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Summary of Crown-funded research on onion thrips and onions – 2005-06

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1 Executive summary

In 2005-06, government funded-research on onion thrips was planned for two areas: comparing crop monitoring methods for detecting thrips; and bioassays to compare the susceptibility of onion bulbs to onion thrips.

1.1 Crop monitoring for onion thrips

In 2005-06, three monitoring methods were compared:

- 100 randomly selected plants,
- 20 groups of five plants, the five plants being selected randomly from within a circle approximately 1 m in diameter, and
- 20 groups of five plants, the five plants being in the same row and adjacent to one another.

Six crops were sampled by all three methods before and after the first cluster of insecticide applications. Each time, two people sampled each crop by all three methods.

There was no difference between the two crop scouts.

The method using single random plants was more efficient than groups of five plants, requiring fewer plants to be sampled for a given level of accuracy.

Industry was consulted over new guidelines for monitoring onion thrips in onion crops based on sampling single plants spread over the whole field.

1.2 Susceptibility of onion bulbs to thrips

There is still little understanding of why onion thrips feed and breed on some lines of onion bulbs and not others. Onion thrips damage to onion bulbs is dependant upon onion thrips being present, the thrips having access to the live fleshy scale on which they feed, and the fleshy scale being susceptible to onion thrips, i.e. being favourable for feeding and breeding. When onion thrips do have access to the fleshy onion scale, it is not known what factors make some bulbs suitable for thrips feeding and breeding, while other bulbs are less so. There is evidence that thrips may complete one generation (eggs to adult) on some lines of newly harvested bulbs, but then do not continue breeding.

Using a new oviposition bioassay we have found that onion bulb susceptibility to thrips was affected by genetic (cultivar) and by agronomic (nitrogen) factors. However, we do not yet know the underlying chemical nature of this resistance. There are indications that as the outer fleshy scale shrinks to become a dry skin, it might become more susceptible to onion thrips and that this may be associated with the mobilisation of nutrients in the shrinking fleshy scale.

In 2005-06 we grew an early onion, Kiwigold (brown), and a main crop onion, May & Ryan (M&R) Regular (PLK-brown), in adjacent blocks of two beds (60 m long). Each bed had six rows 200 mm apart. The bed was divided into eight plots (7.5 m long) giving 16 per cultivar. Plots were allocated to four nitrogen rates (50, 100, 150 and 200 kg/ha) with four replicates. The plants received normal fungicide and insecticide programmes. Seedling establishment was very patchy and there appeared to have been very little compensatory growth by surviving plants in many plots. Bulbs were harvested from the denser plant areas of each plot. No yield data were collected. The Kiwigold bulbs were lifted on 9 February and the M&R Regular were lifted on 7 March. Harvesting was 4 weeks after lifting.

For the bioassay, day-old female onion thrips were allowed to feed and lay eggs in a disc of onion bulb tissue for 3 days. The numbers of eggs laid were counted after staining the disc. Twenty discs per onion were assessed in each bioassay. In each bioassay we used one onion bulb from each plot (four nitrogen treatments times four replicates). Ten discs were taken from the outermost flesh scale and ten from the third scale in from the outside.

There were more eggs laid in the outer scale than on scale 3 of the Kiwigold bulbs, showing that the outer scale was more suitable for thrips breeding than scale 3. By contrast, there was no difference in susceptibility between scale 1 and 3 in M&R Regular bulbs. However, there was no effect of nitrogen treatment on the susceptibility of Kiwigold bulbs, but M&R Regular bulbs increased in susceptibility with increased nitrogen.

In previous years (Martin & Workman 2006, Martin & Workman 2005) both Kiwigold and M&R Regular onion bulbs were more susceptible to thrips under high nitrogen (N4) treatments than low nitrogen (N1) treatments. The anomaly could be linked to the poor plant establishment and unevenness in plant populations, and hence to the available soil minerals/fertiliser.

1.3 *Conclusions and plans for 2006-07*

1.3.1 *Crop scouting*

After consultation with people monitoring onion crops commercially, revised guidelines were prepared and will be tested in the coming 2006-07 growing season. The time to do the sampling will be recorded.

1.3.2 *Susceptibility of onion thrips to onion bulbs*

The data from this year's onion bulb bioassays need to be treated with caution because of the poor and variable plant establishment.

Chemical analysis of onion bulbs from the 2004-05 trial showed that there were major differences in the carbohydrate profile of Kiwigold and Supreme. A comparison of susceptibility to onion thrips was not possible that year for these two cultivars. These two cultivars have been sown for this growing season.

The project has reached a stage where, due to fixed FRST funds and inflation of costs, the costs of growing the crops and the maintenance of the thrips for 12 months of the year mean that the funds required for the

bioassays will become inadequate in the near future. Additional funding is required to support and extend the number of bioassays a year.

2 Introduction

In 2005-06, government-funded research on onion thrips was planned for two areas: comparing crop monitoring methods for detecting thrips; bioassays to compare the susceptibility of onion bulbs to onion thrips.

3 Monitoring onion thrips in onion crops

This research focuses on monitoring thrips at the time of year when onion thrips populations are low and distribution in the field reflects the initial invasion. It is also the time when populations approach or are close to the current action threshold that growers use to start a cluster of insecticide applications.

Methods

In 2005-06, three monitoring methods were compared:

- 100 randomly selected plants,
- 20 groups of five plants, the five plants being selected randomly from within a circle approximately 1 m in diameter, and
- 20 groups of five plants, the five plants being in the same row and adjacent to one another.

The last two methods simulated current crop scout practice.

For this research we are dependent upon being notified of suitable crops to monitor. We received good cooperation and monitored six crops before and after the first cluster of insecticide sprays. Two people monitored each crop each time using all three methods, giving data from 600 plants each time.

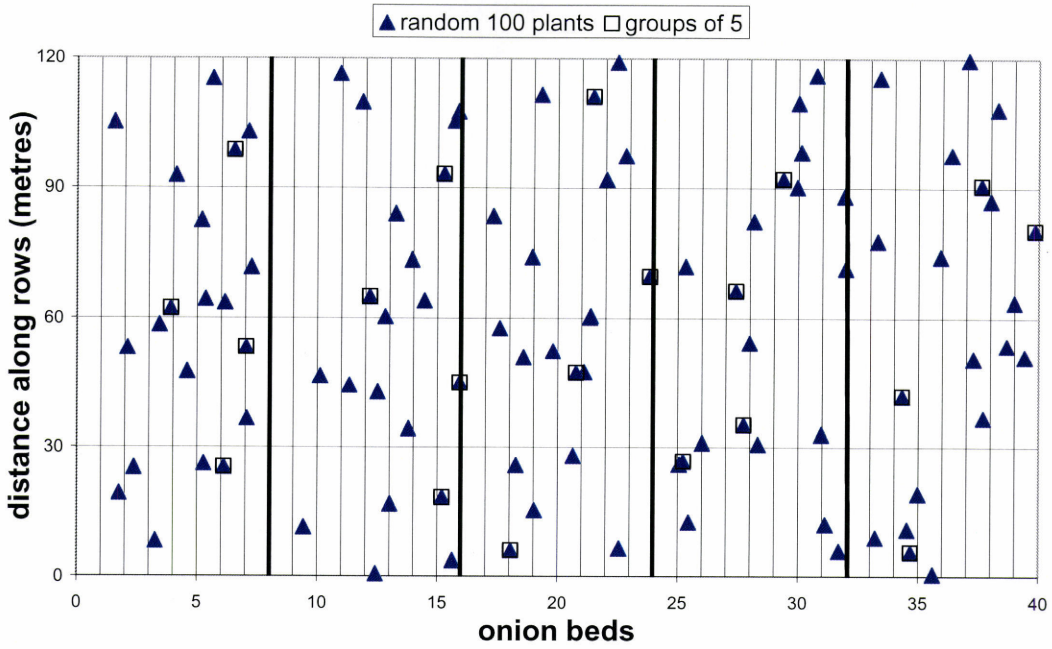

Figure 1: Example of location of stratified random selection of sample plants in a crop with 40 beds 120 m long and subdivided into 20 plots eight beds wide and 30 m long. Each bed has eight rows of plants that are also randomly allocated.

3.1 Results of crop monitoring research

The crops monitored varied from 0.83-2.96 ha (Table 1). When first monitored, thrips populations were all close to the action threshold. After the first cluster of insecticides was applied, thrips populations in four crops had only increased slightly or declined, while the populations in two crops had increased substantially (Figure 2). Fuller details of the research can be found in the paper by Martin et al. (2006). Two key findings were:

- There was no difference in the data from the two crop monitors.
- When estimating the mean number of thrips per plant, fewer plants needed to be sampled for a particular level of precision when sampling individual plants than when sampling groups of five plants (Figure 3). 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 for groups of five plants, 200 plants (40 sets of five) need to be sampled.

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 x3
Calcutta Rd	50 beds, 132 m long	1.14	17×33	25 Oct	14 Dec	methamidophos x3 alphacypermethrin x1
B Jivan SW	65 beds, 264 m long	2.96	22×66	13 Oct	17 Nov	methamidophos x3
Philburn	40 beds, 120 m long	0.83	14×30	7 Nov	13 Dec	methamidophos x4 imidacloprid x1
Stuart Rd	36 beds, 275 m long	1.71	16×55	28 Oct	1 Dec	methamidophos x3 alphacypermethrin x1
Walker, Pdk3	40 beds, 300 m long	2.07	17× 60	14 Nov	23 Dec	chlorpyrifos x2 imidacloprid x2

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

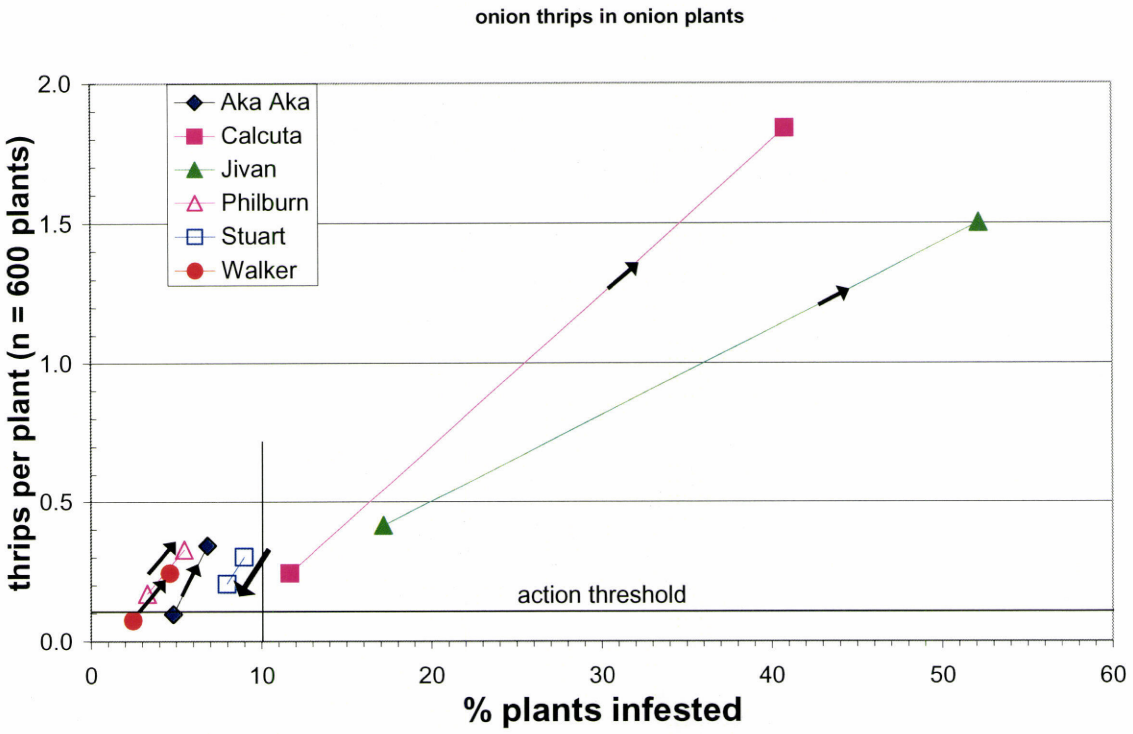

Figure 2: Relationship between onion thrips per plant and percentage plant infestation in six onion crops before and after the first cluster of insecticide sprays. Note that the thrips population increased in five crops and declined in one crop.

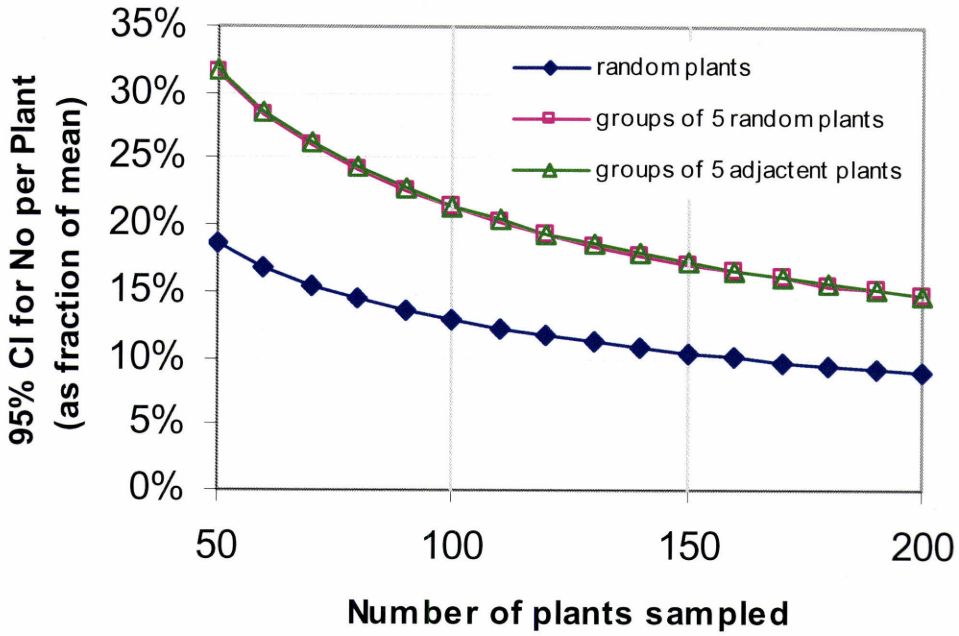

Figure 3: Relationship between number of onion plants sampled and sampling error of the mean number of thrips per plant for three sampling methods.

3.2 *Industry consultation on a new crop monitoring protocol*

On 22 August 2006, representatives of growers and people monitoring onion crops discussed alternatives to the current crop monitoring protocol for onion thrips in onion crops at a meeting in Pukekohe. The aims were:

1. cover the whole field
2. examine single plants, not groups of five plants
3. number of plants to be examined per field is determined by:
    a) Minimum number of sample plants per field
    b) Minimum number of plants per hectare (when fields are large)
4. sample more plants when thrips populations are low, and fewer when populations are high
5. have a method that is also suitable for monitoring for diseases.

The following guidelines were agreed for testing in 2006-07:

1. cover whole field
2. minimum number of plants per field (up to 4 ha size):
    a) 100 when thrips numbers are low, (early season, fewer than 0.5 thrips per plant)

b) 50 when populations are high (more than 0.5 thrips per plant)

3. minimum number of plants per hectare (4 ha and above):

   a) 25 when thrips numbers are low

   b) 12 when thrips numbers are high

4. divide number of beds by four or use groups of 9-11 beds (use wheel tracks for guidance)

5. work out the number of plants to be examined per group of beds (if field is under 4 ha, and there are four groups of beds and thrips numbers are low, number of plants = 25). Divide length of beds by number of plants to work out the number of meters (paces) between sample plants, e.g. 10-15 paces

6. zigzag up the group of 9-11 beds examining a single plant every 10-15 paces up a bed, then cross to another bed and go another 10-15 paces

7. do the same in reverse for another group of 9-11 beds.

An issue of concern was the length of time taken to monitor crops following the new guidelines. Data on the time taken will be part of the 2006-07 FRST-funded research project.

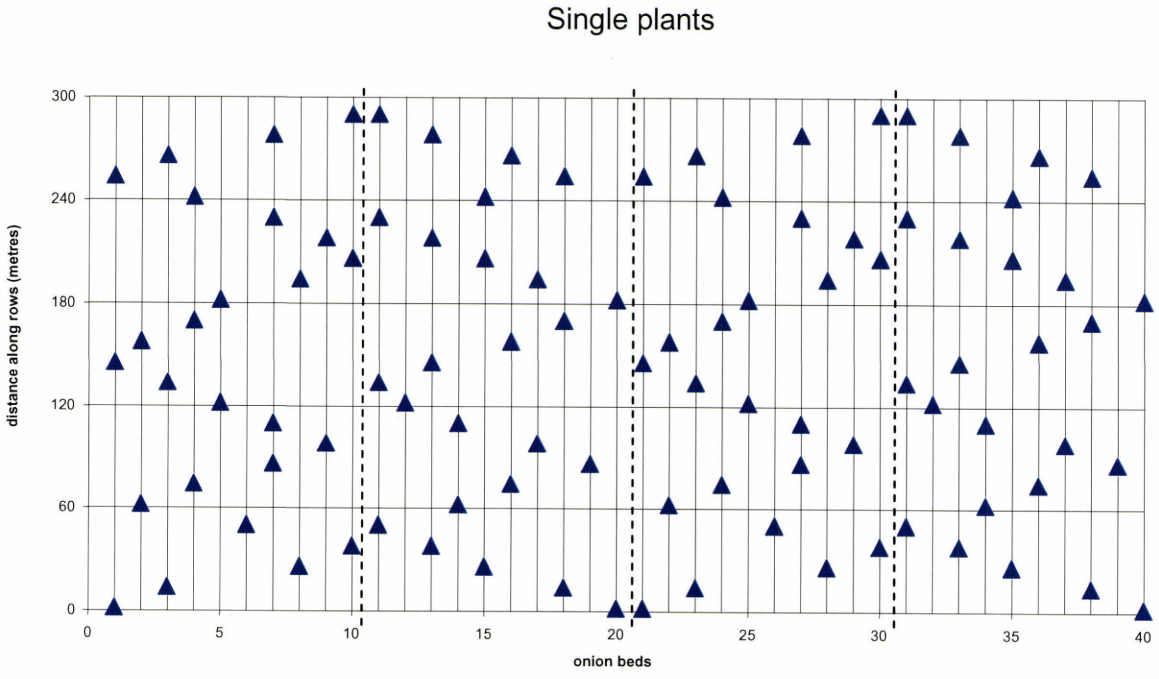

Figure 4: Example of plants sampled when zigzagging up and down four groups of beds.

4 Susceptibility of onion bulbs to onion thrips

4.1 Introduction

There is still little understanding of why onion thrips feed and breed on some lines of onion bulbs and not others. Onion thrips damage to onion bulbs is dependent upon onion thrips being present, the thrips having access to the live fleshy scale on which they feed, and the fleshy scale being susceptible to onion thrips, i.e. being favourable for feeding and breeding.

The presence of onion thrips on bulbs at harvest and in the store is related to growing conditions, the efficacy of insecticide control, harvest practices and procedures in the store. The relative importance of any of these factors is not known.

If onion thrips are present, they can get access to bulbs through split skins or through the neck. Tight necks and intact skins can prevent thrips having access to bulbs and can therefore prevent damage to bulbs.

When onion thrips do have access to the fleshy onion scale, it is not known what factors make some bulbs suitable for thrips feeding and breeding, while other bulbs are less so. There is evidence that thrips may complete one generation (eggs to adult) on some lines of newly harvested bulbs, but then do not continue breeding. There is also evidence that the outer fleshy scale may be more suitable for thrips feeding and breeding when it is shrinking and mobilising nutrients to move them out of the scale into the bulb. This happens during curing when the outer scale is shrinking to become a dry scale and probably when the bulb sprouts.

Crop & Food Research has recently developed a bioassay to provide information on the susceptibility of onion bulbs to onion thrips (Martin & Workman 2006). The research showed that onion bulb susceptibility to onion thrips is affected by both genetic (cultivar) and agronomic (quantity of nitrogen fertiliser) factors.

This year we grew onion bulbs of two brown onion cultivars, each grown with four nitrogen treatments, and in the bioassay we compared the susceptibility of the outer and an inner fleshy scale of the bulbs.

4.2 Field trial

We grew an early onion, Kiwigold (brown) and a main crop onion, May & Ryan (M&R) regular (PLK-brown), in adjacent blocks of two beds (60 m long). Each bed had six rows 200 mm apart. The bed was divided into eight plots (7.5 m long) giving 16 per cultivar. Plots were allocated to four nitrogen rates (50, 100, 150 and 200 kg/ha) with four replicates. Nitrogen (Urea) was applied at sowing, at the 2-3rd true leaf, the 6-8th true leaf and 10 true leaves. The onions were sown on 5 August 2005. The nitrogen treatments (Urea) were applied on 7 November, 7 December, and about 10 January.

The plants received normal fungicide and insecticide programmes. Seedling establishment was very patchy and there appeared to have been very little compensatory growth by surviving plants in many plots. Bulbs were harvested from the denser plant areas of each plot. No yield data were collected. The Kiwigold bulbs were lifted on 9 February and harvested by hand on 7 March and the M&R Regular were lifted on 7 March and harvested by hand on 4 April.

4.3 *Bioassay summary of method*

Day-old female onion thrips were allowed to feed and lay eggs in a disc of onion bulb tissue for three days. The numbers of eggs laid were counted after staining the disc (Martin & Workman 2006). Twenty discs per onion were assessed in each bioassay. In each bioassay we used one onion bulb from each plot (four nitrogen treatments times four replicates). Ten discs were taken from the outermost flesh scale and ten from the third scale in from the outside. See Appendix I for more details.

4.4 *Bioassay results*

The bioassays for Kiwigold were run between 11 April and 9 May 2006, and those for M&R Regular from 23 May and 20 June 2006. The bioassay data have to be biometrically analysed.

Table 2: Mean number of eggs per onion bulb discs from onion scales 1 and 3 from bulbs from four nitrogen treatments (N1 = 50 kg N/ha, N2 = 100 kg N/ha, N3 = 150 kg/ha, N4 = 200 kg/ha).

	N1	N2	N3	N4	Scale 1	Scale 3
Kiwigold	1.88	1.47	1.68	1.21	1.99	1.13
May & Ryan Regular	1.51	2.00	2.45	2.90	2.20	2.23

There were more eggs laid in the outer scale than in scale 3 of the Kiwigold bulbs, showing that the outer scale was more suitable for thrips breeding than scale 3. In contrast there was no difference in susceptibility of scale 1 and 3 in M&R Regular bulbs. However, there was no effect of nitrogen treatment on the susceptibility to thrips of Kiwigold bulbs, but M&R Regular bulbs increased in susceptibility with increased nitrogen.

In previous years (Martin & Workman 2006, Martin & Workman 2005) both Kiwigold and M&R Regular onion bulbs were more susceptible to thrips under high nitrogen (N4) treatments than low nitrogen (N1) treatments. The anomaly could be linked to the poor plant establishment and unevenness in plant populations, and hence to the available soil minerals/fertiliser.

5 Conclusions and plans for 2006-07

5.1 Crop scouting

The 2005-06 crop monitoring data showed that, for a chosen level of accuracy, examining individual plants over the crop meant fewer plants needed to be examined than when using groups of five plants. A new 'commercial' protocol for scouting for onion thrips in onion crops will be tested in the coming 2006-07 growing season and the time to do the sampling will be recorded.

5.2 Susceptibility of onion thrips to onion bulbs

The data from this year's onion bulb bioassays need to be treated with caution because of the poor and variable plant establishment.

Chemical analysis of onion bulbs from the 2004-05 trial showed that there were major differences in the carbohydrate profile of Kiwigold and Supreme. A comparison of susceptibility to onion thrips was not possible that year for these two cultivars. These two cultivars have been sown for this growing season.

The project has reached a stage where due to fixed FRST funds and inflation of costs, the costs of growing the crops and the maintenance of the thrips for 12 months of the year mean that the funds required for the bioassays will become inadequate in the near future. Additional funding is required to support and extend the number of bioassays a year.

6 Acknowledgements

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7 References

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Appendix I Details of protocol for onion bulb bioassays

- Ten 10 mm onion discs were cut from both the first and third scale (layer) of one onion (20 in total).
- One onion disc from each layer and of the four nitrogen levels were placed within a 50 x 9 mm plastic petri dish containing 42.5 mm filter paper and 0.01 mL water.
- This was replicated four times for each of the scales and nitrogen levels.
- A 1-day-old female thrips was placed onto the onion disc in each of the petri dishes.
- After 3 days the thrips were individually checked to see whether they were alive or dead.
- The discs from dead thrips were discarded. Discs from live thrips were stained using acid fuschin in ethanol and glacial ascetic acid.
- Two days after staining the discs were cleared using clearing solution (water/glycerine/lactic acid).
- Once cleared the discs were checked for eggs with transmitted light and the number of eggs recorded.