MONITORING ONION CROPS FOR ONION THRIPS, *THRIPS TABACI*

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ABSTRACT

Onion thrips, *Thrips tabaci* (Thysanoptera: Thripidae), is the main insect pest on New Zealand onions. The onion industry recommends monitoring 50 or 100 plants in 10 or 20 groups of 5 plants and applying a cluster of insecticides when populations reach 0.1 thrips/plant. The robustness of these guidelines was tested by monitoring six crops before and after the first cluster of insecticides. Two people each recorded the numbers of adult and larval thrips in each crop on each occasion using the following strategies: (1) 100 randomly stratified plants, (2) 20 groups of five plants randomly selected from 1 m^2 and (3) 20 groups of five adjacent plants, giving a total of 300 plants sampled. When sampling 100 plants, estimates of thrips/plant were similar for each of the three sampling strategies. However, to obtain a particular level of precision, fewer plants could be sampled using stratified randomly selected plants than groups of five plants.

Keywords: crop sampling, action thresholds, onion thrips, onions.

INTRODUCTION

Onion thrips (*Thrips tabaci* Lindeman (Thysanoptera: Thripidae)) are the main insect damaging onions (*Allium cepa* L.) in New Zealand. Uncontrolled infestations cause loss of green leaf tissue and yield (Edelson et al. 1989). In addition, onion thrips feeding on onion bulbs lower quality and value for export, and have been an important issue for New Zealand onion exporters since 1997 (Wood 2001). After onion thrips resistant to synthetic pyrethroid insecticides were found in New Zealand in 1998, a series of industry-led research projects were undertaken to improve thrips control. One outcome from the early research was an onion industry 'best guess' monitoring method and action threshold. If a threshold of 0.1 thrips/plant from a 50 or 100 plant sample was exceeded then an application a cluster of insecticide sprays was used (Martin 2005). However, the recommendations do not give guidance on the maximum size of the area for each 50 or 100 plant sample and there is varied interpretation of the instructions. Also the action threshold of 0.1 thrips/plant is much lower than thresholds used overseas, e.g. three thrips/onion leaf (Shelton et al. 1987), one thrips/leaf (Edelson et al. 1989) and 4-15 thrips/plant depending on onion plant growth stage (Bird et al. 2004).

A pilot project in 2002 examined the distribution of onion thrips in onion crops at the beginning of the season when populations are close to the New Zealand action threshold. The data indicated that a stratified random sampling method would be necessary to detect the influence of crop boundaries on the initial distribution of thrips within crops. This paper reports on the preliminary results comparing three sampling methods in six onion crops before and after the first cluster of insecticides was applied.

METHODS

Six onion crops were monitored in South Auckland after growers had found the first onion thrips in their crops (Table 1). The crops were monitored before and after the first cluster of insecticide sprays. Plants sampled were selected randomly from 20 plots/crop. The position of each sample plant was defined by the bed number (area between tractor wheels), the plant row number per bed (eight rows/bed) and the distance from the end of the row (to the nearest metre). Random numbers were generated using Microsoft® Office Excel to define plant sample locations. On each occasion, two people independently monitored a crop using each of three monitoring methods: (1) 100 randomly selected plants (five plants sampled/plot), (2) 20 groups (one group/plot) of five plants chosen randomly from within a 1 metre radius of the location, and (3) 20 groups (one group/plot) of five plants adjacent to each other in a row.

TABLE 1: Dimensions and dates of onion crops monitored in South Auckland in 2005.

Property	Dimensions of area monitored	Area (ha)	Plot size (m)	1st sample	2nd sample	Insecticides[1]
Aka aka	58 beds, 140 m long	1.40	20×35	12 Oct	29 Nov	methamidophos ×3
Calcutta Rd	50 beds, 132 m long	1.14	17×33	25 Oct	14 Dec	methamidophos ×3 alphacypermethrin ×1
B Jivan SW	65 beds, 264 m long	2.96	22×66	13 Oct	17 Nov	methamidophos ×3
Philburn	40 beds, 120 m long	0.83	14×30	7 Nov	13 Dec	methamidophos ×4 imidacloprid ×1
Stuart Rd	36 beds, 275 m long	1.71	16×55	28 Oct	1 Dec	methamidophos ×3 alphacypermethrin ×1
Walker, Pdk3	40 beds, 300 m long	2.07	17× 60	14 Nov	23 Dec	chlorpyrifos ×2 imidacloprid ×2

[1]Insecticides applied between first and second crop sampling.

RESULTS

Based on the data from the 600 plants sampled in each crop, two of the six crops had initial populations below the 0.1 thrips/plant action threshold (Fig. 1). After the application of a cluster of insecticides to all six crops, the populations in one crop decreased and the other five crops increased. In particular two crops had over 1.4 thrips/plant.

For estimates of numbers of thrips/plant based on 100 plants, method 2 (groups of five random plants) was closest to the means based on 600 plants (lowest mean squared error or MSE) and tended to give a slightly more consistent estimate (lower SE) than the other methods (Table 2). Method 1 (100 random plants) tended to give a higher estimate, hence the positive bias. For estimates of the percentage of plants infested with thrips based on 100 plants, both methods 1 and 2 had similar MSEs, with method 1 tending to give higher estimates than method 2 (Table 2). Both methods were similarly consistent (similar SEs).

Agreement between the assessors was inspected using Bland-Altman plots. There was no evidence of systematic differences in estimates between the two assessors ($P=0.161$ to 0.942 (blocked by site and date) for the six combinations of method and date). The coefficient of variability between assessors using the same monitoring scheme on the same site at the same date indicated that estimates tended to be closer when using method 1 (35.2% for numbers of thrips/plant and 19.9% for percentage of infested plants) or method 2 (28.7% and 22.4%) than method 3 (50.0% and 36.1%).

Based on 100 plant samples, decisions to spray or not based on four different action thresholds were compared with a cross-validated estimate of the true level of infestation (based on the other 500 plants from that site at that date). Decisions were most often

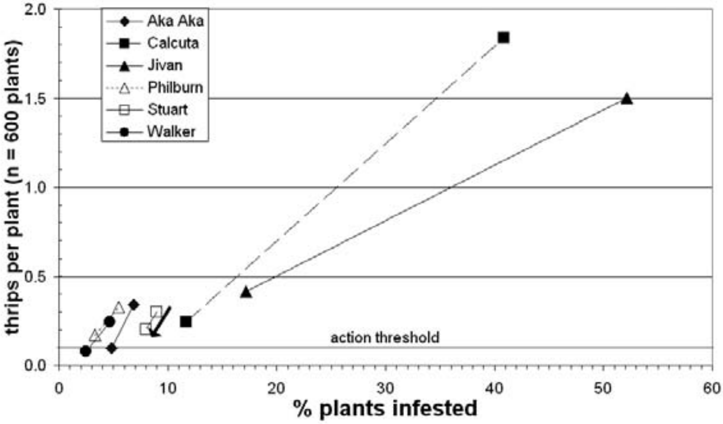

FIGURE 1: Relationship between no. onion thrips/plant and percentage plant infestation in six onion crops before and after the first cluster of insecticide sprays. Note that the population increased after spraying in five crops and declined in one crop (indicated by arrow).

TABLE 2: Mean Squared Errors (MSE), Bias and Standard Errors (SE) of estimates of thrips per onion plant and proportion of infested onion plants based on 100 plant samples compared to 600 plant samples.

	Thrips/plant			Percentage of infested plants		
Sampling method	MSE[1]	Bias[2]	SE[3]	MSE	Bias	SE
100 random plants	266	0.85	3.40	6.41	0.83	0.50
20 groups of five random plants	153	-0.49	2.58	6.78	0.21	0.54
20 groups of five adjacent plants	408	-0.36	4.21	13.86	-1.04	0.75

[1]MSE=mean squared difference between individual estimate and mean of all six assessments for that site at that date.
[2]Bias=mean difference between individual estimate and mean of all six assessments for that site at that date.
[3]SE=variability of differences.

'incorrect' for thresholds of 0.2 and 0.3 thrips/plant (Table 3). In part, this was because at a threshold of 0.1 the thrips populations were such that most estimates were above the threshold, while at a threshold of 0.4, most estimates were below, and so correct classification was easier. Method 2, the groups of five random plants, had lower misclassification rates than the other monitoring schemes at all thresholds.

There was a strong relationship between the percentage of plants infested and the numbers of thrips/plant, with r^2 values of 0.87, 0.85 and 0.77 for each method, respectively. However, this is driven by the very high thrips numbers in the later sampling at crop sites Jivan and Calcutta, and the relationship is much weaker for less than 0.5 thrips per plant.

TABLE 3: Misclassifications (based on cross-validated estimates of the true level of infestation) of whether thrips populations are above or below various action thresholds.

Action threshold (thrips/plant)	Error type	Sampling method: 100 random plants	Groups of five random plants	Groups of five adjacents plants
0.1	False Positive	13%	0%	4%
	False Negative	13%	8%	25%
0.2	False Positive	13%	8%	8%
	False Negative	25%	21%	29%
0.3	False Positive	17%	8%	21%
	False Negative	17%	17%	17%
0.4	False Positive	21%	13%	21%
	False Negative	4%	0%	4%

When estimating the mean number of thrips per individual plant, fewer single plant samples (method 1) are required for a particular level of precision than groups of five plants (methods 2 and 3) (Fig. 2). For example, a random sample of 80 plants had a 95% confidence interval of ± 15% of the mean whereas to obtain an estimate with the same level of confidence using method 2, 200 plant samples (40 sets of 5) were required.

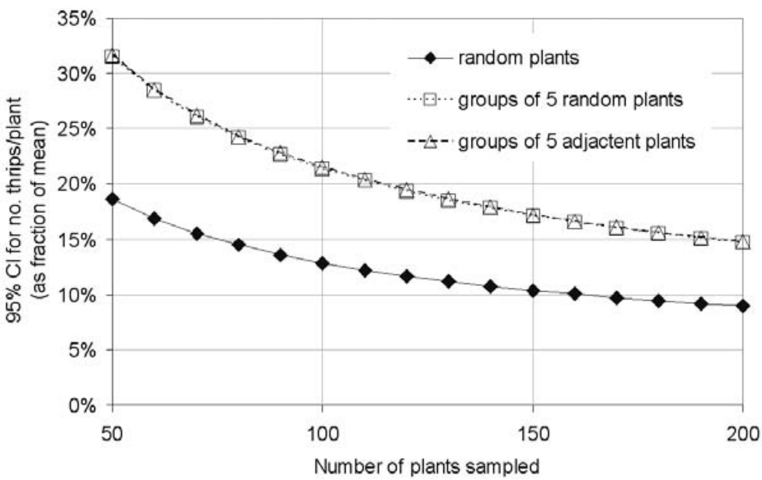

FIGURE 2: Relationship between the number of onion plants sampled and the sampling error (95% confidence interval (CI) as a percentage of the mean) of the mean number of thrips/plant for the three sampling methods.

DISCUSSION

The current recommendation of sampling 20 groups of five plants provides similar estimates of thrips populations as 100 randomly selected plants, though they may give a slight underestimate (Table 2). However, it is better that the plants in a group of five are selected randomly in a 1 m radius from the sample point than if they are selected as a group of five adjacent plants. It is also reassuring that two experienced assessors or crop scouts obtained similar results. The relationship between the proportion of plants infested and the mean number of thrips per plant was too variable for a presence-absence sampling method to be practical for onion thrips on onions.

The key issues are (1) how many onion plants should be examined to have a reasonable chance of making the correct decision about whether to spray or not? and (2) is the existing action threshold appropriate? The monitoring data show that for a particular level of precision, fewer plants need to be examined when plants are selected by stratified random sampling than when selected in groups of five (Fig. 2). However, it may be quicker to walk to fewer areas of the crop and sample more groups of five plants than to more places to sample individual plants, i.e. 40 groups of five (200 plants) compared with 80 single plants.

The action threshold of 0.1 thrips/plant was arbitrarily set at a time when the industry was experiencing major problems with field control of thrips and contamination of onion bulbs (Wood 2001). In North America action thresholds are much higher, e.g. three thrips/onion leaf (Shelton et al. 1987), one thrips/leaf (Edelson et al. 1989) and 4-15 thrips/plant depending on onion plant growth stage (Bird et al. 2004). This may be related to different sowing times or markets for the bulbs.

Canadian and Northern USA onions are sown in spring, whereas New Zealand crops are sown from late autumn (May) to early spring (September). This means that New Zealand crops are vulnerable to infestation by onion thrips over a much longer period, from late May after early crop seedlings emerge, although there is a period from mid-June until mid-August when onion thrips do not fly (N.A. Martin, unpubl. data) possibly because maximum day temperatures are too cold for onion thrips flight. There is potential for a build up of thrips within a crop over a long period in the spring with early infestation from outside the crop or from thrips overwintering in bulbs left from a previous crop. This may be why populations can reach levels of more than 300 thrips/plant if untreated (P.J. Workman & N.A. Martin, unpubl. data) compared with only 60-70 thrips/plant in untreated Canadian crops (MacIntyre-Allen et al. 2005).

In New Zealand, the primary concern for thrips control is preventing thrips contamination of onion bulbs (Wood 2001), but no relationship has been found between numbers of thrips on plants prior to harvest and numbers on bulbs after harvest. However, the susceptibility of bulbs to onion thrips is influenced by both genetic (cultivar selection) and agronomic (nitrogen fertiliser) factors (Martin & Workman 2006). Now that there is a greater selection of insecticides available (Wood 2001) and an ability to reduce field populations (Fig. 1), there may be scope to raise the action threshold and reduce the number of insecticide applications to onion crops.

ACKNOWLEDGEMENTS

Frances MacDonald and Sintia Winkler for sampling crops, and Carol Curtis for data entry. Anna Sinclair, Eamon Balle and Bharat Jivan for access to onion crops and details of insecticides used. Paul Munro for advice.

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