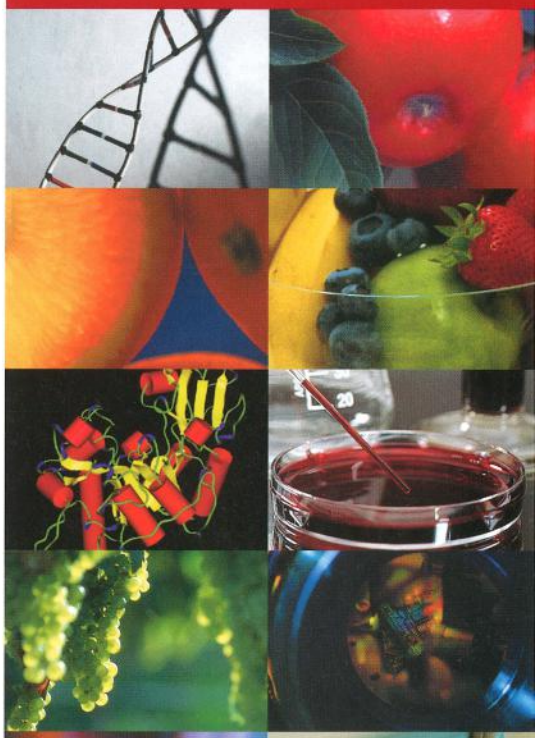
16197

HortResearch
www.hortresearch.co.nz



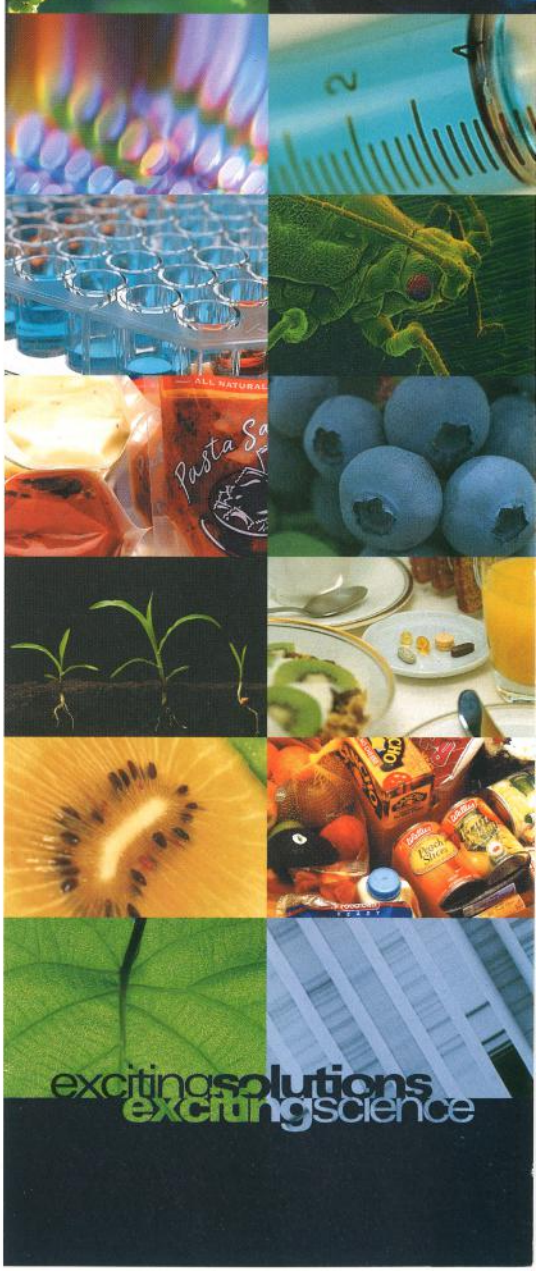
Further research into the source of thrips infestations in stored onion bulbs

Chhagan, A. and Jamieson, L.E.

August 2005

Final Report NZ Onion Exporters Association

HortResearch Client Report No. 16197
HortResearch Contract No. 19720



HortResearch Corporate Office
120 Mt Albert Road, Private Bag 92 169
Mt Albert, AUCKLAND, NZ
Tel: +64-9-815 4200
Fax: +64-9-815 4201

Chhagan, A. and Jamieson, L.
Mt Albert Research Centre
120 Mt Albert Road, Private Bag 92 169
Mt Albert, AUCKLAND, NZ
Tel: +64-9-815 4200
Fax: +64-9-815 4201

CONTENTS

EXECUTIVE SUMMARY

Further research into the source of thrips infestations in stored onion bulbs

Final Report NZ Onion Exporters Association

Chhagan, A. and Jamieson, L.E. August 2005

A high incidence of onion thrips (*Thrips tabaci*) in export onion consignments has been a serious problem for the New Zealand onion industry since 1997. Feeding damage by thrips causes blemishes, shrivelling and skin separation, often resulting in a significant decrease in onion bulb quality. Consignments containing thrips not only lower the market value of the onions, but also infringe the quarantine regulations of importing countries.

Research has identified that key factors include skin splitting, topping methods and length, curing time, the time of the season when onions are harvested, and storage temperature conditions (Chhagan and Jamieson, 2003; Jamieson *et al.*, 2001; 2002). However, these factors do not always entirely explain why some lines with low thrips numbers pre-harvest suffer significant damage during storage.

The increase in thrips populations during storage could be the result of either thrips on onions bulbs from field infestations reproducing in storage, immigration of adults into stored bulbs from other sources, or a combination of both. The following report details research investigating the source of thrips infestations in stored onion bulbs.

Objectives

The main objectives of the study were as follows:

- To monitor thrips populations in onions before and during storage
- To determine whether the source of onion thrips in stored onions is entirely infestation from field populations.

Methods

- Thrips numbers were monitored in 19 commercial onion crops in the Pukekohe and Matamata regions before lifting, and after six weeks storage. Storage samples consisted of both thrips-proof samples that were bagged just after harvest, and thrips-accessible onions.

Key results

- Thrips numbers in all fields varied considerably before lifting, with the number of thrips ranging from 0 - 647 per 50 plants.
- From before topping through to six weeks after storage, thrips populations generally increased in early/mid season crops, and decreased in late season crops.
- There was no linear relationship between the number of thrips before lifting and the number of thrips in onions stored in thrips-proof bags for six weeks after harvest. This suggests that an additional sample at harvest needs to be assessed in future trials, to investigate the relationship further.

- Onions placed in thrips-proof bags generally had fewer thrips compared with exposed onions after storage, suggesting that there are factors other than field infestation contributing to thrips populations in stored onions.
- Before lifting the onions, the majority of thrips found were in the larval stage. After storage, the proportion of adult thrips increased, suggesting that thrips populations are "aging", and not reproducing well on 'Pukekohe Long Keeper' onion bulbs.

Future Research

- To repeat the experiment conducted in Year 1, with an additional sampling time between lifting and storage. This will provide a better indication of the number of thrips in onions arriving into storage from field populations.

For further information contact: Lisa Jamieson
HortResearch
Private Bag 92 169
Auckland
Phone: (09) 815 4200
Fax: (09) 815 4201
Email: ljamieson@hortresearch.co.nz

INTRODUCTION

A high incidence of onion thrips (*Thrips tabaci*) in export onion consignments has been a serious problem for the New Zealand onion industry since 1997. Feeding damage by thrips causes blemishes, shrivelling and skin separation, often resulting in a significant decrease in onion bulb quality. Consignments containing thrips not only lower the market value of the onions, but also infringe the quarantine regulations of importing countries.

As a result of this, a number of research projects were established to gain a better understanding of onion thrips and factors contributing to infestations on onions both in the field and in storage. Research has identified that key factors include skin splitting, topping methods and length, curing time, the time of the season when onions are harvested, and storage temperature conditions (Chhagan and Jamieson, 2003; Jamieson *et al.*, 2001; 2002). However, these factors do not always entirely explain why some lines with low thrips numbers pre-harvest suffer significant damage during storage.

The current study was initiated to identify the source of onion thrips infestations in stored onions. The increase in thrips populations during storage could be the result of either thrips on onions bulbs from field infestations reproducing in storage, immigration of adults into stored bulbs from other sources, or a combination of both. Previous research examining thrips on onions during harvest and into storage have not distinguished the relative impacts of these two mechanisms. Knowledge of the source of thrips infestations in storage is vital to enable management of thrips in stored onions. If thrips population increase in storage is primarily the result of field infestations subsequently reproducing, then temperature management in storage may offer a means to limit thrips development. If thrips migration is the major contributing factor, then insect repellence or insect proofing technology should become a priority.

The objectives of the commercial trial in 2004-05 were:

- To monitor thrips populations in onions before and after storage, and
- To determine whether the source of onion thrips infestations in stored onions are entirely from field populations.

METHODS

The study was conducted on 19 commercial onion crops in the ('Pukekohe Long Keeper' Pukekohe and Matamata regions. Fields were selected to provide a range of crop maturity times (i.e. a range of lifting and harvest dates). The crops and their respective sampling dates are shown in Table 1.

FIELD SAMPLING REGIME

The pre-lift assessment was carried out in the field whereby a sample of 100 onions from each field (10 per replicate) was assessed for the presence of thrips. Each onion was assessed by counting the number of thrips present in the neck region and on the leaves of the plant. The life stage of any thrips found was also recorded.

At harvest, onions were collected from bins in storage. Ten onions were collected from each bin and placed in insect-proof bags (thrips-proof samples: 10 replicates). Each bag was labelled and left in the bin for approximately 6 weeks. Once this period had lapsed, the bags of onions were collected from storage. A further sample of 10 onions was also collected from each bin at this point (thrips-accessible samples: 10 replicates).

All bags of onions were stored at HortResearch (Mt Albert Research Centre) at 12°C, until assessed.

Temperature monitoring

At harvest, Tiny Talk® temperature loggers were placed within a bagged sample in one of the bins in each of the storage sheds.

POSTHARVEST ASSESSMENT METHOD

Each onion was dissected and examined under magnification for thrips numbers (live and dead), life stage (larvae, pupa, adult) and location on the onion (neck, bulb).

Statistical analyses

The mean number of thrips per 50 onions from each field at each sampling time was calculated using Microsoft® Excel (2000). Analysis of variance (ANOVA, R Development Core Team) was used to compare the numbers of thrips for each sampling time in each field.

Using the total number of thrips counted in each of the 19 fields, linear models were used to quantify the relationship between the number found in thrips-proof onions and the number on thrips-accessible onions. The relationship between the number of thrips in onions before listing and the number in storage onions (thrips-proof) was considered in the same way.

Table 1. Location and sampling dates of each experimental field.

Field	Season category	Location	Pre-lift sample	Date thrips-proof samples were bagged at harvest	Time between pre-lift and bagging of thrips-proof sample at harvest (d)	6 weeks storage sample
1	Early[1]	Pukekawa	10 Jan 05	2 Feb 05	23	7 Mar 05
2	Early	Buckland	28 Dec 04	17 Jan 05	20	16 Feb 05
3	Early	Buckland	28 Dec 04	17 Jan 05	20	22 Feb 05
4	Early	Ramarama	12 Jan 05	2 Feb 05	21	10 Mar 05
5	Early	Bombay	12 Jan 05	2 Feb 05	21	11 Mar 05
6	Early	Karaka	28 Dec 04	17 Jan 05	20	25 Feb 05
7	Early	Pukekohe	28 Dec 04	17 Jan 05	20	25 Feb 05
8	Mid[2]	Pukekawa	19 Jan 05	2 Feb 05	14	15 Mar 05
9	Mid	Matamata	19 Jan 05	23 Feb 05	35	11 Apr 05
10	Mid	Matamata	19 Jan 05	8 Mar 05	48	5 May 05
11	Mid	Te Kohanga	19 Jan 05	23 Feb 05	32	11 Apr 05
12	Mid	Puni	19 Jan 05	4 Feb 05	16	17 Mar 05
13	Mid	Pukeoware	19 Jan 05	23 Feb 05	35	11 Apr 05
14	Late[3]	Aka Aka	16 Feb 05	16 Mar 05	28	11 May 05
15	Late	Pukekawa	16 Feb 05	17 Mar 05	29	5 May 05
16	Late	Pukekawa	15 Feb 05	11 Apr 05	24	22 Jun05
17	Late	Pukekawa	15 Feb 05	11 Apr 05	57	22 Jun 05
18	Late	Pukekohe	2 Feb 05	16 Mar 05	42	11 May 05
19	Late	Pukekawa	18 Feb 05	11 Apr 05	53	22 Jun 05

[1]Early season crops = lifted before mid January and generally harvested in January.
[2]Mid season crops = lifted between mid January and mid February and generally harvested in February.
[3]Late season crops – lifted after mid February and generally harvested in March.

RESULTS AND DISCUSSION

The number of thrips found varied both within and between crops. Although both live and dead thrips were found, only live thrips data is presented here.

The mean number of thrips found per 50 plants from each field before lifting and after six weeks storage is shown in Table 2 and Figure 1.

Before lifting
Numbers of thrips varied considerably before lifting, with the number of thrips ranging from 0 - 647 per 50 plants. No seasonal trend could be established between thrips numbers before lifting over time.

Comparison of thrips populations in the field and after storage
The numbers of thrips on onions from early/mid crops increased between lifting and 6 weeks after storage for 11 of the 13 fields. However, this difference was significant in only seven of the fields (Table 2). Alternatively, the number of thrips on onions in late season fields generally decreased between lifting and 6 weeks after storage (five of the six fields). This general increase in the numbers of thrips between the field collection and after 6-8 weeks storage for early/mid season crops, and general decrease for late crops is consistent with previous trials (Jamieson *et al.*, 2002).

This difference in thrips numbers between early/mid and late season crops may be because of temperature differences over the two periods. Temperatures recorded in this year's study (Figure 2) support previous data that have shown that early and mid-season harvested onions experience a higher temperature regime during the storage period than those harvested later in the season. As temperature is a major factor influencing thrips development, one would assume that thrips infesting the early-season onions would develop faster than those on the late-season onions. However, a higher proportion of the early/mid season crops were handclipped. Previous research has highlighted that handclipped crops are more likely to have higher numbers of thrips in onions after storage (Jamieson *et al.*, 2001). In this study onions from fields that were handclipped had on average 18.4 times more thrips after storage (in thrips-proof bags) compared with thrips numbers before topping. Those onions that were machine topped only had an average of 0.3 times the number of thrips after storage (in thrips-proof bags) compared with numbers before lifting.

One of the aims of assessing onions stored in thrips-proof bags was to determine the relationship between field and storage populations. Although in previous trials for early/mid season crops there has been a linear relationship between the number of thrips before lifting and after eight weeks storage (Jamieson *et al.*, 2002), no significant linear relationship could be established between the number of thrips before lifting and the number of thrips after six weeks storage for early/mid season crops in this study (Figure 3). This lack of relationship between field and storage samples could be caused by a number of factors. Firstly, onions experienced a range of time-periods between lifting and harvest (Table 1). In previous years, sampling the number of thrips at harvest has shown that there are very few adult or larval thrips on bulbs at this time (Jamieson *et al.*, 2002), indicating that thrips may be entering storage facilities as eggs on bulbs, or invading stored bulbs from other sources. However,

there was a positive correlation between the number of thrips before lifting and after storage for late harvested fields ($R^2 = 0.62$), but insufficient data to show a significant relationship ($P > 0.05$).

Thrips 'invasion' during storage

The second aim of assessing the numbers of thrips on onions stored in thrips-proof bags was to compare these with onions that were exposed to thrips and determine if thrips were moving into stored onions during storage. At 15 of the 19 sites, a higher number of thrips were generally found in thrips-accessible onions compared with those stored in thrips-proof bags. However, only four of the 19 fields revealed a statistically significant difference because of the high level of variation between samples from different bins (Table 2). In general, it was estimated that 40.5% and 46.3% of thrips found in early/mid and late crops respectively probably entered the onions at some stage during storage.

The following model was fitted to predict the number on thrips-accessible samples as a function of the number found on onions in thrips-proof bags (independent of season):

No. of thrips on thrips-accessible onions
= 8.05 + 1.36 * no. of thrips on bagged samples.
($F = 33.45$; df = 1, 13; $P < 0.001$)

Life stages of thrips at different sampling times

The percentage of thrips of each life stage at each sampling period is shown in Figure 4. Before lifting, most thrips found were in the larval stage, while the majority of thrips found after 6 weeks storage were adults.

Table 2: Mean number of thrips per 50 onions (± SE) from each field before lifting and each sampling time and results of ANOVA tests.

Field	Season category	Topping method (machine topped or handclipped)	Pre-lift	6 weeks storage Thrips-proof	6 weeks storage Thrips-accessible	Pre-lift v. Thrips proof	Pre-lift v. Thrips access.	Thrips-proof v. Thrips access.	Magnitude to increase (>1) or decrease (<1) from pre-lift to 6 weeks after storage. Thrips-proof	% of thrips that probably 'invaded' stored onions
1	Early	MT	16.5 ± 5.5	25.0 ± 6.5	55.5 ± 11.0		✔	✔	1.5	55.0
2	Early	HC	3.0 ± 1.3	50.0 ± 25.5	88.5 ± 27.2	✔	✔		16.7	43.5
3	Early	HC	0 ± 0	23.0 ± 8.2	48.0 ± 8.6	✔	✔	✔	23	52.1
4	Early	HC	1.5 ± 1.1	38.5 ± 14.0	48.5 ± 9.7	✔	✔		25.7	20.6
5	Early	HC	4.0 ± 1.5	26.0 ± 11.2	19.5 ± 3.9		✔		6.5	0
6	Early	HC	0.5 ± 0.5	2.0 ± 1.1	19.5 ±10.4				4	89.7
7	Early	HC	13.5 ± 3.7	99.0 ± 22.9	74.0 ± 19.3	✔	✔		7.3	Graded[1]
8	Mid	MT	647 ± 74.5	31.5 ± 8.2	33.0 ± 8.4	✔	✔		0.05	4.5
9	Mid	HC	15.5 ± 6.7	40.5 ± 12.2	94.0 ± 19.5		✔	✔	2.6	56.9
10	Mid	HC	0 ± 0	106.0 ± 18.7	492.5 ± 68.8	✔	✔	✔	106	78.5
11	Mid	HCML[2]	17.0 ± 10.8	11.5 ± 5.6	28.5 ± 10.8				0.7	59.6

Field	Season category	Topping method (machine topped or handclipped)	Pre-lift	6 weeks storage Thrips-proof	6 weeks storage Thrips-accessible	Pre-lift v. Thrips proof	Pre-lift v. Thrips access.	Thrips-proof v. Thrips access.	Magnitude to increase (>1) or decrease (<1) from pre-lift to 6 weeks after storage. Thrips-proof	% of thrips that probably 'invaded' stored onions
12	Mid	HC	13.5 ± 4.8	28.5 ± 9.1	38.0 ± 6.5		✔		2.1	25
13	Mid	HC	1.5 ± 0.8	39.0 ± 12.0	46.0 ± 11.7	✔	✔		26	0
14	Late	MT	165.5 ± 47.7	16.0 ± 16.0	0 ± 0	✔	✔		0.1	0
15	Late	HC	15.0 ± 3.9	21.5 ± 6.5	86.0 ± 14.2	✔		✔	1.4	75
16	Late	MT	18.5 ± 8.3	0.5 ± 0.5	0.5 ± 0.5	✔	✔		0.002	0
17	Late	HC	287.5 ± 63.2	19.5 ± 6.9	23.5 ± 7.2	✔	✔		0.07	17.0
18	Late	MT	100.5 ± 23.2	0.5 ± 0.5	3.5 ± 3.0	✔	✔		0.005	85.7
19	Late	MT	19.0 ± 5.5	0 ± 0	4.0 ± 1.2	✔	✔		0	100

✔ Results of ANOVA revealed a significant difference between the mean number of thrips at different sampling times.

[1] This line of onions was graded. Therefore, because the onions that were most likely to be infested with thrips were removed, it was inappropriate here to compare thrips-proof with thrips-accessible samples.

[2] HCML = handclipped and machine lifted.

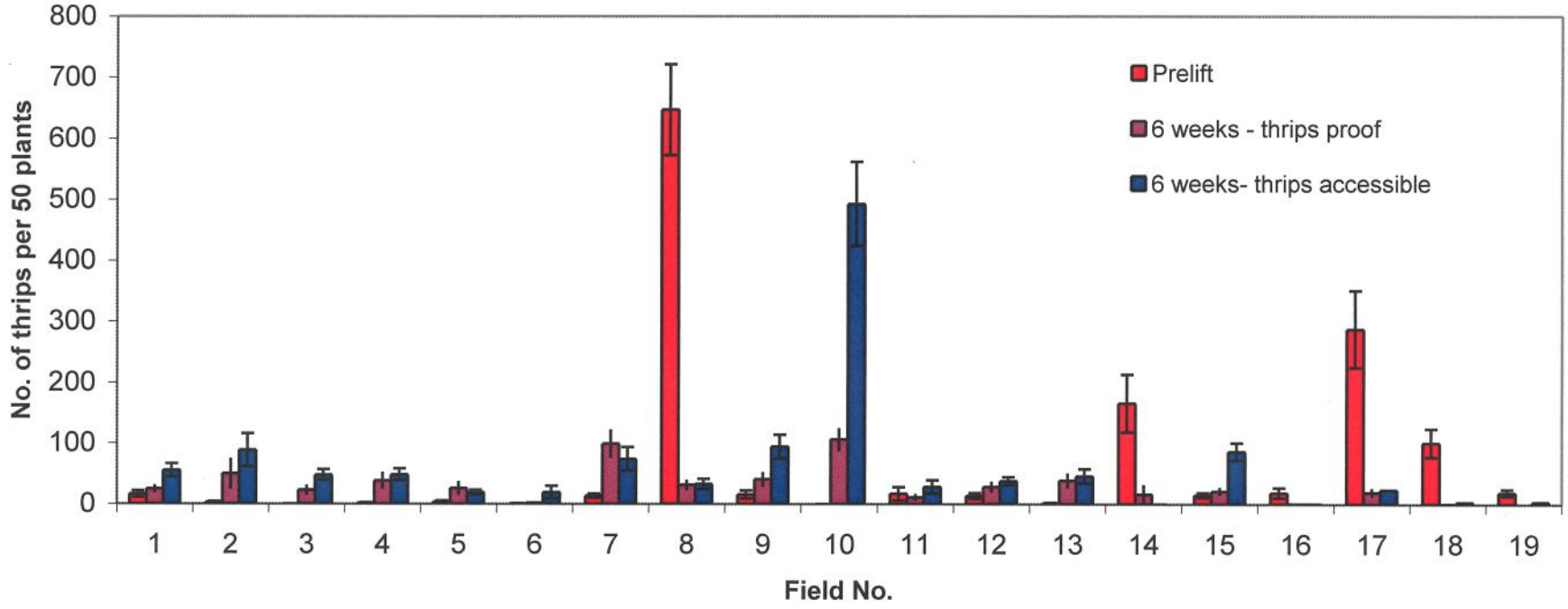


Figure 1: Mean number of thrips per 50 onions (±SE) from each field before lifting and after 6 weeks storage.

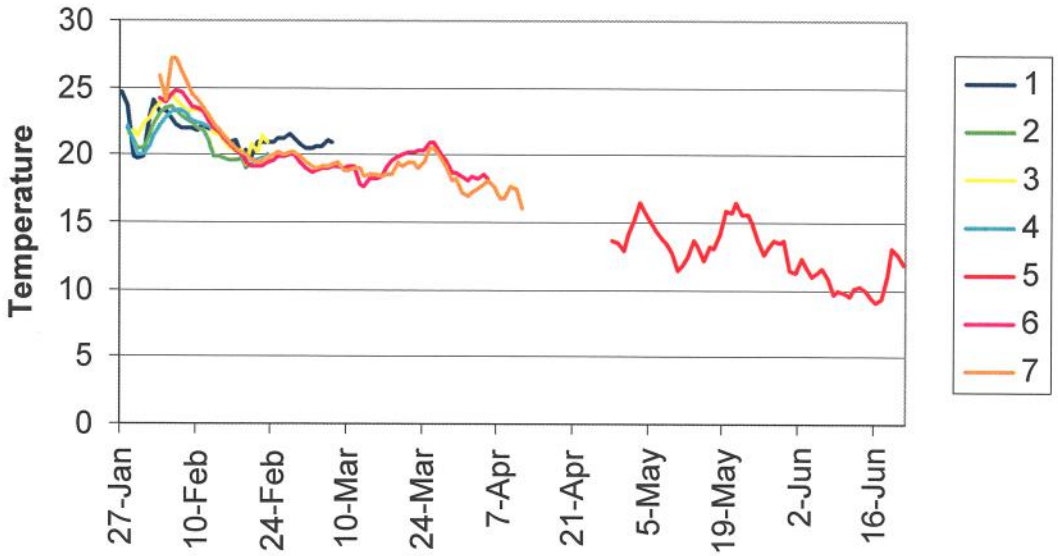


Figure 2: The average daily temperature in storage facilities in Pukekohe during the 2004-05 season.

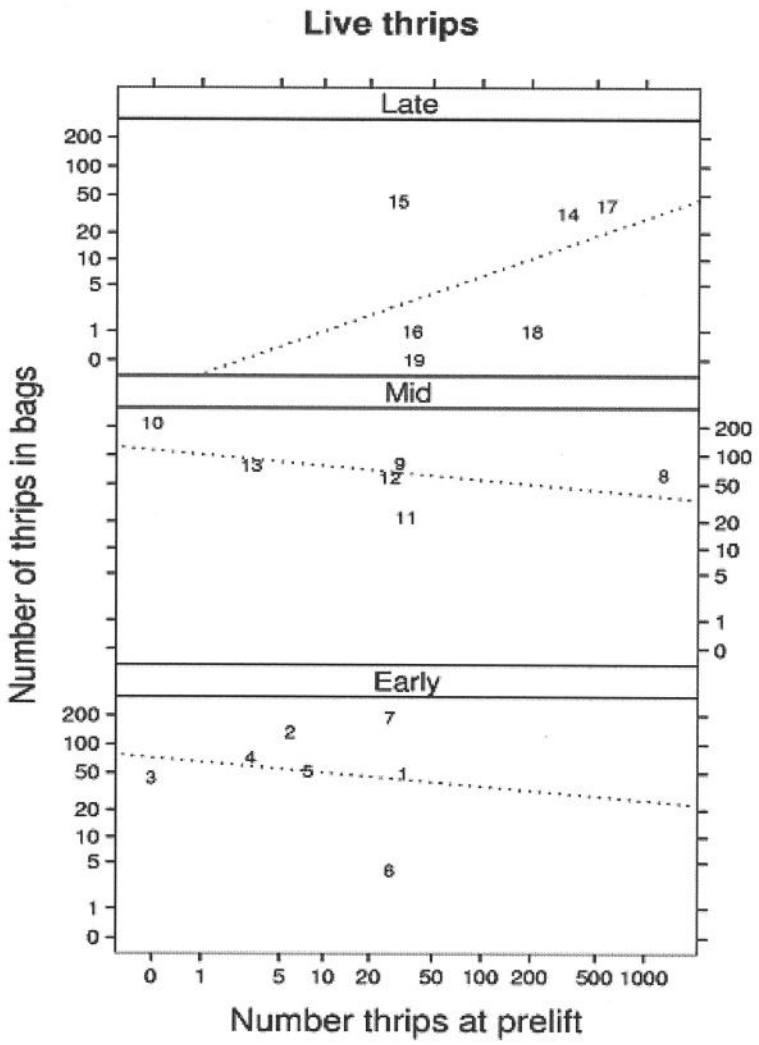


Figure 3 Number of onion thrips before lifting versus number of thrips after six weeks storage (thrips-proof) for early, mid and late fields. Each number on the graph represents the data point for the corresponding field number.

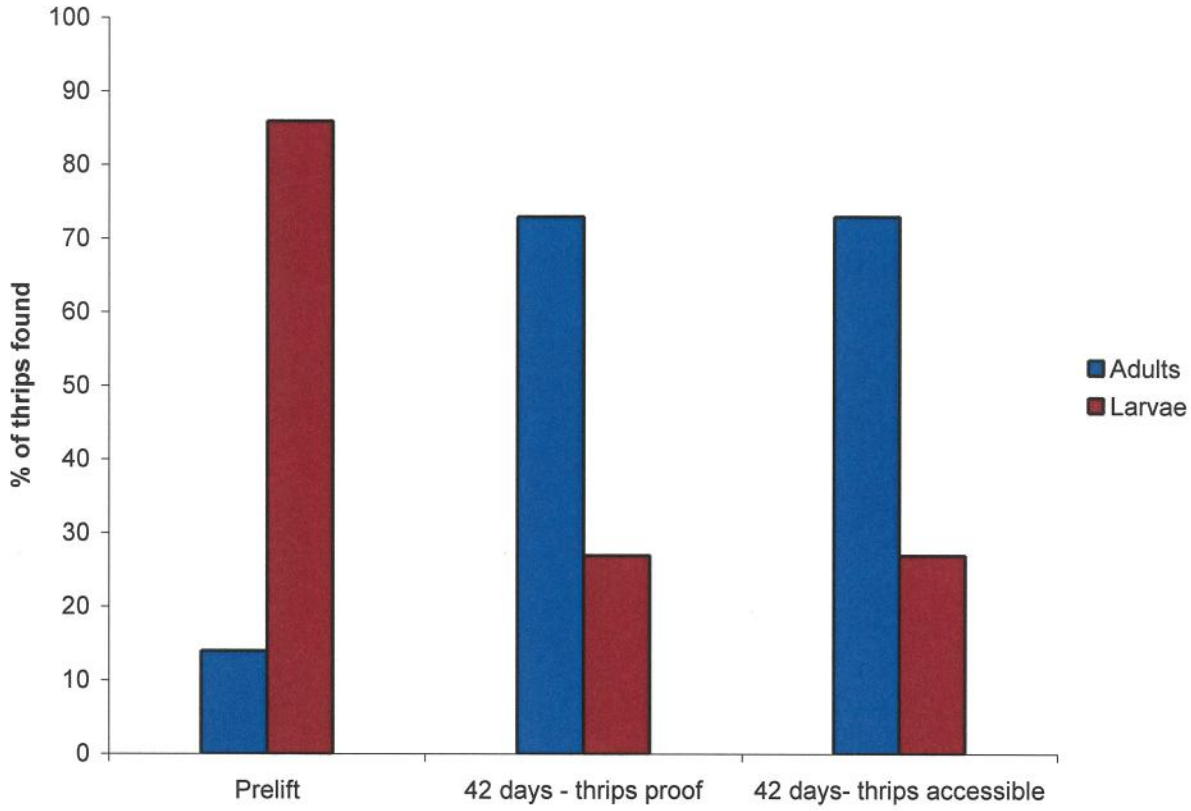


Figure 4: The percentage of thrips of each life stage at each sampling time.

CONCLUSIONS

- Thrips numbers in all fields varied considerably before lifting, with the number of thrips ranging from 0 - 647 per 50 plants.

- From before topping through to six weeks after storage, thrips populations generally increased in early/mid season crops, and decreased in late season crops.

- There was no linear relationship between the number of thrips before lifting and the number of thrips in onions stored in thrips-proof bags for six weeks after harvest. This suggests that an additional sample at harvest needs to be assessed in future trials, to investigate the relationship further.

- Onions placed in thrips-proof bags generally had fewer thrips compared with exposed onions after storage, suggesting that there are factors other than field infestation contributing to thrips populations in stored onions.

- Before lifting the onions, the majority of thrips found were in the larval stage. After storage, the proportion of adult thrips increased, suggesting that thrips populations are "aging", and not reproducing well on 'Pukekohe Long Keeper' onion bulbs.

RECOMMENDATIONS

- To repeat the experiment conducted in Year 1, with an additional sampling time between lifting and storage. This will provide a better indication of the number of thrips in onions arriving into storage from field populations.

REFERENCES

Chhagan, A and Jamieson, L. 2003. Identifying factors that may contribute to high thrips infestations on onion bulbs in storage. Report to the Onion Exporters Association. Report No. 9962.

Jamieson, L., Chhagan, A., Fullerton R. A., and Tyson, J. L. 2002. Monitoring onion thrips in export onions. Report to the New Zealand Onion Exporters Association. Report No. 2003/2

Jamieson, L., Chhagan, A., Stevens, P., Fullerton, R. A., and Tyson, J. L. 2001. Management and control of onion thrips in export onions during harvesting, storage and shipping. Report to the New Zealand Onion Exporters Association. Report No. 2002/10.