9.25	1.05	1.9	0	0	0	0	1.05	1.9	2.95	0.8	3.69
	3 26.4	0.15	0.75	0	0	0	0	0.15	0.75	0.9	0.4	2.25
	4 18.5	0.55	2.05	0	0	0	0	0.55	2.05	2.6	0.75	3.47
	5 13.6	0.65	0.7	0	0	0	0	0.65	0.7	1.35	0.6	2.25
mean per line	16.55	1.09	2.45	0	0	0	0	1.09	2.45	3.54	0.71	4.99

low thrips		Total thrips per bulb		all thrips stages								
Bin	neck length (mm)	under dead skin	j	between outer 5 scale	inner 5 scale	between outer 5 scale	inner 5 scale	juveniles	adults	Total Thrips infestation	bulb infestation	thrips per infested bulb
mean per bin	1 19.75	0	0	0	0	0	0	0	0	0	0	#DIV/0!
	2 19.6	0	0	0	0	0	0	0	0	0	0	#DIV/0!
	3 25.25	0	0	0	0	0	0	0	0	0	0	#DIV/0!
	4 25	0	0.15	0	0	0	0	0	0.15	0.15	0.15	1
	5 19.1	0	0.05	0	0	0	0	0	0.05	0.05	0.05	1
mean per line	21.74	0	0.04	0	0	0	0	0	0.04	0.04	0.04	1

## Appendix II

### Summary of onion thrips sticky trap data

Table A: Mean number of onion thrips per readable yellow sticky trap from the A S Wilcox & Sons onion store. Traps set up on 14 February 2001 and changed weekly.

Line of onions	Position of trap	trap collection dates	21-Feb-01	28-Feb-01	7-Mar-01	14-Mar-01	21-Mar-01	28-Mar-01	4-Apr-01	11-Apr-01
Low thrips	inside	1.60	2.75	2.40	0.80	0.60	0.80	0.60	0.60	0.40
	on top	326.40	94.33	24.00	4.67	8.75	3.20	1.40	1.40	1.00
	outside	60.20	23.20	7.60	5.20	3.00	2.20	2.00	2.00	0.40
high thrips	inside	2.4	5	1.8	0.8	0.4	1	0.4	0.4	0.2
	on top	307.20	65.40	19.60	12.40	5.40	2.40	2.20	2.20	1.80
suspended traps	outside	41.40	22.60	12.20	4.00	2.60	2.20	1.00	1.00	0.80
	traps	89.25	38.38	13.13	7.00	2.88	1.38	0.38	0.38	0.13

Table B: Mean number of onion thrips per readable yellow sticky trap from the RPD onion store. Traps set up on 28 February 2001 and changed weekly.

Lines of onions	Trap position	trap collection dates							
		7-Mar-01	14-Mar-01	21-Mar-01	28-Mar-01	4-Apr-01	11-Apr-01	18-Apr-01	25-Apr-01
Low thrips	Inside	0.00	0.40	0.20	0.00	0.00	0.20	1.00	0.40
	on top	0.25	1.67	1.50	1.80	2.00	3.00	1.75	7.20
high thrips	Outside	2.80	1.60	0.60	2.80	3.20	3.20	4.40	3.80
	Inside	0.8	0.6	0	1	0	0.6	1	0.8
Suspended traps	on top	3.67	1.50	2.00	11.00	6.00	5.25	13.50	8.67
	outside	2.60	1.80	4.25	4.00	10.00	10.25	19.00	7.20
		1.63	1.75	1.17	1.00	3.83	3.83	2.57	6.29



Table C: Mean number of onion thrips per readable yellow sticky trap from the May & Ryan onion store. Traps set up on 28 March 2001 and changed weekly.

Lines of onions	Trap position	trap collection dates									
		4-Apr-01	11-Apr-01	18-Apr-01	25-Apr-01	2-May-01	9-May-01	16-May-01	23-May-01		
Low thrips	Inside	0.40	0.40	0.40	0.60	0.00	0.00	0.20	0.00		
	on top	6.40	6.60	3.80	8.20	8.00	5.20	8.60	1.00		
high thrips	Outside	3.00	3.20	2.80	2.40	6.20	1.40	3.00	1.20		
	Inside	0.6	0.6	0	0.2	0.8	1	0.6	0.4		
suspended traps	on top	3.00	5.40	3.20	20.00	33.20	24.60	33.40	20.80		
	outside	1.60	2.00	8.80	6.20	8.80	7.00	11.60	6.20		
		2.63	1.25	1.38	5.25	16.88	10.25	5.88	1.38		

Table D: Number of readable yellow sticky traps in the A S Wilcox & Sons onion store.

		trap collection dates							
		7-Mar-01	14-Mar-01	21-Mar-01	28-Mar-01	4-Apr-01	11-Apr-01	18-Apr-01	25-Apr-01
low thrips	inside	5	4	5	5	5	5	5	5
	Low thrips								
	on top	5	3	3	3	4	5	5	5
high thrips	Low thrips								
	outside	5	5	5	5	5	5	5	5
	Low thrips								
suspended traps	inside	5	3	5	5	5	5	5	5
	High thrips								
	on top	5	5	5	5	5	5	5	5
suspended traps	High thrips								
	outside	5	5	5	5	5	5	5	5
	High thrips								
suspended traps		8	8	8	8	8	8	8	8

Table E: Number of readable yellow sticky traps in the RPD onion store.

		trap collection dates							
		7-Mar-01	14-Mar-01	21-Mar-01	28-Mar-01	4-Apr-01	11-Apr-01	18-Apr-01	25-Apr-01
low thrips	inside	5	5	5	5	5	5	5	5
	Low thrips								
	on top	4	3	4	5	5	4	4	5
high thrips	Low thrips								
	outside	5	5	5	5	5	5	5	5
	Low thrips								
suspended traps	inside	5	5	5	5	5	5	5	5
	High thrips								
	on top	3	2	2	3	4	4	2	3
suspended traps	High thrips								
	outside	5	5	4	3	4	4	4	5
	High thrips								
suspended traps		8	4	6	5	6	6	7	7

Table F: Number of readable yellow sticky traps in the May & Ryan onion store.

		trap collection dates							
		7-Mar-01	14-Mar-01	21-Mar-01	28-Mar-01	4-Apr-01	11-Apr-01	18-Apr-01	25-Apr-01
low thrips	inside	5	5	5	5	5	5	5	5
	Low thrips								
	on top	5	5	5	5	5	5	5	5
high thrips	Low thrips								
	outside	5	5	5	5	5	5	5	5
	Low thrips								
suspended traps	inside	5	5	5	5	5	5	5	5
	High thrips								
	on top	5	5	5	5	5	5	5	5
suspended traps	High thrips								
	outside	5	5	5	5	5	5	5	5
	High thrips								
Total		8	8	8	8	8	8	8	8