New Zealand Institute for Crop & Food Research Limited
A Crown Research Institute

CROP & FOOD RESEARCH

Mana Kai Rangahau

Crop & Food Research Confidential Report No. 673

Onion thrips: management of onion stores

N A Martin

June 2002

A report prepared for
New Zealand Onion Exporters Association

Copy 8 of 22

New Zealand Institute for Crop & Food Research Limited
Private Bag 4704, Christchurch, New Zealand

Contents

1 Executive summary

Onion stores may contain both ungraded onions brought in from the field and onions that have been graded and packed ready for export. This project investigated some aspects of onion store management with the aim of making practical recommendations to reduce the risk of onion thrips contaminating 'clean' bulbs. Discussions were held with nine people involved in the onion industry, and a draft of the report based on these discussions was sent to the New Zealand Onion Exporters Association (NZOEA) Research Committee and the interviewees for comment before this final report and the recommendations presented within it were compiled.

No major practical changes are required to current procedures for two reasons. Firstly, there is no clear evidence that large numbers of thrips transfer to clean lines of onion bulbs. Secondly, while store managers tend to keep 'dirty' and 'clean' lines separate, during the year there are times when space is limited and it is not always possible to do so.

The survey revealed several aspects of onion storage that affect levels of thrips infestation in onion bulbs during storage and the subsequent level of damage to bulbs. These topics are discussed in the report and recommendations made.

1.1 Recommendations

The following recommendations are not presented in order of priority.

- **Traceability and detecting common factors that make onion bulbs susceptible to pests and diseases.** A small working group should:
  - devise a common format for recording information that will meet EUREP-GAP requirements,
  - decide upon the additional information needed to identify factors that make bulbs susceptible to thrips and disease, and
  - design an onion quality recording form for importers that includes pests and diseases

The recording system should include domestic and reject lines.

- **Preharvest.** Two areas of interest to the onion industry are: factors that make onion bulbs resistant or susceptible to onion thrips, and the agronomic and post top fall practices that reliably improve skin quality. The NZOEA should support and facilitate research on:
  - onion bulb resistance to onion thrips, and
  - factors influencing onion skin quality.

- **Handling and grading onions.** The NZOEA should commission a study on current handling and grading practices and make recommendations on best practices that reduce damage to bulbs.
- **Removing field heat from onions.** The NZOEA should investigate the practicality of methods to rapidly remove excess field heat from onions.
- **Improving onion stores.** Onion thrips and some bulb diseases develop faster when bulb temperatures are high. Excess heat in onion stores could be reduced by improved design. The NZOEA should commission guidelines on store design and cooling.
- **Onion stores and global warming.** There are opportunities to design onion stores that maximise natural ventilation and minimise the use of energy to keep onions cool. These objectives should be incorporated into guidelines on onion store design and cooling.
- **EUREP-GAP and Integrated Pest Management (IPM).** In order to meet EUREP-GAP requirements, the onion industry should plan to integrate all crop protection information into an IPM system for pests, diseases and weeds.
- **Pesticide reduction strategy and IPM.** The government is currently debating a pesticide reduction strategy; implementation of IPM is the best way to achieve this. The onion industry should document changes in pesticide use during the transition from current practices to the adoption of IPM in order to demonstrate its contribution to the pest reduction strategy and to provide information that can be used to market the industry's commitment to environmental quality.

2 *Introduction*

Onion stores may contain ungraded onions brought in from the field and onions that have been graded and packed ready for export. Onions may be held in a store for a few days or for many months. There is a risk that pest-free onions may become contaminated by pests from other lines of onions held in the same store. Concern has been expressed that onions with nil or low numbers of onion thrips could become contaminated in storage and unacceptably high populations of thrips could subsequently develop.

This project investigated some aspects of onion store management with the aim of making practical recommendations to reduce the risk from onion thrips contaminating 'clean' bulbs.

3 *Methods*

While it is possible to make recommendations that are theoretically sound, I felt that it was important to only consider ideas that might be practical within the New Zealand onion industry. For this reason I held discussions with

people involved with various aspects of onion production, storage, and export (Table 1). Some stores were also inspected and management of onions within those stores described. Notes from the discussions were collated by topic and summarised. This information was combined with results from previous research. A draft of this report was also sent to members of the NZOEA and those interviewed for further comment.

Table 1: People consulted during discussions about onion store management.

Name	Company	Date of discussion
Brent Wilcox, Anna Ravlich	A S Wilcox & Sons	25 Oct 2001
Mike Blake	RPD	25 Oct 2001
Graham Russell	ASPAC Distributors Ltd	14 Nov 2001 (phone)
Pam Strange	NZ Growers	22 Nov 2001
Fenton Hazelwood	Balle Brothers	22 Nov 2001
Richard Wood	Vegcon Services Ltd	5 Dec 2001
Garth Wilcox	Wilcox Brothers	5 Dec 2001
John Thacker	Ian Croft Produce	5 Dec 2001

4 Results

4.1 Traceability

At least some UK supermarkets require extensive information about the onions supplied to them. This includes details on: the way onions are grown, the grower and the property, the crop, and how bulbs are handled after harvest. This information is similar to that likely to be required under EUREP-GAP.

The traceability requirements provide an opportunity to identify common factors associated with thrips and disease (black mould and onion soft rot) infested onion lines. It is also essential to include feedback on onion 'quality' from importers and to ensure that factors considered important in relation to thrips and disease infestation are recorded.

A small working group should:

- examine the current traceability requirements and devise a common format for the industry that will meet EUREP-GAP requirements,
- design a format for recording information on onion bulb quality for use by importers that includes objective measures of insect and pathogen levels and damage,
- decide upon additional information that should be recorded on factors that make bulbs susceptible to thrips and diseases.

- Some lines of bulbs that have high levels of pests and diseases at harvest and/or grading are not packed for export. These lines of bulbs should also be included in a traceability system, as should onions intended for the domestic market.

4.2 *Preharvest (removal from the field)*

Evidence to date strongly indicates that thrips infestation in a line of onions originates in the field, although postharvest procedures can minimise the development of an infestation and the amount of damage sustained by bulbs. Research has identified three factors affecting infestation and subsequent development of thrips populations on bulbs (Martin & Workman 2001):

- access of thrips to onion bulb flesh,
- susceptibility (resistance) of the onion bulb flesh to onion thrips, and
- strain of onion thrips.

4.2.1 *Access of thrips to onion bulb flesh*

In cured onions, thrips access bulb flesh through the neck and through splits in the outer dry skins. Onion thrips can only feed, damage and breed on onion bulbs if they have access to live bulb scales. Any preharvest and postharvest procedures that ensure the neck is tight and not damaged, and that there are no splits in the dry skins, will minimise onion thrips infestations and bulb damage. Preharvest processes that affect skin quality include the way that the onions are grown and lifted, topped and cured.

Growing conditions, such as geographic area and agronomic practices, are reported to influence onion skin quality, but there is no consensus on the best practices. Scientific evidence that early removal of bulbs from the field and artificial curing enhance skin retention (e.g. Wright & Grant 1997) is not conclusive, although rots were reduced and skin colour improved.

Other research funded by the NZOEA is investigating the effect of preharvest and harvest procedures on levels of thrips infestation.

During the interviews, comments were made about the differences between onion bulbs grown at Pukekohe (hard onion bulbs resistant to thrips) and bulbs grown in other parts of the country. These differences may relate either to aspects of bulb quality that prevent thrips from accessing bulb flesh, or to the possibility that Pukekohe bulbs are resistant to onion thrips. At present, there is no evidence to determine which of the two ideas is most accurate. Research must be undertaken to investigate the two concepts because they have different implications for how onions are grown, pre and postharvest handling and field control of thrips.

Care while handling onions before and during harvest can reduce damage to the dry skins and the neck and, therefore, the risk of thrips infestation. Topping practices and their timing influence the tightness of the neck between top fall and final grading.

4.2.2 *Susceptibility (resistance) of onion bulb flesh to onion thrips*

Onion thrips breed less well on onion bulb scales than they do on green onion leaves and on leeks. This shows that onion bulbs are partly resistant to onion thrips. Recent research has also shown that resistance to onion thrips by onion bulbs varies between lines of onions. This may be due to genetic and/or agronomic factors, both of which offer scope to reduce the risk of onion thrips damage to onion bulbs.

Bulbs of red onions are consistently more susceptible to onion thrips than Pukekohe Long Keeper type onions, but resistance in Pukekohe Long Keeper onions also varies between lines - some lines are strongly resistant and suffer levels of damage that do not affect their market value when artificially infested with thrips. However, experiments to distinguish between the role of genetic and agronomic factors in determining the resistance of onion bulbs to onion thrips have not been done.

A demonstration of a genetic basis for onion bulb resistance to onion thrips requires an experiment where genetically different onion lines are grown in a replicated trial under defined agronomic conditions. An experiment to demonstrate an agronomic basis for onion bulb resistance requires the same seed line of onion to be grown in a replicated trial using different agronomic treatments. While the key experiments were not done in 2001-2002, good progress was made with developing a more sensitive bioassay for testing the resistance of individual onion bulbs to thrips.

4.2.3 *Strain of onion thrips*

Two types of onion thrips strains that can have an adverse effect on onion bulb quality have been found. One group of strains are resistant to insecticides. A second group of strains are less affected by any resistance amongst onion bulbs. Insecticide resistant strains of thrips affect the efficacy of field control and the insecticide options available. If insecticide resistance results in poor thrips control close to top fall this can result in high thrips populations and an increased chance of bulb infestation.

Research in 2000-2001 demonstrated that thrips vary in their ability to breed on onion bulbs. Thrips that are better adapted to breeding on onion bulbs are more likely than `normal' onion thrips to cause levels of damage that affect the value of crops if they gain access to onion bulbs. It is important to be aware of this variability in thrips strains when interpreting data from unreplicated trials and industry reports. A thrips-infested onion line may be due to infestation by thrips that are affected less than normal by any resistant capability of the bulbs and not to agronomic or postharvest handling procedures applied to the line of bulbs.

4.2.4 *Preharvest: summary*

An indicator of the levels of subsequent onion thrips damage to bulbs is the thrips population on the onions when they are removed from the field. Factors at harvest that could influence subsequent thrips damage are:

1. the numbers of thrips present,
2. whether the thrips are adapted to survival on onion bulbs (thrips strain),

3. where the thrips are on the bulbs (at root base, under dry skins, in neck),
4. the quality of onion skins (a. proneness to split and looseness, b. tightness and long neck or loose short neck), and
5. whether the bulbs are resistant or susceptible to thrips.

These factors are largely independent of each other. There is variable knowledge about each. On the basis of current knowledge, growers can influence items 1, 3, and 4 by using insecticides and particular agronomic practices. Improved onion bulb resistance (5) would mitigate failures in items 1-4, but requires further research.

Handling of bulbs during and after harvest will influence bulb skin quality and the ability of thrips to access bulb flesh. Storage conditions will also influence the ability of thrips to feed, breed and damage bulbs.

4.3 *Storage, grading and packing*

There are a variety of practices and procedures for handling onions, from removal from the field, grading and packing prior to shipping. An important factor is the use of a central grading and packing area with only a small storage capacity. In these circumstances, onions from the field are held by the grower before grading and again after grading until the line is assembled for export.

A major factor limiting options for segregation of lines is the lack of space at the peak of the season. This means that sometimes graded and packed lines may be next to onions brought in from the field or second grade onions may be put with first grade onions. However, in general the process is organised to maximise the opportunities to separate onions at different stages of processing and of different quality.

As an example, onions for one company may go to the grader direct from the field and then be held for 7-14 days prior to export, or the onions may be stored in a grower's shed until grading, packing and export. Another company returns the graded onions in bins to the grower to keep until export to Europe.

4.3.1 *Grading*

Two issues were raised during discussion: damage to onions during grading, and storage of lower grade onions.

Damage to bulbs. For thrips to breed in bulbs they need access to the live flesh scales. Any procedure that breaks the dried skins and exposes the fleshy scales or the entrance through the neck could make a line of bulbs more susceptible to thrips.

At least one person mentioned that onions should be handled gently and another asked about how to grade onions to cause the least damage to bulbs. During the last two years I have seen several grading systems and I believe that there is considerable scope for the industry to learn from current practice and for recommendations to be made about best practice.

Storage of low grade onions. Second grade onions are likely to have more split skins and are, therefore, more likely to have high thrips populations during storage. Ideally these second grade onions, cull onions and other 'dirty' lines should be kept away from 'clean' lines, but in practice sometimes 'clean' and 'dirty' lines may be stored next to each other.

Where fans are used to circulate air within a shed, a concern was expressed that this practice spreads thrips and, potentially, to clean lines.

Onion thrips do fly in onion stores, but there is no consensus about whether 'clean lines' can become significantly contaminated from nearby 'dirty' lines. However two useful comments were made. Firstly, there are reports of 'clean' lines being stored next to thrips-infested lines during shipping and the 'clean' lines being thrips-free at the end of the journey. This, however, may reflect the fact that the 'clean' line is resistant to onion thrips rather than a lack of movement of thrips. Secondly, one interviewee pointed out that in a shed of stacked bins there are few places where thrips can access onions in a bin, i.e. through the horizontal slits on the sides of bins and on the top of bins. As a consequence the outermost onion bulbs are most likely to become infested.

This idea that thrips have limited access to bulbs in bins suggests that thrips movement and contamination of clean lines is of minor importance. It could be tested by putting bins of thrips-free onions into stores with high numbers of flying thrips and at intervals examining bulbs from the top, sides and centre of the bin.

4.3.2 *Storage of onions and shed design*

Issues relating to segregation of 'clean' and 'dirty' lines have been discussed in the previous section. This section focuses on issues relating to storage shed design.

Onion thrips and black mould both grow better at high temperatures. Therefore, thrips and black mould problems can be minimised by keeping the onions as cool as practical. This can be assisted by removing field heat as soon as possible and by keeping the stores cool.

Field heat. It is likely to be impractical to control field heat by harvesting when bulbs are cool and by shading bins in the field. This means that field heat must be removed as soon as binned onions are brought in from the field. This could be achieved by having a separate area to receive and cool onions by forcing cool air through the bins. Once the onions are cooled they can be transferred to another area for storage.

Keeping onions cool. Store design is variable and there seems scope for improving cooling and energy efficiency. It should be possible to prevent unnecessary heating of onions through appropriate shed design and without the use of high energy costs. Key principles are:

- insulating the roof to prevent heat radiating down onto the onion bins,
- providing adequate space between the top bin and the ceiling,
- using natural ventilation,
- using cold night air,

- allowing heat to exit through the highest point in the roof of the store,
- positioning air intakes close to the floor and extraction fans at the high point in the roof of the store to allow cool air to fill up the store without mixing with escaping hot air, and
- allowing enough room between rows of bins for warm air to escape and for cool air to enter bins.

Some sheds already feature natural ventilation. For example, some have walls made of vertical planks with gaps between. Some sheds are sited so that they are exposed to the southerly or westerly winds, which are believed to be cooler. However, roof insulation and ridge ventilation may need to be checked and improved.

Other stores are more enclosed and use fans to draw in air and/or to expel air. It is important that the fans are properly sited. For example, fans removing hot air should be at the apex of the roof.

Openings for passive air movement and for fan inlets and outlets should be sufficiently large to allow for a full air change within a sufficiently short time. Engineering advice may be helpful in this area.

There is scope to improve onion storage shed design and cooling, and engineering expertise could usefully assist with this objective. The NZOEA should commission guidelines for the design and operation of onion stores, including ways of improving existing structures and building new stores.

4.4 *Other issues raised*

Three issues were raised that are outside the scope of the report but could affect the levels of thrips infestations.

- It was stated that onions in reefer ships experience a more uniform temperature and remain cooler than onions shipped in containers.
- It was suggested that in the long term there might be merit in adopting the UK practice of artificially curing onions. They are harvested and sized while green and cured at 28°C.
- It would be useful to have a database of existing information on onion cropping.

5 *Discussion*

5.1 *Onion stores*

No major practical changes are required to current procedures for two reasons. Firstly, there is no clear evidence that large numbers of thrips transfer to clean lines of onion bulbs. Secondly, while store managers tend to keep 'dirty' and 'clean' lines separate, during the year there are times when space is limited and it is not possible to do so.

Onion thrips breed faster at higher temperatures and the survey identified opportunities for improving the management of stores, store design to improve heat removal and ways of increasing the efficiency of cool stores. Issues that should be considered are:

- a special area for removing field heat from bins of onions,
- the distance between rows of bins so that the gap does not impede air exchange,
- ways of maximising natural ventilation,
- the optimum position for fan air intakes and outlets, and
- roof insulation to reduce radiant heat and adequate space between the topmost bin and the ceiling.

Guidelines on store design and cooling are also required.

5.2 Handling of bulbs

Thrips problems tend to be worse where the dry outer skins are split to expose fleshy scales. The benefits of gentle handling of bulbs were emphasised by survey respondents. Important factors include methods of handling in the field, grading processes and the transfer of bulbs between bins/containers. It would be useful to document current procedures and make recommendations on best practices.

5.3 EUREP-GAP, IPM and other trends

Currently some European supermarkets require detailed documentation about how crops are grown. Exports of fresh produce to Europe are likely to have to meet EUREP-GAP requirements within a few years. This will have the advantage that it will standardise the requirements for all European retailers. The crop protection component of EUREP-GAP is basically an integrated pest management (IPM) system. This needs to be more comprehensive that the current pesticide resistance management strategy for thrips. It must cover all pest, disease and weed control. It would be advisable to start planning for the integration of all crop protection information into a single IPM system.

The government is currently debating a pesticide reduction strategy. IPM systems usually result in a reduction of pesticides used in a crop. The industry should document changes in pesticide use during the transition from current practices to IPM. This would demonstrate the industry's contribution to a pesticide reduction strategy and provide information that can be used to market the industry's environmental credentials.

Global warming, carbon taxes and energy use are likely to be issues in the near future. Onion stores with fans and cooling systems require energy. There are opportunities when designing onion stores to maximise natural ventilation and to minimise the use of energy to remove excess heat from onion bulbs. This could be part of the industry's contribution to reduced energy and carbon use. The industry can assist by providing guidelines for energy efficient store design.

6 Recommendations

The following recommendations are not presented in order of priority.

- **Traceability and detecting common factors that make onion bulbs susceptible to pests and diseases.** A small working group should:
  - devise a common format for recording information that will meet EUREP-GAP requirements,
  - decide upon the additional information needed to identify factors that make bulbs susceptible to thrips and disease, and
  - design an onion quality recording form for importers that includes pests and diseases

The recording system should include domestic and reject lines.

- **Preharvest.** Two areas of interest to the onion industry are: factors that make onion bulbs resistant or susceptible to onion thrips, and the agronomic and post top fall practices that reliably improve skin quality. The NZOEA should support and facilitate research on:
  - onion bulb resistance to onion thrips, and
  - factors influencing onion skin quality.
- **Handling and grading onions.** The NZOEA should commission a study on current handling and grading practices and make recommendations on best practices that reduce damage to bulbs.
- **Removing field heat from onions.** The NZOEA should investigate the practicality of methods to rapidly remove excess field heat from onions.
- **Improving onion stores.** Onion thrips and some bulb diseases develop faster when bulb temperatures are high. Excess heat in onion stores could be reduced by improved design. The NZOEA should commission guidelines on store design and cooling.
- **Onion stores and global warming.** There are opportunities to design onion stores that maximise natural ventilation and minimise the use of energy to keep onions cool. These objectives should be incorporated into guidelines on onion store design and cooling.
- **EUREP-GAP and Integrated Pest Management (IPM).** In order to meet EUREP-GAP requirements, the onion industry should plan to integrate all crop protection information into an IPM system for pests, diseases and weeds.
- **Pesticide reduction strategy and IPM.** The government is currently debating a pesticide reduction strategy; implementation of IPM is the best way to achieve this. The onion industry should document changes in pesticide use during the transition from current practices to the adoption of IPM in order to demonstrate its contribution to the pest reduction strategy and to provide information that can be used to market the industry's commitment to environmental quality.

7 Acknowledgements

Thanks to members of NZOEA and other people working in the onion industry for their time, contribution to ideas and comments on a draft of this report.

8 References

Martin, N.A.; Workman, P.J. 2001: Onion thrips breeding and damage to onion bulbs: laboratory studies. *Crop & Food Research Confidential Report No. 409.* 9 p.

Wright, P.J.; Grant, D.G. 1997: Effects of cultural practices at harvest on onion bulb quality and incidence of rots in storage. *New Zealand Journal of Crop and Horticultural Science 25*: 353-358.