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Summary of Crown-funded research on onion thrips and onions – 2004-05

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1 Executive summary

In 2004-05, government funded-research on onion thrips was planned for three areas: comparing crop monitoring methods for detecting thrips; natural enemies of onion thrips; and bioassays to compare the susceptibility of onions to onion thrips. No progress was made with crop monitoring and studies on natural enemies.

1.1 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 in 2003-04 we found that susceptibility to thrips in two brown and two red onion cultivars was affected by genetic (cultivar) and by agronomic (nitrogen) factors. The two brown cultivars were more susceptible than the two red cultivars, and high nitrogen inputs increased susceptibility. However, after storage we found more thrips damage on bulbs of the red cultivars than on the brown onions. 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 2004-05 we further tested the new bioassay method on four onion cultivars, two white and two brown. These comprised an early white, ('Supreme') and main crop white ('K5193') and early brown ('Kiwigold') and a main crop brown ('M&R Regular'). Four nitrogen treatments (50, 100, 150, 200 kg N/ha) were allocated in a Latin square design.

The data have to be biometrically analysed, though trends in the data have been summarised. Bulbs in the low nitrogen treatment were consistently lighter than the other treatments. It is also notable that this year the main crop produced flower heads and that the number was greatest in the low nitrogen plots of main crop white cultivar K5193.

The bioassay data showed no difference in susceptibility between the two main crop cultivars, but fewer eggs were laid in the low nitrogen treatments than the high nitrogen treatment, suggesting that the high nitrogen treatment increased the susceptibility of the onion bulbs. There are indications of a similar trend in the Kiwigold bulbs.

The mean number of eggs laid in the first and second fleshy scales of Kiwigold (N1) and M&R Regular (N4) were similar.

Chemical analysis showed that amounts of the carbohydrate fructans declined with increasing nitrogen and there was much less fructans in Supreme than in other cultivars. However, the indications are that old bulbs of Supreme and Kiwigold have similar susceptibility to onion thrips.

1.2 Conclusions and plans for 2005-06

- To encourage participation of growers, compensation for onion plants destroyed during sampling will be offered to growers whose crops are sampled.
- No field trials of natural enemies are planned for 2005-06.
- This year's bioassay and yield data still have to be biometrically analysed, but there appears to be a similar relationship between nitrogen treatment and susceptibility to onion thrips as last year. The relationship between levels of fructans and thrips susceptibility needs further investigation, but will have to wait until 2006-07.
- For 2005-06 two brown cultivars (Kiwigold and M&R Regular) have been planted with the same four nitrogen treatments, to assess the susceptibility of bulbs to all four rates of nitrogen fertiliser and to test bulbs closer to harvest. A comparison of the susceptibility of the onions' outermost scales (while shrinking) and their internal scales to thrips will be attempted.

2 Introduction

In 2004-05, government-funded research on onion thrips was planned for three areas: comparing crop monitoring methods for detecting thrips; natural enemies of onion thrips; and bioassays to compare the susceptibility of onions 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 at which growers use to start a cluster of insecticide applications.

In 2004-05, three monitoring methods were compared, as in the previous season, examining:

- 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 method was designed to detect levels of aggregation of thrips-infested plants.

For this research we are dependent upon being notified of suitable crops to monitor. This research was planned to be associated with the IPM for Alliums SFF, but at the last minute this did not happen. As we were not notified of suitable crops, no progress was made.

4 Natural enemies of onion thrips in onion crops

This year, the trial to test the efficacy of commercial formulations of *Verticillium lecanii* was delayed because product was still awaiting registration with MAF. A block of early and main crop onions was planted and used by other Crop & Food Research staff for onion thrips research.

5 Susceptibility of onion bulbs to onion thrips

5.1 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 depends on 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 access bulbs through split skins or through the neck. Tight necks and intact skins can prevent thrips damaging 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.

Crop & Food Research has recently developed a bioassay to provide information on the susceptibility of onion bulbs to onion thrips. The research supporting this bioassay has been submitted for publication in a scientific journal. Last year we found that onion bulb susceptibility to thrips was affected by genetic (cultivar) and agronomic (nitrogen) factors. The two brown onion cultivars tested were more susceptible than the two red onion cultivars and high nitrogen inputs increased susceptibility. However, after storage we found more thrips damage on bulbs of the red cultivars than on the brown onions. 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.

This year we further tested the new bioassay method on four onion cultivars (two white and two brown), each grown with four nitrogen treatments.

5.2 *Field trial*

We grew two early onions, Kiwigold (brown) and Supreme (white), and two main crop onions, May & Ryan regular (PLK-brown) and K5193 (white). Each cultivar had four beds 60 metres long. The two early cultivars were grown in alternating beds, as were the two main crop cultivars. Each bed had 6 rows 200 mm apart. The pairs of beds were divided into four plots (15 m long) giving 16 plots for each pair of cultivars. Plots were allocated to four nitrogen rates (50, 100, 150 and 200 kg/ha) and with four replicates in a Latin square design. The same Latin square was used for each cultivar. Nitrogen (urea) was applied at the flag leaf stage, at the 2-3rd true leaf, the 6-8th true leaf and at 10 true leaves. The early onions were sown on 15 June 2004, and the main crop onions were sown on 14 July 2004. The nitrogen treatments (urea) were applied on 1 September, 15 October, 26 November and 21 December 2004. A small amount of additional nitrogen was applied to all plots as calcium nitrate (1.5 kg/100 litres at 400 L/ha) on 17 November and 24 November 2004.

The plants received normal fungicide and insecticide programmes. Bulbs were lifted on 17 February 2005 and harvested by hand on 24 February from three areas per plot. The sample areas (1 metre long and the four central rows) were 3, 7 and 10 metres from the road end of each plot. After drying, the bulbs from each sample area were graded, counted and weighed, and the number that produced seed heads recorded. Bulbs from the central area from each plot were kept for thrips bioassays and 10 bulbs from the central sample area were sent to John McCallum (Crop & Food Research, Lincoln) for chemical analysis.

5.3 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 number of eggs laid was counted after staining the disc. Up to 20 discs per onion were assessed in each bioassay. In each bioassay we used onion bulbs from two nitrogen treatments, N1 (50 kg/ha) and N4 (200 kg/ha), and only bulbs from two plots per treatment. We also compared the consistency of data from each bulb by testing each half of the bulb on two consecutive days (Table 1). The second fleshy scale was used for all bioassays, but we also compared the first and second fleshy scales for one bulb in each bioassay.

The bioassays were delayed until June 2005 because predator mites invaded the thrips colony, and then the colony was required as a standard for bioassays comparing insecticide resistance in thrips from three field sites. By the time the onion bulb bioassays were started, the Supreme onions were sprouting and not in a fit condition for testing.

Table 1: Dates of bioassays.

Early crop Kiwigold and Supreme	**Main crop** M&R Regular and K5193
19 Jul 2005	7 Jun 2005
20 Jul 2005	8 Jun 2005
26 Jul 2005	14 Jun 2005
27 Jul 2005	15 Jun 2005
2 Aug 2005	21 Jun 2005
3 Aug 2005	22 Jun 2005
9 Aug 2005*	28 Jun 2005
9 Aug 2005*	29 Jun 2005
10 Aug 2005*	6 Jul 2005
10 Aug 2005*	6 Jul 2005
16 Aug 2005*	12 Jul 2005
17 Aug 2005*	13 Jul 2005

* Supreme bulbs not tested (quality too poor).

5.4 *Yield data*

The data still have to biometrically analysed, but bulbs in the N1 treatment were consistently lighter in weight than the other treatments (Table 2). It was also notable that this year the main crop produced flower heads, most of which were in the N1 plots of the main crop white cultivar K5193.

Table 2. Number and weight of onion bulbs, seed heads per square metre, and mean weight of bulbs of four cultivars grown with four rates of nitrogen.

	Number of bulbs	Total weight	Mean weight	Seed heads
Kiwigold				
N 1	304.58	32.49	44.45	0
N 2	337.08	46.37	57.31	0
N 3	346.67	47.14	56.66	0
N 4	326.67	43.77	55.83	0
Supreme				
N 1	350.42	33.05	39.30	0
N 2	314.17	39.61	52.53	0
N 3	323.75	34.29	44.13	0
N 4	337.50	36.68	45.29	0
M&R Regular				
N 1	227.92	31.34	57.29	10.42
N 2	205.00	35.50	72.15	5.42
N 3	250.42	36.38	60.53	5.83
N 4	240.42	36.64	63.50	10.00
K5193				
N 1	189.17	32.10	70.70	48.33
N 2	182.92	40.29	91.78	10.83
N 3	188.75	41.30	91.18	16.25
N 4	185.42	39.91	89.68	13.75

5.5 Bioassay results

The bioassay data still have to be biometrically analysed. In the main crop onions there appeared to be no difference in numbers of thrips eggs laid on the two cultivars, but fewer eggs were laid at the low nitrogen treatments than the high nitrogen treatment (Table 3), suggesting that the high nitrogen treatment increased the susceptibility of the onion bulbs to thrips activity. There are indications of a similar trend in the Kiwigold bulbs.

Table 3: Mean number of eggs laid by a female onion thrips in 3 days in a disc of onion bulb flesh.

	Bioassay 1				Bioassay 2			
Cultivar	M&R Regular		K5193		Kiwigold		Supreme	
Nitrogen treatment	N1	N4	N1	N4	N1	N4	N1	N4
Mean	1.59	4.83	1.59	3.59	1.60	2.77	1.10*	1.50*

* Many bulbs were sprouting, data from two plots only.

The mean number of eggs laid in the first and second fleshy scales of Kiwigold (N1) and M&R Regular (N4) were similar.

5.6 Chemical analysis data

Dr John McCallum (Crop & Food Research, Lincoln) conducted chemical analyses on Kiwigold, M&R Regular, Supreme and K5193 bulbs. The analysis of carbohydrates showed that fructans were lowest in Supreme (4.57-5.71% dry weight) compared to the other three cultivars (17.4-25.7% dry weight) and declined with increased nitrogen. High concentrations of fructans may be associated with the keeping quality of onion bulbs.

6 Conclusions and plans for 2005-06

6.1 Crop scouting

The new protocol for testing crop scouting methods gave good data in 2003-04 and will be tested more widely this year. This season, growers will be offered compensation for the onion plants destroyed during sampling in an effort to increase the number of suitable crops for sampling.

6.2 Susceptibility of onion thrips to onion bulbs

This year's data confirms that increased nitrogen fertiliser makes onion bulbs more susceptible to onion thrips. This appears to be correlated with a decrease in fructans. However, the cultivar Supreme, which had much lower fructans than the other three cultivars, appeared to be as susceptible to onion thrips as the low nitrogen treatment bulbs of the other cultivars. This suggests that there may not be a direct link between susceptibility to onion thrips and quantity of fructans in the bulbs, However, the Supreme bulbs were deteriorating and may not have been representative of the bulbs used for chemical analysis. Bioassays comparing recently harvested bulbs of Supreme and Kiwigold may help to determine if there is a direct link between the proportion of fructans and susceptibility of bulbs to onion thrips. This will have to wait until 2006-07 when the Kiwigold and Supreme can be planted in a replicated field trial.

Last year, the biometric analysis of the bioassay data showed that there was merit in comparing the proportion of discs with zero eggs, more than one egg and more than three eggs. These comparisons will again be made.

One of our objectives is to measure the consistency of the data and for this we test the two halves of an onion bulb on consecutive days. We will use both this year's and last year's data for this analysis.

The 2003-04 research indicated that there may be changes in the susceptibility of the outer fleshy scale of the onion bulb and that these could be associated with the maturation process of the bulb and the shrinkage of the outer fleshy scale as it becomes a dry skin. This year's preliminary examination of this process gave no conclusive results.

Another cultivar nitrogen trial has been established for 2005-06, using the two brown onion cultivars only. This smaller trial will allow time to compare bulbs grown with all four nitrogen treatments and to compare changes in susceptibility of the outermost flesh scale.

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