Final Report

Development of an Onion White Rot Forecast Model for Tasmania

Project leader:

Calum Wilson

Delivery partner:

University of Tasmania, Tasmanian Institute of Agriculture

Project code:

VN14001

Project:

Development of an Onion White Rot Forecast Model for Tasmania – VN14001

Disclaimer:

Funding statement:

This project has been funded by Hort Innovation, using the onion research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Publishing details:

ISBN 978 0 7341 4409 6

Published and distributed by: Hort Innovation

Level 8
1 Chifley Square
Sydney NSW 2000

Telephone: (02) 8295 2300

www.horticulture.com.au

Content

Summary

Onion white rot, caused by, *Sclerotium cepivorum*, is a highly destructive fungal disease of commercial onion crops. The prevalence of the disease is widespread throughout Tasmania's coastal production areas and is rapidly spreading to the less intensively cropped areas. Individual crop losses vary dramatically, although complete crop losses are rare as heavily infested paddocks are normally not planted.

This project aimed to develop an onion white rot forecast model to better target the application of currently available fungicides, to improve the level and consistency of control and to guide methodologies for screening new fungicides through an understanding of the target root zone. Data on onion root development was collected for the three planting windows (early, intermediate and late) in Tasmania over two growing seasons (2016-17 and 2017-18) in field and planter bag trials.

In field observations, onion root biomass was greatest in the top 100 mm of soil for both seasons across all planting windows. This information may enable growers to target the appropriate root zone with fungicides by irrigating fungicide into the soil. Onion root growth was found to be related to soil temperature, with both root depth and biomass increasing with increasing temperatures. Soil moisture was not found to be a determinant of root growth, suggesting that the moisture conditions observed during this project were all within the acceptable range for onion production. Root biomass increased linearly with soil temperature but increased a faster rate in later sowings.

The timing of onion white rot infection and the effect of inoculum depth were studied in planter bag trials. Onion white rot incidence was not directly associated with root development suggesting that a combination of factors influence disease outbreaks. Whilst disease levels varied between seasons, incidence of onion white rot infected bulbs was lowest in the late planted trials and highest in the early and intermediate plantings. Studies in controlled environments indicated that onion white rot incidence decreases at temperatures above 20°C. Furthermore, some trials indicated that the pathogen may be killed in the top 50 mm of soil during hot weather conditions, which will significantly reduce the likelihood of bulb infection. If feasible, planting later in the season is recommended for fields known to have a history of OWR and potential soil inoculum. Fungicide management is still recommended to reduce the risk of infection reaching the bulbs, with adjustments to timing of application and compliance with fungicide registration guidelines.

The timing and timing and incidence of onion white rot was highly variable in planter bag trials across all seasons and windows. Visual observations of the spatial distribution of root within planter bags suggested greater aggregation of roots compared to field grown plants. This likely reflects the differences in soil structure between fields and resulted in uneven contact rates between roots and inoculum. This observed variably resulted in unreliable prediction of infection based on measured root growth and environmental parameters. However major risk factors were determined from the data gathered that will be of benefit to Tasmanian onion growers for estimation of likely disease risk. Furthermore, prediction of onion root development with soil temperature was shown which may be of additional value in assessing crop development and water requirements.

An unplanned beneficial outcome of this project was contact with Dr Fred Crowe, a world leading authority on onion white rot disease from Oregon State University in the USA. Dr Crowe will visit Tasmania in October 2018 to attend Onions Australia meetings, to present at the Tasmanian Institute of Agriculture Open Day and to discuss onion white rot with growers, industry and researchers. Funding for this visit was sourced from Hort Innovation via a submission from Onions Australia. Dr Crowe's visit has the support of the Tasmanian onion industry and it is hoped that the visit may lead to collaborative research activities with the United States onion industry in the future.

Keywords

Onion white root rot, *Sclerotium cepivorum*, root development, inoculum depth, soil temperature, soil moisture, predictive model

Introduction

Onion white rot is a destructive fungal disease that reduces yields in commercial onion crops. The prevalence of the disease is widespread throughout Tasmania's coastal production areas and is rapidly spreading to the less intensively cropped areas away from the coast. Individual crop losses vary dramatically, although complete crop losses are rare as heavily infested paddocks are normally not planted. This soil borne disease is caused by, *Sclerotium cepivorum* and affects *Allium* species including garlic, leek, chives and spring onion. The fungus infects plant roots and progresses up the roots to the base of the onion bulb. Infection can spread from the roots of one plant to another, resulting in patches of infected plants.

A number of control strategies are currently available for commercial implementation, including two fungicides with the active ingredients tebuconazole and triadimenol, as well as cultural controls such as the time of planting and plant density (Dennis 1997). However, each control strategy on its own is unlikely to provide consistent control in fields with anything other than low levels of inoculum in the soil. Additionally, not all available options can always be implemented by growers due to other factors such as market requirements for bulb size, time of supply, or the need to spread planting windows so that harvests can be managed within existing infrastructure constraints. So while an integrated control strategy has long been recommended, the level of control that can be achieved and the cost involved leaves substantial room for improvement.

Results from previous trials (Pung, 2008) suggest that the mode of action of the fungicides tebuconazole and triadimenol is to temporarily inhibit mycelial growth in the soil. This would slow down the rate of initial infection from sclerotia, inhibit or slow disease progression upwards and towards bulbs and/or slow down root-to-root spread. However, this inhibitory effect is only likely to occur while the concentration of fungicide is high enough. Results from trials in 2012 (Dennis 2012) support this theory, where higher concentrations and volumes of fungicide reduced levels of disease. This was likely due to sufficient active ingredient getting into the root zone before infection could impact on bulbs. Hence, maintaining a threshold concentration of fungicide in the relevant soil profile during periods of fungal activity may be the key to effective control. To facilitate this, the target depth of soil where disease is likely to be active at different times of the season and for different planting times needs to be determined.

Optimising onion white rot control with fungicides is the most valuable short-term strategy for industry, as fungicides are the mainstay of commercially available and applicable integrated control strategies in Tasmania. The development of an onion white rot forecast model to better target the application of currently available fungicides should improve the level and consistency of control. It may also provide information to guide methodologies for screening new fungicides and application options by knowing the target root zone and when to apply new products in screening trials. Development of the model will include key parameters that influence onion white rot development; namely, time of planting, soil temperature, soil moisture, root biomass and depth of infection. Because onions are grown commercially over a relatively long season (May to February), data was collected for three planting windows that represent early, intermediate and late plantings; May, July and September.

Methodology

Experiments and field trials

Data on onion root development were collected for three planting windows (early, intermediate and late) for two growing seasons (2016-17 and 2017-18) in field and planter bag trials. The timing of onion white rot infection and the effect of inoculum depth was studied in planter bag trials. Assessments commenced when the plants were at two leaf stage and continued for up to 30 weeks.

Environmental conditions data collection

Air temperature, relative humidity, soil temperature and soil moisture were monitored with data loggers and sensor probes in field and planter bag trials for both season. Loggers were placed into two bags at the bag trial site and one logger was placed in to each of the six fields in each season. The aim was to collect data on the conditions in commercial onion crops in Tasmania and to provide a comparison with conditions in planter bag trials. Temperature and moisture sensor probes were placed in soil at depths of 50 mm, 100 mm, 200 mm, and 300 mm.

Field data collection

Onion root development was measured in six commercial onion fields in 2016-17 and again in 2017-18. The fields were located in the north of Tasmania, from Hagley to Rocky Cape. Soil cores were collected at various depths and the dry root biomass was estimated. The purpose of these trials was to determine the time taken for roots to reach specific depths in commercial fields and to estimate the quantity of root biomass at various soil depths. In the 2017-18 season, soil core samples were collected fortnightly in 50 mm increments up to 300 mm depth in soil. In the 2016-17 season, the soil depths assessed were 0 to 50 mm, 50 to 100 mm, 100 to 200 mm and 200 to 300 mm. Samples were collected at four weekly intervals.

Details of the crop development stage were also recorded (the number of leaves and bulb diameter). This information may help link the growth stage of the plants with root biomass so that disease risk predictions and field inspections can be based on above ground plant material.

Planter bag trials

All planter bag trials were established at the TIA Vegetable Research Facility at Forth in Tasmania. Planter bags were placed in 350 mm deep trenches to maintain the soil temperature in the bags as close as possible to a field situation. The trenches were located on a slight slope and lined with gravel to provide drainage. Soil for the planter bag trials was collected from the TIA Dairy Research Facility at Elliot. This soil had no history of onion cropping and was expected to be free of *S. cepivorum* sclerotia.

Onion root growth planter bag trials

The aim of these trials was to measure onion root growth in planter bags for comparison with root development in commercial onion crops. Root biomass was measured at various soil depths in the 2016-2017 bag trials. The soil/root depths and root biomass estimation methods were the same as those described above for the field root sampling. At each sampling period, the roots of 10 planter bags were assessed and above ground plant details were recorded. One onion variety was assessed for each planting window.

In the 2017-18 season, the depth of the longest root was recorded, and root biomass was estimated for all roots found in the bag, not for specific depth increments. Two onion varieties were assessed for each planting window. Three bags of each variety were assessed fortnightly. Plant growth-stage (number of leaves and/or bulb diameter) data were collected for both seasons.

Timing of infection planter bag trials

These trials aimed to determine the initial timing of infection when inoculum (sclerotia) were mixed into soil. Destructive fortnightly root assessments were done to look for root symptoms. Fortnightly *in situ* assessments were also done to record above ground symptoms for plants not destructively assessed. This was done for three planting windows in each of the two seasons. For the destructive assessments, plants were considered to be infected when mycelia were observed on roots and/or bulbs. Bulb infection was recorded for both destructive and in situ assessments.

In 2016-17, sclerotia were mixed into the soil at a rate of approximately 40 sclerotia per litre of soil (or approximately 140 sclerotia/bag). Planter bags were filled with 3.5 litres of inoculated soil. Four onion seeds were planted into each bag and then thinned to two plants as required. Planting times for the three planting windows coincide with field planting dates. A single onion variety was assessed for each planting window. In the 2017-18 season, the amount of inoculum was increased to approximately 240 sclerotia per litre of soil (850 sclerotia per bag). The two onion varieties assessed in the root development trial were assessed in this season. Three onion seeds were planted into each bag.

Effect of onion white rot inoculum depth planter bag trials

These trials aimed to determine the time taken for infection to occur when inoculum was placed at specific depths in the soil in planter bags. Roots were examined for symptoms of infection and the time taken for infections to cause above ground symptoms and/or bulb infection. This was done for three planting windows each season.

In the 2016-17 season, inoculum was placed at soil depths of 0 (soil surface), 50 mm,100 mm, 200 mm and 300 mm (one depth per planter bag) at a rate of approximately 40 sclerotia/bag. In the 2017-18 season, inoculum was placed at depths of 50 mm increments (one depth per planter bag) at a rate of approximately 840 sclerotia/bag. The shallowest depth was 50 mm and 300 mm was the deepest inoculum depth.

Monitoring of commercial field sites to ascertain the conditions (soil temperature and soil moisture) that precede onion white rot infection

In addition to monitoring environmental conditions in fields with low risk of onion white rot, commercial fields likely to have onion white rot were monitored, for the two planting windows in the 2017-18 season. The aim was to collect additional data on soil conditions in the field that precede infection and expression of symptoms (wilted plants and infected bulbs) in the field.

Two fields were located at Moriarty and the other field was located at Don, in the north-west of Tasmania. The field at Don and one of the Moriarty fields were planted in June. Soil and ambient conditions were monitored with the same data logger parameters as described above. Loggers were placed into fields shortly after planting. These fields were inspected fortnightly for above ground symptoms of onion white rot. Root sampling was not done in these crops.

The remaining Moriarty field was planted in September. Root data was collected from this field because planting at one of the proposed late planting field trial sites was aborted. Data loggers were also placed at this site.

Effect of temperature on disease development in a controlled environment - planter bag trial

The aim was to ascertain the time required for symptoms to occur and the rate of disease progression under controlled environmental conditions. Planter bags were maintained in individual growth chambers at a range of diurnal temperature conditions (23/18, 20/15, 17/12 and 14/9 °C day/night), with a 14 hour light and 10 hour dark photoperiod. Approximately 140 sclerotia of *S. cepivorum* were placed at a depth of 50 mm in soil on either side of the planter bags. The soil and the inoculum used in this experiment were from the same sources as those used in the 2017-18 outdoor planter bag trials Four seeds were planted into each planter bag. Plants were inspected twice a week for symptoms.

Data analysis

Data analysis and model development was based on data collected from fields and bag trials (root biomass and time to reach specific soil depths). Modelling of bag growth was based on models obtained from field data. The aim was to calibrate root growth in bags with root growth in fields.

The predictors tested included cumulative day degrees (mean daily soil temperature multiplied by number of days), cumulative day moisture (mean soil moisture multiplied by number of days) and sowing windows. For the timing of infection and effect of inoculum depth trials, relationships between initial bulb symptoms and onion root growth were examined, as well as soil temperature and moisture and planting window.

Outputs

Project results

The considerable variability within disease incidences across trials and seasons meant a fully operational predictive disease model was not possible. However major risk factors were determined from the data gathered and this information will be of benefit to Tasmanian onion growers for estimation of likely disease risk. Furthermore, prediction of onion root development with soil temperature was shown which may be of additional value in assessing crop development and water requirements.

The main project results were:

Prediction of root growth in field and bag trials

- Modelling of root growth in planter bags was based on root growth models obtained from field data. The aim was to calibrate bag data with field data and then extrapolate bag data to field data.
- Root depth and biomass were best predicted by cumulative day degrees alone. The inclusion of soil moisture did not improve the predictive power of the models.
- Growing window (early, intermediate or late) influenced biomass predictions but not root depth.
- The rate of root depth development with respect to cumulative day degrees was consistent across sowing windows. In both field and bag trials, the rate of root biomass growth was higher in the late plantings than in the early and intermediate plantings.
- Soil moisture was not found to be a determinant of root growth, suggesting that the moisture conditions observed during this project were all within the acceptable range for onion production.
- While overall root depth and biomass development was consistent between field and planter bags, visual observations suggested that spatial distribution of roots in the horizontal plane of planter bags was more aggregated and irregular in bags than in the field; likely a result of soil structure differences between the two media.

Prediction of the timing of OWR infection and effect of inoculum depth in planter bag trials

- Disease incidence (infected bulbs) was highest for the early plantings and least for the late plantings (Appendix 1).
- The optimal depth for inoculum appeared to be 100 mm for promotion of disease initiation and incidence of bulb infection; both timing of disease initiation and incidence declined at shallower and deeper depths.
- Timing to initial disease symptoms and incidence of disease symptoms decreased from early to late plantings suggesting that factors other than root growth influence disease outbreaks.
- High variability in observed timing and incidence of onion white rot infections in planter bags meant that no direct relationships between disease and root growth, and/or environmental parameters, could be reliably modelled.
- The trend for highest disease incidence (infected bulbs) in the early plantings and negligible disease in the late planting was evident for the Baron onion variety which was planted as a standard across the three planting windows in 2017-18 (Appendix 1). This indicates that the decrease in disease incidence with successively later plantings was influenced by conditions during the growing season rather than differences in susceptibility of onion varieties.
- Abnormally high temperatures experienced during trials in the final season led to periods of elevated soil temperatures in the critical top 100 mm. There were no new bulb infections during these periods. Newly infected bulbs were again found after a few days of cooler weather. It is suspected that the mycelia near the soil surface are killed or inhibited by the heat and that mycelia from lower depths where it is cooler, survive and progress up towards the bulb.

Effect of temperature on OWR disease development in a controlled environment

- Plants with onion white rot infection were observed in all temperature treatments in the growth chamber experiment (temperature range tested was from 9 to 23 °C) (Appendix 1).
- The greatest number of symptomatic plants were observed for the 20/15 °C and 17/12 °C temperature treatments.
- Infection occurred fastest in the 20/15 °C (56 days after seeds were planted).
- Below this optimal temperature range, time to initial symptoms increased with decreasing temperature. The temperature below which infection fails to occur could not be determined within the tested temperature range.
- Day degree total to initial symptoms was highest for the 23/18 °C treatment and disease incidence was relatively low. This suggests that fungal activity is limited by higher temperatures.
- The degree day estimates in this trial were comparable to those observed in planter bag trials exposed to field climatic conditions.

Project Milestones and final report

These were prepared and shared with HIA and key industry stakeholders in the project

Industry communications

We generated and circulated industry publications to aid in the communication of the project outcomes to the industry. These include:

Industry fact sheet

A fact sheet outlining the major project outcomes, key points and recommendations will be made available to industry.

Industry magazine and media publications

Wilson, CR and Jones, SJ, "Development of an onion white rot forecast mode for Tasmania", *Australian Onions,* Onions Australia, Skye, Victoria, **33** (2016) [Magazine Article]

Onions Australia, 'Key findings from onion white rot research released' *Layers,* Onions Australia, **August** (2018) [Newsletter Article]

Onions Australia 2018, *Forecasting onion white rot in Tasmania,* Video, Onions Australia http://www.onionsaustralia.org.au/news-updates/rd-videos/

Newspaper articles

Jones, SJ "Onion fungi trial on course", *The Advocate,* Fairfax media, Australia, **25 August** (2016) [Newspaper Article]

Jones, SJ" White rot control method" *The Advocate,* Fairfax media, Australia, **28 September** (2017) [Newspaper Article]

We also provided frequent updates on project progress and outcomes to industry partners by:

- Approximately 12 face-to-face and telephone discussions with industry stakeholders, as well as email correspondence.

Outcomes

Major disease risk factors associated with the growing environment, but not directly with plant root growth were determined that will benefit Tasmanian onion growers for estimation of likely disease risk.

Prediction of onion root development with soil temperature was shown which may be of additional value in assessing crop development and water requirements.

Disease risk is indirectly related to onion root growth and more directly related to temperature

Soil temperature appears to be an important factor in disease development. Onion root growth, both in terms of biomass and root depth, was increased by increasing soil temperatures in these studies. However, timing and incidence of onion white rot was not directly associated with root development suggesting that factors other than root growth influence disease outbreaks.

Growth chamber studies indicated that onion white rot development decreased at temperatures above 20 °C. Additionally, onion white rot, but not root growth, was reduced in later sowing windows where relative soil temperatures were higher. These observations suggest that for a predictive model for onion white rot to be developed, further work is required to determine the effect of temperature on onion white rot sclerotial germination and survival and fungal activity, including under field conditions.

Disease risk is driven from inoculum in the top 100 mm of soil

Disease symptoms were highest when inoculum was in the top 100 mm of soil. This observation and the finding that infections occurred most frequently in earlier plantings, was discussed with local industry at a Tasmanian Onion Agronomy Group meeting. The Chairman of the group, Tim Groom, (Wynyon Pty. Ltd.) said this information was new and important for onion growers and industry advisors. Mr Groom said the information would enable growers to target the appropriate root zone with fungicides by irrigating the fungicide into the soil. This practice has potential to increase the effectiveness of fungicide applications and reduce the incidence of bulb infection. Further research to evaluate the effectiveness of fungicide applications in this target root zone and to determine the effective dose is recommended.

Disease risk in Tasmania is lowest in late plantings

The incidence of infected bulbs in the bag trials was highest when onions were planted from May until early August and lowest when onions were planted in September. For fields with a known history of OWR, planting late in the season may reduce the risk of disease. Fungicide management is still recommended with adjustments to timing , possible inclusion of a late application and compliance with chemical registration guidelines.

Elevated soil surface temperature may kill pathogen in the critical top 50 mm of soil

Observations of the timing of bulb infections in trials during the 2017-18 indicated that the pathogen may be killed in the top 50 mm of soil during hot weather conditions. Additionally, infected bulbs were not detected in bags with inoculum at or above 50 mm in the late planted depth trials for both seasons. Thus, high temperatures near the soil surface may reduce the likelihood of infection reaching bulbs. Further work is required to determine if this is the case.

Pathogen present at depth may survive elevated soil surface temperature and result in late infections

However, despite the potential benefits of elevated soil temperatures in reducing surface inoculum, the pathogen may survive in the cooler lower soil depths and progress up towards the bulb if the soil temperatures decrease towards the end of the season and before harvest. A late fungicide application may be effective in targeting mycelium close to the base plate and preventing infection reaching the bulbs in this scenario.

Collaborative relationship established with Dr Fred Crowe

Dr Fred Crowe is a world leading authority on onion white rot disease and has an extensive research and working knowledge of the disease on onions and garlic. A collegial relationship has been established with Dr Crowe during the course of this project. Dr Crowe has provided information and advice on technical aspects, including the latest research on onion white rot in the United States.

Dr Crowe will be visiting Tasmania in October 2018 to attend Onions Australia meetings, to present at the Tasmanian Institute of Agriculture Open Day and to discuss onion white rot with growers, industry and researchers. Funding for this visit was sourced from Hort Innovation via a submission from Onions Australia. Dr Crowe's visit has the support of the Tasmanian onion industry and it is hoped that the visit may lead to collaborative research activities with the United States onion industry in the future.

Monitoring and evaluation

This project was developed prior to the requirement to develop an M&E Plan. Nevertheless, this project has delivered against a number of key criteria typical of most research projects. Key Evaluation questions (KEQ's) for the project are provided below with an indication of whether project expectations were met:

What has been the impact and/or outcome of the project?

- To what extent has the project contributed to increased knowledge
- To what extent has the project contributed to the goals of the stakeholders and HIA

Industry knowledge gain has been progressed through informal meetings and discussions with project stakeholders. The knowledge gained has been utilized to inform industry on disease risk factors. This improved understanding of the host:pathogen dynamic provides further insight into management options for this disease – a key goal of project stakeholders and Hort innovation.

The project has also contributed to the stakeholders and HIA by also suggesting further potential research priorities that will aid in management of onion white root rot.

To what extent has the project met participation objectives?

- How effectively has the project shared its findings with stakeholders and the broader agricultural community
- Did the project achieve its outcomes measured or otherwise

Communication with key stakeholders (including Tim Groom (Wynyon Pty. Ltd.), Jason McNeill (Premium Fresh Tasmania), Andrew Doran (Terranova Seeds Pty. Ltd.), Aiden Porter (Botanical Resources Australia) and Julian Shaw (Agronico)) has been effective with meetings and discussion of research ideas. Informal discussions and articles in industry magazines and rural press have also enabled the sharing of findings with industry.

As stated above, this project has meet key outcomes of increasing fundamental knowledge and unlocking putative control and management options.

How effectively was the project delivered?

- Timeliness, within budget
- What impacted on these?

The project has been undertaken on budget. The timeline for this project has needed to be extended with no impact on budget to undertake final trials, required to manage limitations in disease levels in prior work and appropriate analysis of data sets.

What resources have been used to run the project?

- How could the project have been run more efficiently
- What other resources, in-kind or otherwise were used to meet the project outcomes

Limitations in disease expression in some trials have been an issue for the project. This is despite best practice to encourage disease and as such there are few changes that could have been recommended. Monitoring of root growth in planter bag systems was a significant challenge. Trialing and adapting improved experimental bag systems to enable more efficient root monitoring throughout the project have provided superior systems for this type of work. Support from industry was very good and appreciated.

The stakeholders also provided in kind support through field sites and were generous with their time for informal discussions on research progress. Other in-kind support has been provided by the University of Tasmania to provide and fund technical assistance, laboratory and field infrastructure.

Recommendations

1. *The impact of environmental conditions on sclerotial germination and pathogen survival requires further examination*

The findings of this project indicate that factors other than root growth influence disease outbreaks. The impact of higher soil temperatures on sclerotial germination, pathogen survival and fungal activity appears to be a critical component in the development of a forecasting model for onion white rot. However, the experimental design of this project was not structured to test the effect of specific temperatures. Additionally, sporadic infection rates made attempts at predictive modelling of disease onset difficult and analysis outputs were not robust enough to be considered reliable. It is therefore recommended for development of a more robust model that may be of predictive use for growers, that additional research be conducted into this relationship and any potential interactions with other soil environmental conditions. Based on the observations of this project, these relationships may include a potential optimum for fungal activity of approximately 15 to 20 °C, but reduced germination, sclerotial and or hyphal death with sustained temperatures above 20 °C.

2. *Fungicide applications need to target the top 100 mm of soil*

The findings that most onion roots (> 80%) were in the top 100 mm of soil in commercial fields indicates that fungicide applications should target this area of the soil. While disease outbreaks were not found to be directly related to root growth in bag trials, the high biomass in this soil depth under field conditions potentially provides opportunity for root-to-root spread of infection. Additionally, the incidence of infections was highest when inoculum was at this depth in planter bag trials. Targeting the top 100 mm soil could be achieved by irrigating the fungicide into the soil to ensure that active ingredients reach the target root zone. Growers could calculate the amount of water required over the treatment area. The timing of fungicide applications targeting this soil depth is likely to vary with planting windows.

3. *Fields considered to be at risk of having onion white rot would be best planted later in the season.*

The incidence of infected bulbs was lowest in the late planted bag trials and highest in the early and intermediate plantings. Discussions with onion industry representatives indicate that this has also been observed in commercial field operations. Fields considered to be at risk of developing onion white rot could be planted later to minimise the risk. This recommendation does not negate the need for fungicide control and applications are still likely to be needed for effective disease control.

4. *A late fungicide application to prevent late infections*

While the incidence of infection in the late plantings was relatively low, the results of the inoculum depth bag trials indicate that the fungus may be killed in the top 50 mm of soil during hot weather conditions but survive in lower soil depths that are cooler. This means that fungi in the lower soil depths may remain active and progress up towards the bulb if ambient and soil temperatures are lower towards the end of the season and before harvest. Inclusion of a late season application in the fungicide spray program may be needed to target mycelium close to the base plate and prevent infection reaching the bulbs. Any adjustments to timing of application would need to be compliant with fungicide registration guidelines.

5. *Further research to evaluate the effectiveness of fungicide applications in the target root zone and to determine the effective dose is required*

The practice of targeting the top 100 mm of soil has potential to increase the effectiveness of fungicide applications and reduce the incidence of bulb infection. Further research to evaluate the effectiveness of fungicide applications in this target root zone and to determine the effective dose under field conditions is recommended.

Refereed scientific publications

None to date – preparation and submission for publication of a journal article is anticipated by end of 2018

References

Dennis, J. 1997. Progress towards an integrated control strategy for onion white root rot disease, including the use of artificial germination stimulants. Proceedings of the Second International Symposium on Edible Alliaceae. Acta Horticulturae Number 555:117-121

Dennis, J., Birtill, R., Congerton, J. 2012. Field Fresh Tasmania R&D 2011/12 Season Report

Pung, H. 2008, VN05010 Investigations on the efficacy of Folicur in lime super carrier and development of alternative carriers for white rot control in onions. HAL Project Final Report VN05010

Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report

Acknowledgements

We would like to acknowledge a range of people who have provided advice and assistance to this project. This assistance ranges from formal and informal discussions, providing detailed feedback and helping/undertaking field-based studies and providing cultivars for assessment.

We. would like to acknowledge the key industry people who assisted the project: Tim Groom (Wynyon Pty. Ltd.), Jason McNeill (Premium Fresh Tasmania), Andrew Doran (Terranova Seeds Pty. Ltd.), Aiden Porter (Botanical Resources Australia) and Julian Shaw (Agronico).

Growers who kindly allowed the field data to be collected from their crops were: Alan Stevens, Alastair Mitchelson, Stuart Crichton, Shane Radford, David Addison, Colin Chaplin, George Griffin and Josh Mitchell.

Also, to technical TIA staff who have assisted with the study, especially Pattie Weichelt, and Philip Beveridge. Thanks also to Tim Smallbon (TIA) for technical advice.

Dr Fred Crowe, who provided information and insights throughout the second season of this project.

Appendices

Appendix 1: Summary of experimental results

Modelling Onion Root Growth

Root growth in field and bag trials

Field trial data

Root biomass was greatest in the top 50 mm of soil for both seasons and all planting windows. Less biomass was found in each subsequent depth below 50 mm with the least amount of roots found in the lowest sampled depth (up to 300 mm). This trend of higher root biomass in the top 50 and 100 mm of soil persisted throughout the season. For example, in the 2017-18 season, more than 82 % of the roots found were in the top 100 mm of soil samples collected from 140 to 175 days after planting, (Table 1). The findings were similar for the 2016-17 season with average root biomass greater than 84% in the top 100 mm of soil for all six sites.

Table 1. The percentage of root biomass in soil samples from commercial onion fields in the 2017-18 season. Samples were collected from 50 mm increments of soil depth.

	Field site 2017-18					
Soil depth (mm)	1[a]	2	3	4	5	6
0 to 50	66.01	80.63	58.52	64.65	82.27	55.75
50 to 100	18.56	12.82	27.76	23.96	13.17	26.77
100 to 150	9.20	4.50	7.63	4.98	3.52	12.80
150 to 200	4.18	1.41	3.61	3.49	0.87	3.67
200 to 250	1.88	0.46	2.09	2.12	0.17	0.88
250 to 300	0.16	0.18	0.40	0.80	0.01	0.12
no. days after planting	175	168	171	161	144	140

[a] – Fields 1 and 2 represent early planted fields; 3 and 4 represent intermediate planted fields and 5 and 6 represent late planted fields.

The time that it took for roots to reach specific depths in the soil varied for the two seasons. In the 2016-17 season roots were found below 100 mm 70 days after planting for all planting windows. Roots were found below 100 mm 51 to 55 days after planting in the late plantings. In the 2017-18 season, the time taken for roots to reach below 100 mm was longest for the early plantings (99 to 132 days) and fastest for the later plantings (41 to 51 days). Possible reasons for this include changes to the sampling method (smaller depth increments) in the 2017-18 season, differences in onion varieties and seasonal environmental conditions.

Onion root growth planter bag trials

The distribution of root biomass in soil depths in the planter bags did not reflect root biomass at depth in field samples in 2016-17. This was particularly evident later in the season when roots accumulated in the 200 to 300 mm depth of the bags and biomass was highest in the lowest soil depth. By comparison, root biomass in the field samples was consistently lower in the bottom soil depths of 200 to 300 mm.

In the 2016-17 season, roots were found below the 100 mm soil depth 67 days after planting for the early planting and 55 days for the late planting. In the 2017-18 season roots were found below 100 mm 83 days after planting for the early planting and 31 days for the late planting**.**

Development of an Onion root growth model

Root growth under field conditions, measured as both root depth and root biomass, was initially model using linearized versions of the standard growth curves (linear, logistic, exponential, monomolecular and Gompertz; Gottwald et al. 1989). Data was transformed and model fits compared by backtransforming predicted values for each model to the original scale and modeling against observed values (Neher et al). The model with the highest R^2 in this backtransformed data comparison was selected.

Depth of root growth was best described by a Gompertz growth model with cumulative day degrees as the predictor variable (Fig. 1). Including either cumulative water moisture and/or sowing window as model predictors did not significantly improve the fit of this model. Season was included in the model as a random intercept in a mixed model. Under the optimal model the estimated rate parameter was 110.7 with an estimated initial root growth of -1.7 mm. Fitting the model developed from field observations to those recorded from planter bags provided an estimated rate parameter of 110.9 and an initial root depth of -0.44 mm (Fig. 2).

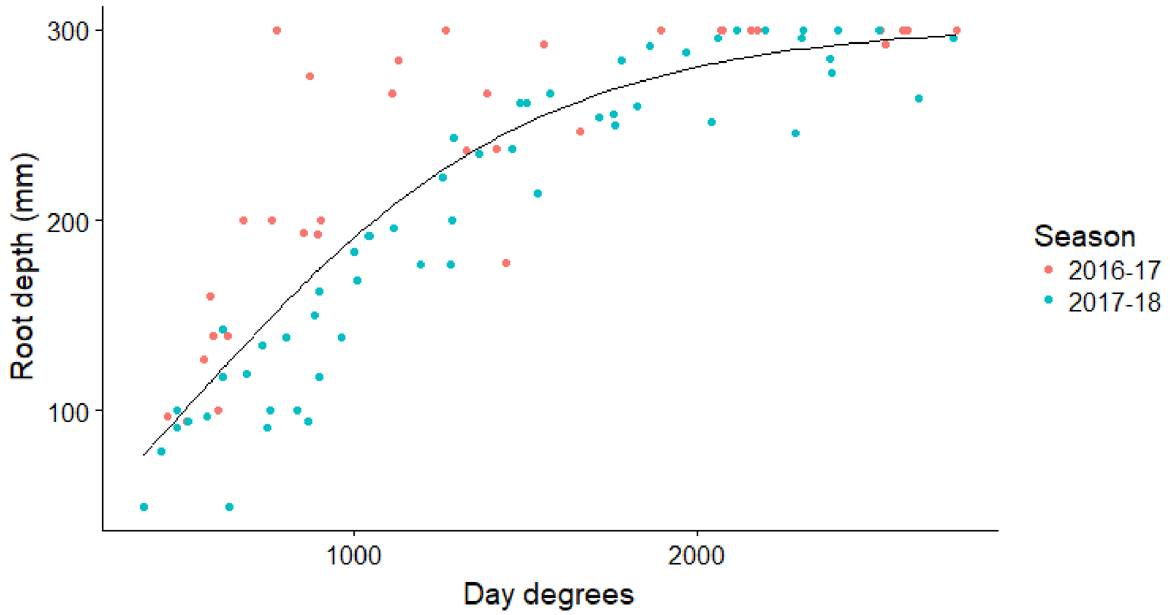

Figure 1. Onion root depth change over time, expressed as cumulative day degrees above 0.

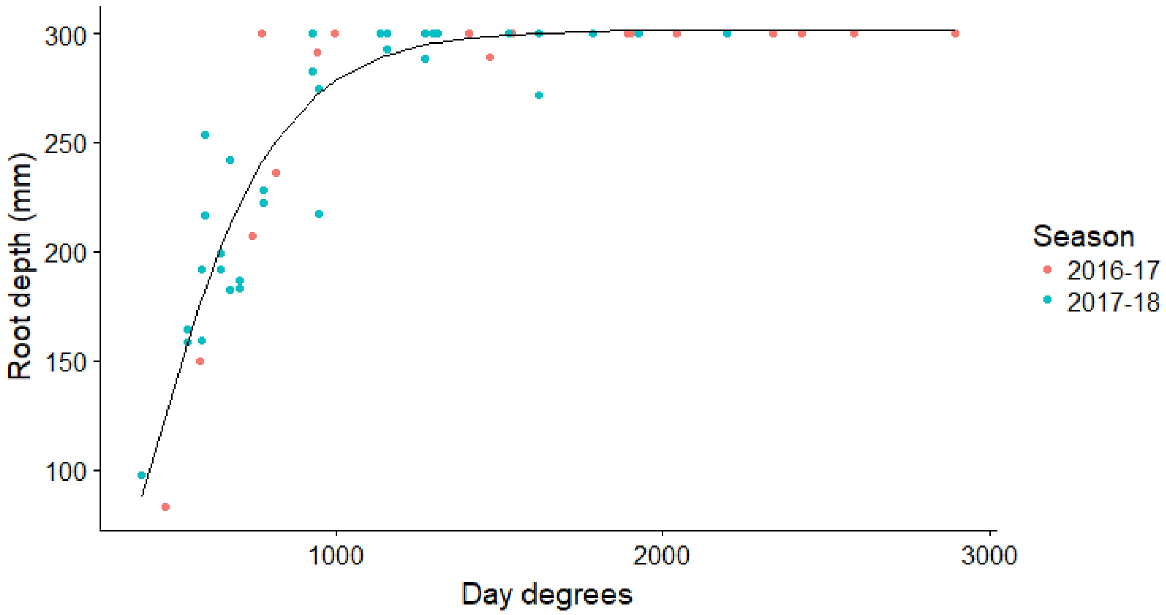

Figure 2. Onion root depth in planter bags over time. Time is expressed as cumulative day degrees above 0.

Root biomass development was best described by a linear model with cumulative day degrees as the primary predictor variable and Season included as a random intercept. The additional of sowing Window as a predictor variable to this model indicated a significant interaction between cumulative day degrees and window. Inclusion of cumulative soil moisture did not significantly affect model predictions and was excluded from the optimal model. Under the optimal model, rate of root biomass growth was 0.002, 0.015 and 0.037 g per day degree for the early, intermediate and late windows respectively (Fig. 3). Initial root biomass was estimated to be 0.05, 0.03 and 0.01 g for the early, intermediate and late windows, respectively.

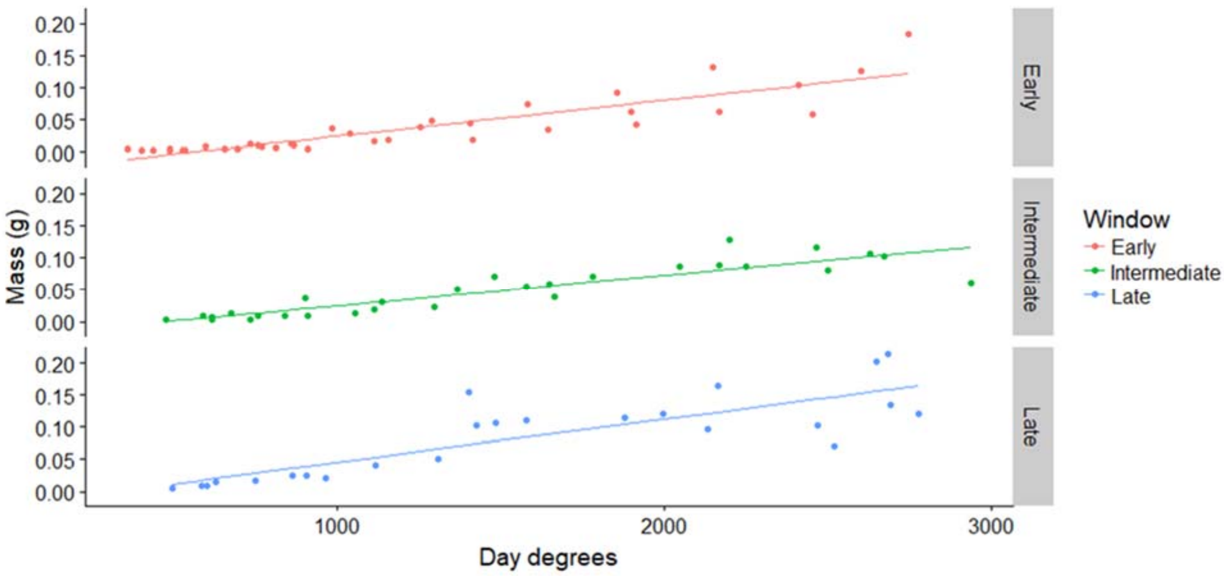

Figure 3. The change in onion root biomass under field conditions over time, where time is expressed as cumulative day degrees.

Fitting the models this model to planter bag observations resulted in rate parameter estimates of 0.056, 0.053 and 0.135 g per day degree for the early, intermediate and late windows, respectively, suggesting that rate of biomass development was greater in planter bags than in the field (Fig. 8). Initial root biomass for these windows (in order) was estimated to be -1.51, -0.03 and -0.01 g.

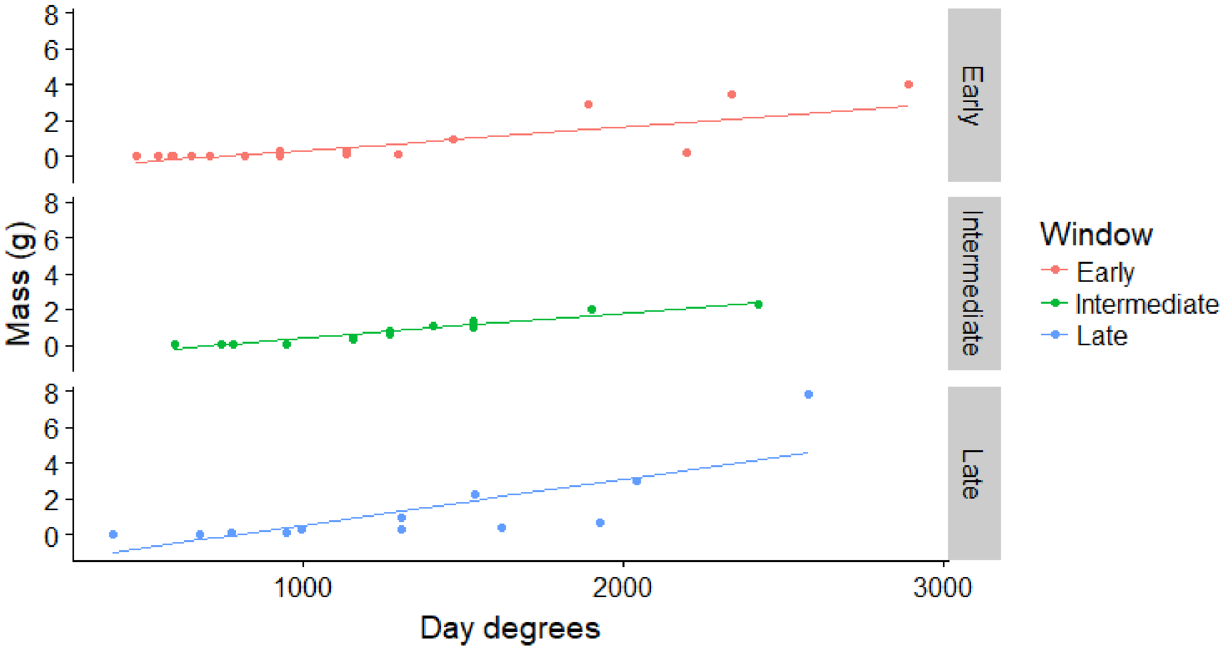

Figure 4. The change in onion root biomass in planter bags over time, where time is expressed as cumulative day degrees.

Modelling Onion white root rot infections

Timing of infection planter bag trials

Bulb infection was greatest in the early planting (Table 2). Infected bulbs were first observed in the early planting in late November. Infection was not observed on bulbs of the intermediate and late plantings until mid-February. The presence of mycelia on roots was recorded during destructive disease assessments. This was not considered to be a reliable indicator of timing and location of the initial infection because the fungus could have been active in other sections of roots before the roots were examined.

Table 4. The number of planter bags with onion bulb infection for early, intermediate and late planting windows in the 2016-17 season.

Symptom	Early[a]	Intermediate	Late[b]
Bulb infection	13[c]	2[d]	1[e]

[a] – Early Cream Gold variety was planted for early and intermediate planting windows.
[b] – Regular Cream Gold onion variety was planted for the late planting window.
[c] – 90 planter bags were assessed for the early planting window.
[d] - 75 planter bags were assessed for the intermediate planting window.
[e] - 70 planter bags were assessed for the late planting window.

The incidence of infected bulbs was greater in the 2017-18 season than in 2016-17. This was likely influenced by the modification of experimental methods and increased amount of inoculum added to bags in the latter season. Disease incidence was highest in the early planting and lowest in the late planting (Table 3). Infected bulbs were first observed in late October in the early planting and late November for the intermediate planting. No diseased bulbs were found for the late planting.

The trend for highest disease incidence (infected bulbs) in the early planting and negligible disease in the late planting was evident in the Baron variety which was planted as a standard across the three planting windows in 2017-18. This indicates that the decrease in disease incidence with successively later plantings was influenced by conditions during the growing season rather than differences in susceptibility of onion varieties.

Table 5. The number of planter bags with onion bulb infection for early, intermediate and late planting windows in the 2017-18 season.

	Early		Intermediate		Late	
Symptom	Baron[a]	M&R Early[b]	Baron	ELPK	Baron	Plutonus
Bulb infection	18[c]	9	11[d]	6	0[e]	0

[a] – Baron onion variety was planted in each planting window
[b] – M&R Early, ELPK and Plutonus were planted as a second onion variety in the early, intermediate and late planting windows respectively.
[c] – 45 bags were assessed for each onion variety in the early planting
[d] – 39 bags were assessed for each onion variety in the intermediate planting
[e] – 33 bags were assessed for each onion variety in the late planting

Development of an Onion White Root Rot infection model

Trial 2: Onion white root rot incidence on bulbs in planter bag trials

Disease incidence was greater in 2017/18 than 2016/17. Disease incidence was higher in Early plantings than late. No OWR symptoms were observed on uninoculated bulbs. Initial disease symptoms observed from 1200 (Early) 1700 (Intermediate) and 2300 (Late) day degrees.

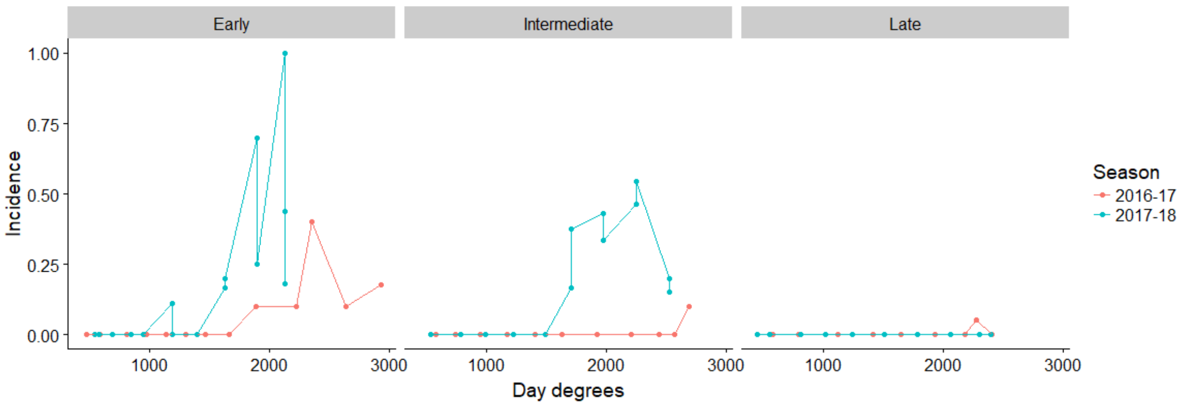

Figure 5. Time to initial disease measured in day degrees for Early, Intermediate and Late plantings for the 2016-17 and 2017-18 planter bag trials. Data points represent the total number of infected plants.

Trial 3: Onion white root rot incidence on bulbs in planter bag trials of inoculum depth

OWR symptoms were first observed at approx. 2300-2500 day. degrees (139-143 days at Late, 167-174 days in Intermediate, 204-210 days in early) (Figure 6A). The greatest disease was observed when inoculum was at 50 and 100 mm depths in soil (Figure 6B and Tables 6 and 7). No OWR was observed on uninoculated bulbs.

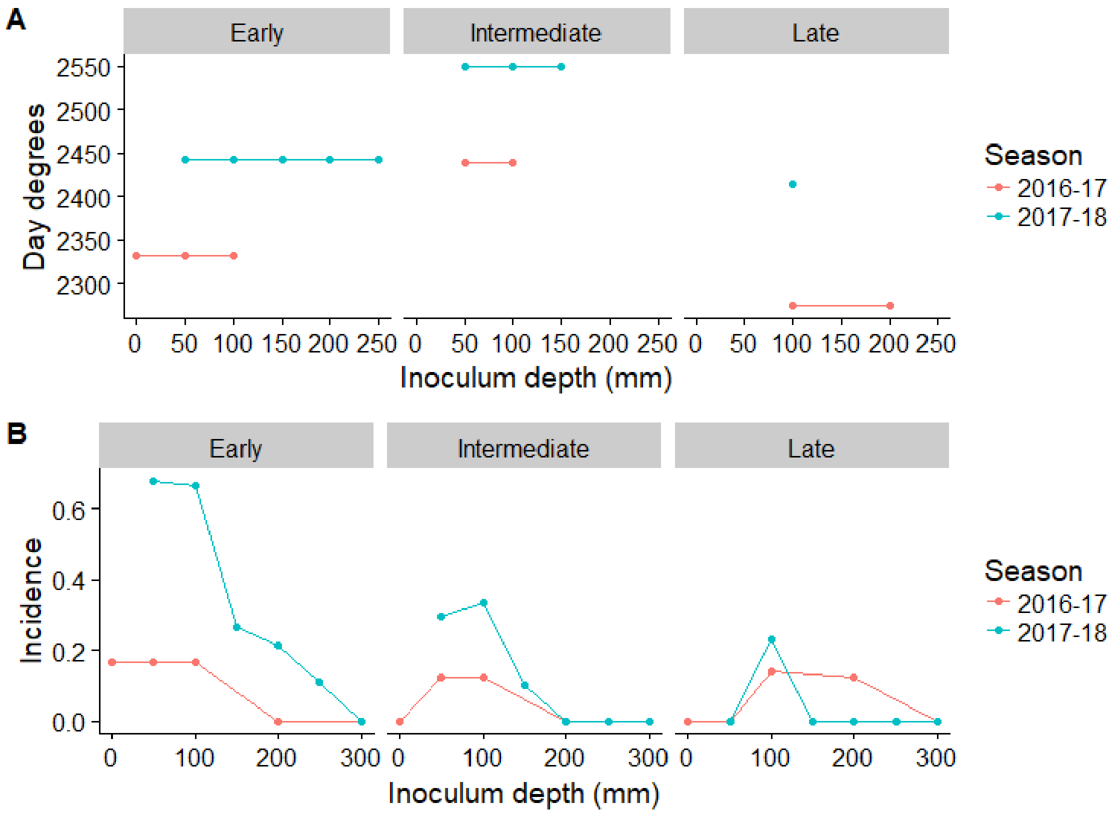

Figure 6. Incidence of infected bulbs for Early, Intermediate and Late plantings for the 2016-17 and 2017-18 inoculum depth planter bag trials. The time to initial infection in day degrees from seed sowing (A) and the maximum number of infected plants observed (B).

Effect of onion white rot inoculum depth planter bag trials

For the 2016-17 season, disease incidence was generally low. Infected bulbs were only observed in bags with inoculum top 100 mm soil for the early and intermediate plantings (Table 6). Bulbs with onion white rot were in bags with inoculum at 100 and 200 mm depths for the late planting. For the early planting, infected bulbs were first observed in mid- December. Infected bulbs were first observed early and mid-February for the intermediate and late plantings respectively.

Table 6. The number of planter bags with infected onion bulbs for each inoculum depth assessed for each planting window in the 2016-17 season.

Inoculum depth (mm)	Early[a]	Intermediate	Late[b]
0[c]	1[d]	0	0
50	1	1	0
100	1	1	1
200	0	0	1
300	0	0	0

[a] – Early cream gold onion variety was planted for the early and intermediate planting window.
[b] – Regular cream gold onion variety was planted for the late planting window.
[c] - 0 depth represents sclerotia placed on top of the soil.
[d] -15 planter bags were assessed for each inoculum depth and planting window.

The incidence of infected bulbs was higher in the 2017-18 season than in the previous season. As stated above, this was likely influenced by an increase in the amount of inoculum placed into the planter bags in this season. Infected bulbs were initially observed in late November for the early planting (at 200 mm depth), late December for the intermediate planting (50 and 100 mm depths) and mid-February for the late planting (100 mm depth.

Table 7. The number of planter bags with infected onion bulbs for each inoculum depth assessed for each planting window in the 2017-18 season.

Inoculum depth (mm)	Early[a]	Intermediate[b]	Late[c]
50	11	6	0
100	13	7	2
150	6	2	0
200	8	0	0
250	3	0	0
300	0	0	0

[a] – M&R Early onion variety was planted and 39 bags were assessed for each inoculum depth in the early planting.
[b] – Baron onion variety was planted and 33 bags were assessed for each inoculum depth in the intermediate planting
[c] – Plutonus onion variety was planted and 27 bags were assessed for each inoculum depth.

Environmental conditions data

In 2016-17, field ambient temperatures ranged from -0. 45 °C to 36.4 °C. Soil temperatures were generally similar to, or lower than, ambient temperatures and with less fluctuations. Ambient temperatures at the bag trial site ranged from -0.87 to 31.28 °C. The maximum soil temperatures recorded in planter bags for the 50 mm soil depth (35.10 °C) was within the observed maximum soil temperature range for commercial fields (27.23 to 37.78°C).

Ambient and 50 mm depth soil temperatures in fields in the 2017-18 season ranged from -6.42 to 35.53 °C and 0.25 to 35.25 respectively. Ambient and 50 mm soil temperatures at the planter bag trial site ranged from -1.61 to 35.48 °C and -0.451 to 37.98 °C respectively.

For the 2016-17 season, mean soil moisture levels in the top 50 mm of field crops (range of 0.08 to 0.25 m^3/m^3) were generally lower than for the same soil depth in the bag trials (range of 0.23 to 0.37 m^3/m^3). In the 2017-18 season, mean soil moisture in the top 50 mm ranged from 0.17 to 0.25 m^3/m^3 at the bag trial site. Mean soil moisture range for the top 50 mm at field sites that season ranged from 0.07 to 0.25 m^3/m^3.

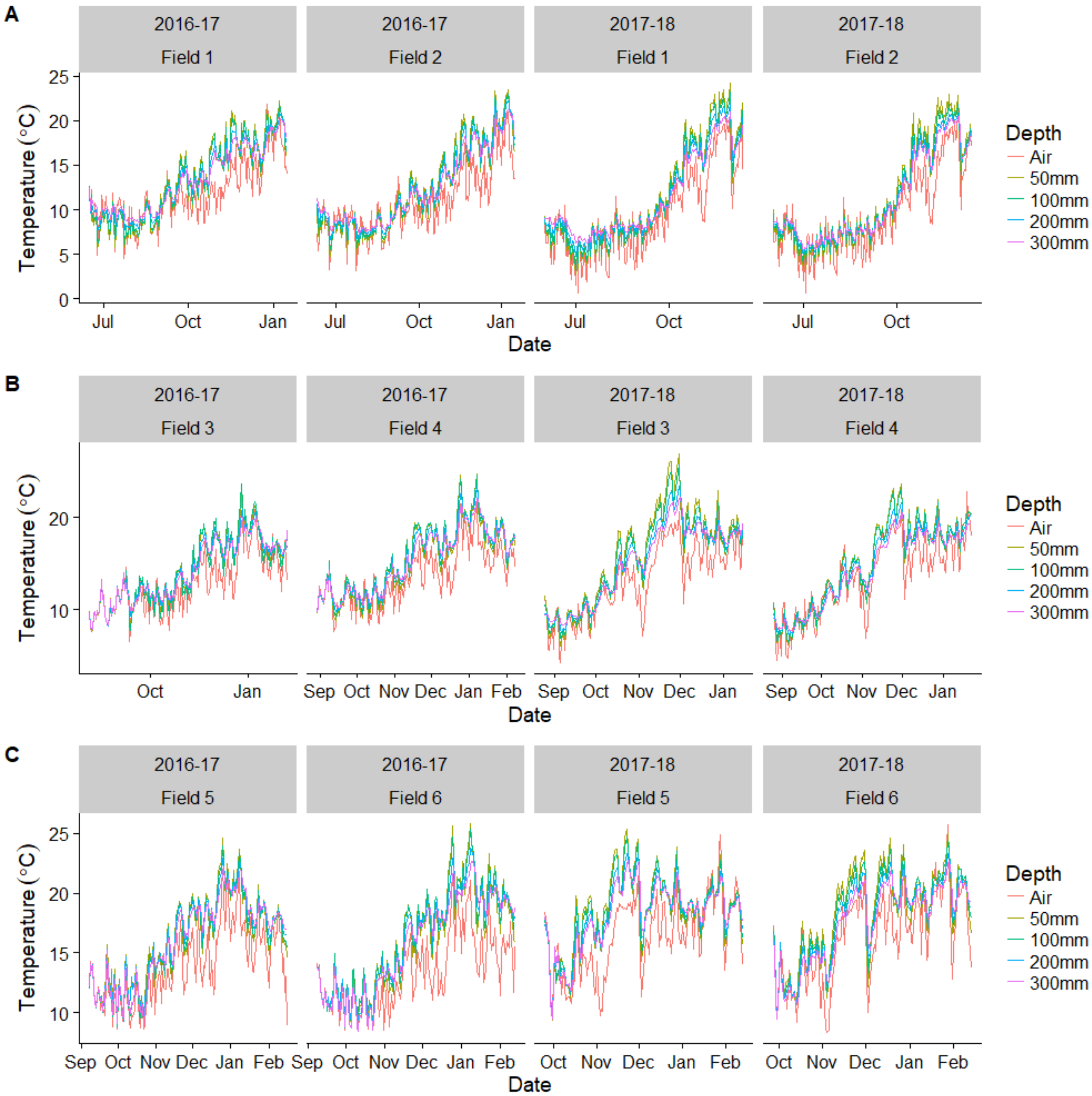

Figure 7. Mean daily temperatures of soil at varying depths in the profile as well as ambient air temperature. Planting windows are indicated as: A = Early, B= Intermediate and C = Late.

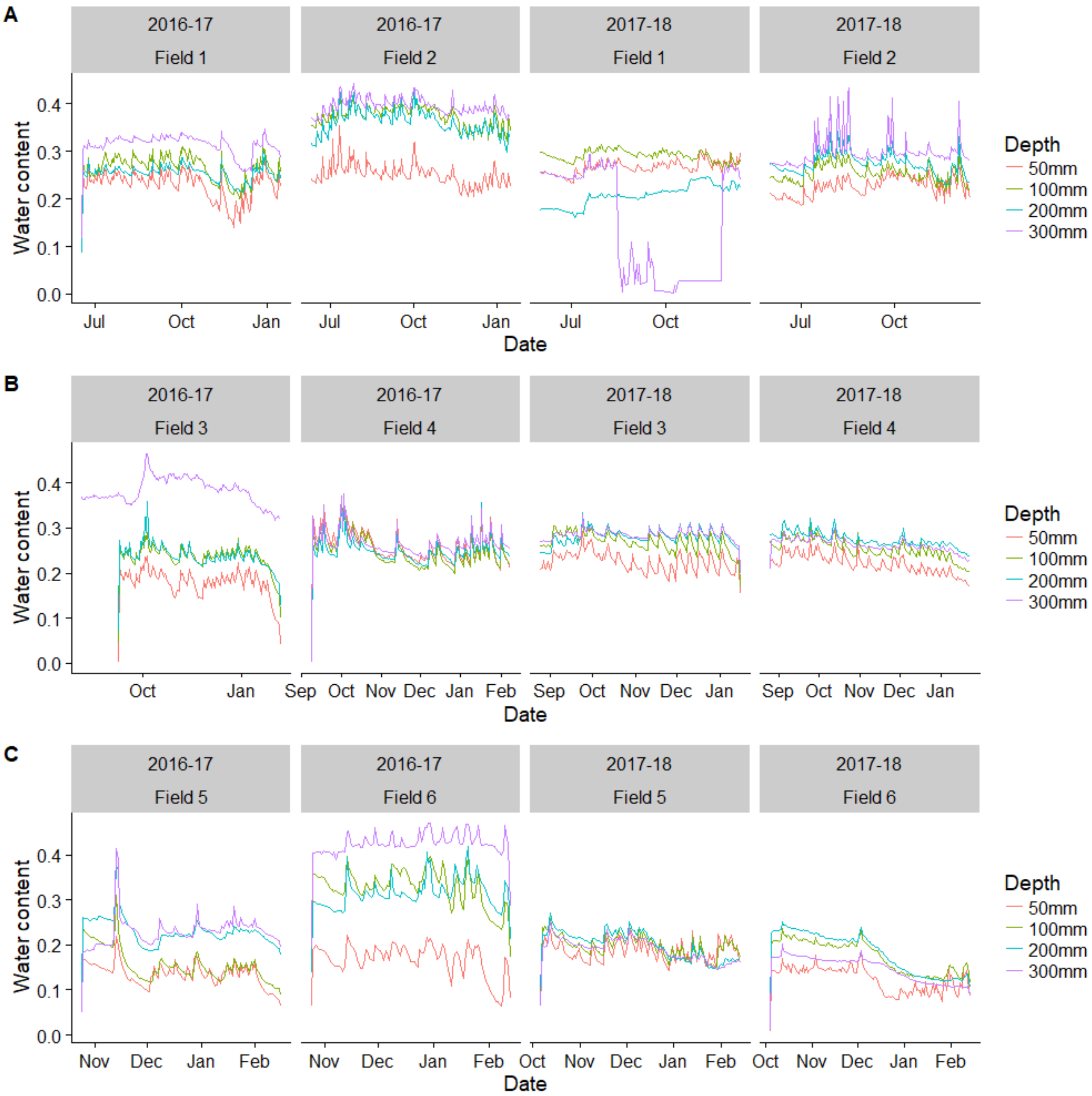

Figure 8. Mean daily water content of soil at varying depths in the profile of commercial onion fields. Planting windows are indicated as: A = Early, B= Intermediate and C = Late.

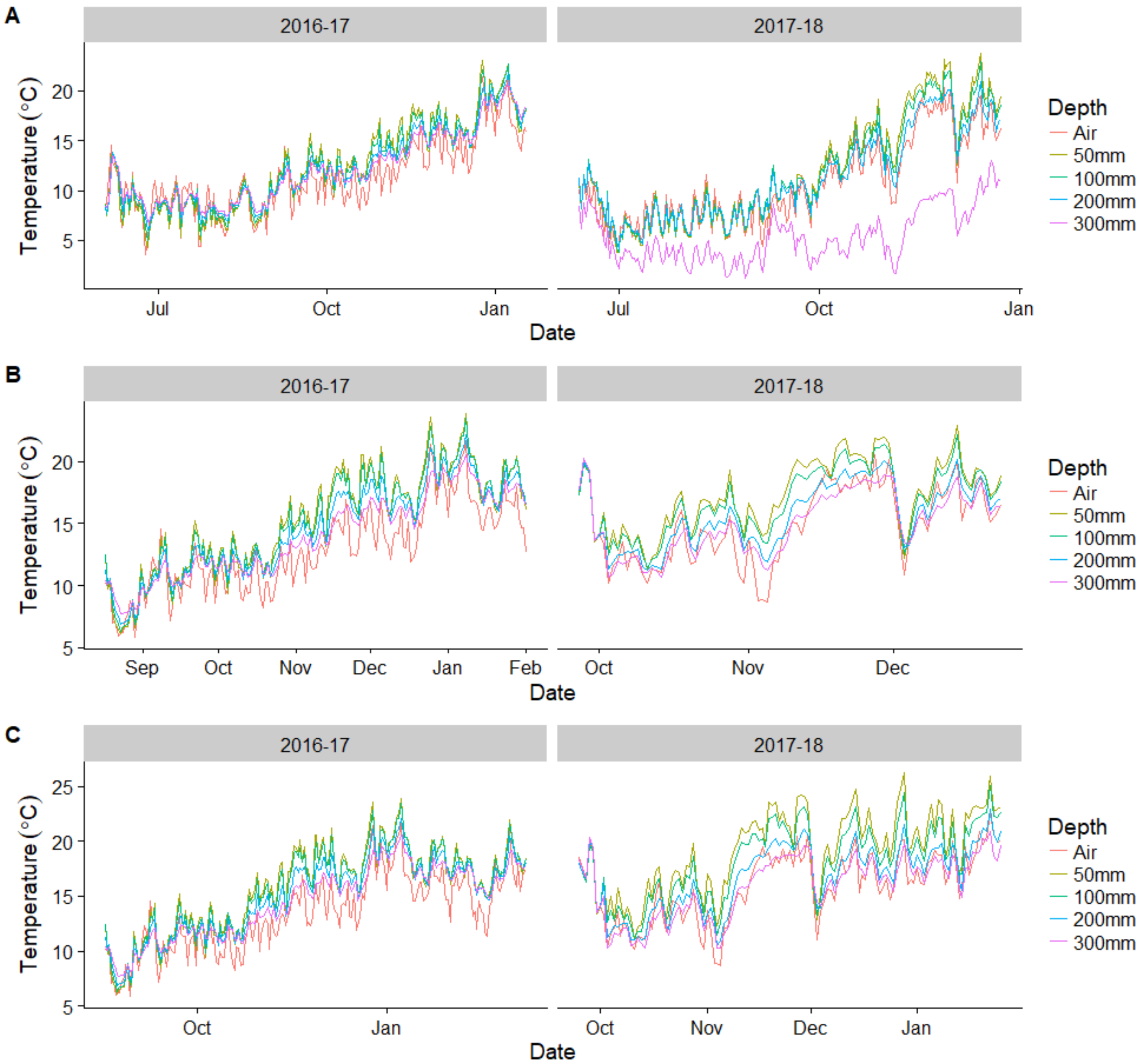

Figure 9. Temperature plots from planter bag trials showing mean daily temperatures of soil at varying depths in the profile as well as ambient air temperature. Planting windows are indicated as: A = Early, B= Intermediate and C = Late. Loggers were located at a single site and in close proximity. Logger data for the Early planting (A) in 2017-18 was used for the period from early August to late September.

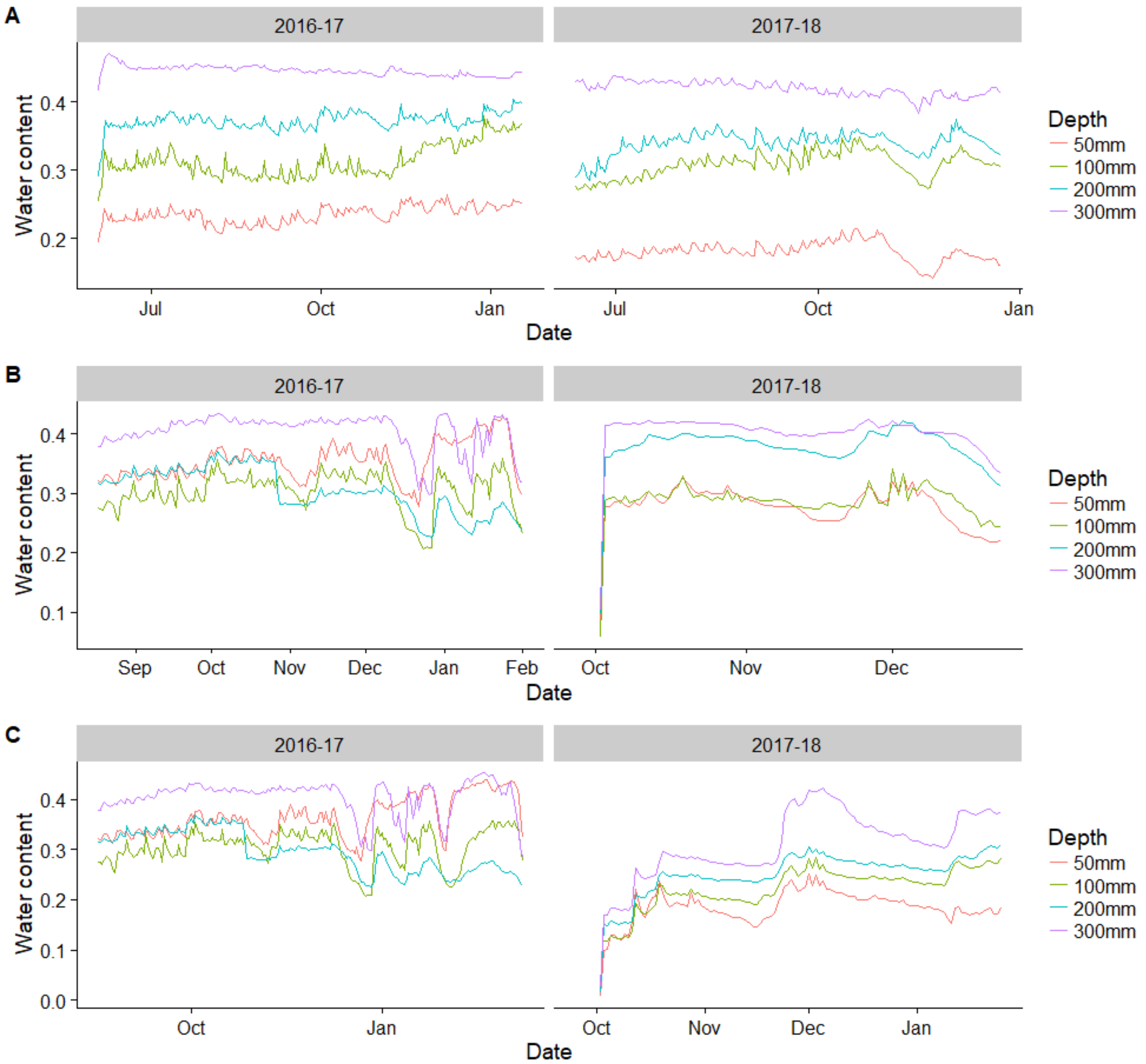

Figure 10. Plots showing water content (m^3/m^3) for planter bag trials showing mean daily values at varying depths in the soil profile. Planting windows are indicated as: A = Early, B= Intermediate and C = Late. Loggers were located at a single site and in close proximity. Logger data for the Early planting (A) in 2017-18 was used for the period from early August to late September.

Monitoring of commercial field sites in 2017-18 to identify the conditions (soil temperature and soil moisture) that precede onion white rot infection

Disease incidence was low at all three fields (and noted as similarly low across all Tasmanian commercial fields). Diseased bulbs were detected in late November and late December at the June planted Moriarty field. The onion processing company rated this field to have 3-5 % incidence of infected bulbs at the time of harvest. Disease was not observed in the Don field during the growing season or on harvested onions. Diseased bulbs were not detected during the growing season in the September planted Moriarty field. This crop was rated as having less than 3% onion white rot incidence after harvest and evaluation by the processing company.

Effect of temperature on disease development in a controlled environment - planter bag trial

Plants with onion white rot infection were observed in all of the temperature treatments in the growth chamber experiment. Infected necrotic plants were removed and examined under magnification. Hyphae were visible on the necrotic plants and sclerotia of *S. cepivorum* had formed in plant tissues of several necrotic plants. Isolations from symptomatic plant material and/or hyphae growing on soil near plant stems confirmed infection with *S. cepivorum.*

The greatest number of symptomatic plants were observed for the 20/15 °C and 17/12 °C temperature treatments (Table 6). Infection occurred fastest in the 20/15 °C (56 days after seeds were planted). Below this optimal temperature range, time to initial symptoms increased with decreasing temperature. After the first infection was observed, new infections occurred over the longest period for the 20/15 °C treatment (84 days) compared to 41, 59 and 21 days for 14/9 °C, 17/12 °C and 23/18 °C treatments respectively.

The temperature below which infection fails to occur could not be determined within the temperature range tested in this experiment. Day degree total to initial symptoms was highest for the 23/18 °C treatment and disease incidence was relatively low. This suggests that fungal activity is limited by higher temperatures.

Table 8. The number of bags with infected plants and plants with onion white rot infection; and the number of days and the day degrees from planting seed to when infection was first observed under four diurnal temperature treatments. Mean time to infection for each temperature treatment is expressed in days and cumulative day degrees.

	Temperature			
	14/9 °C[a]	17/12 °C	20/15 °C	23/18 °C
No. bags with infected plants	2[b]	6	7	2
No. plants with infection	3[c]	9	11	3
Time for first infection to be observed (days)	105[d]	77	56	70
Time for first infection to be observed (as day degrees)	1251.3	1148.6	1003.3	1464.2
Mean time to infection (days)[e]	132.3	99.1	96.7	79.3
Mean time to infection (cumulative day degrees)[f]	1577.0	1478.4	1733.0	1659.4

[a] – Temperature treatments in each growth chamber were diurnal 14 light and 10 hours darkness photoperiods
[b] – 20 bags with inoculum placed at a depth of 50 mm (on either side of the bag) were assessed for each temperature treatment
[c] – Four seeds were planted into each bag
[d] - The number of days for infection to be observed after seed was planted
[e] – Mean time to first observed symptoms of plants that showed infection during trialf - Mean time to first observed symptoms of plants that showed infection during trial expressed as cumulative day degrees

References

Gottwald, T. R., Timmer, L. W., and McGuire, R. G. 1989. Analysis of disease progress of citrus canker in nurseries in Argentina. Phytopathology 79:1276-1283.

Neher, D. A., Reynolds, R. L., and Campbell, C. L. 1997. Analysis of disease progress curves using linear models. Pages 29-33 in: Exercises in Plant Disease Epidemiology. L. J. Francl and D. A. Neher, eds. The American Phytopathological Society, St. Paul, MN.

Appendix 2: Industry Publications and Fact sheet

Development of an onion white rot forecast model for Tasmania

Project VN14001 Development of an onion white rot forecast model for Tasmania, Associate Professor Calum Wilson and Dr Suzie Jones, Tasmanian Institute of Agriculture

Onion white rot (OWR), caused by *Sclerotium cepivorum*, is a widespread and destructive fungal disease of commercial onion crops and was identified as a high priority disease in the onion industry Strategic Agrichemical Review Process (SARP)

Fungicides provide the foundation for currently available integrated strategies for management of OWR in Tasmania. Hence optimisation of control with fungicides is a valuable short term strategy for the Tasmanian industry. The mode of action of currently available fungicides is to temporarily inhibit mycelial growth in the soil. This effect is likely to slow down the rate of initial infection from sclerotia and/or slow down root to root spread, but only while the concentration of fungicide is high enough. Obtaining and maintaining a threshold concentration of fungicide in the relevant soil profile may be a key component of effective disease management. Identification of target depths of soil where the disease is active at different times of the season, and for different planting times, needs to be determined to guide the timing of fungicide applications. Additionally, knowledge of relationships between crop growth stage and environmental conditions that promote disease onset are required to guide disease management strategies.

This project aims to develop an OWR forecast model based on growing conditions in Tasmania and to improve the level and consistency of fungicide control through identification of conditions that precede high risk infection periods. The project will run for three years and is funded by Horticulture Innovation Australia Limited using the onion industry levy and funds from the Australian Government. Development of the model will take into account key parameters that influence OWR development: time of planting, soil temperature, soil moisture, root biomass at various soil depths (linked to crop growth stage and relevant to potential root-to-root spread of infection) and depth of infection. To account for potential differences in disease development at different planting times data will be collected for three representative planting windows - May, July and September. Separate forecast models will developed for each of the three planting periods. The OWR forecast models will be delivered as a standalone fact sheet detailing the combinations of soil temperature, soil moisture and crop growth stage, for each planting window, that signal the start of infection periods.

Pilot studies were done in the 2015/16 season to test and develop the research methodologies. The disease forecast model will be based on data collected from commercial field crops and in-situ planter bag trials conducted in the 2016/17 and 2017/18 seasons. Planter bag trials will be conducted at the TIA Vegetable Research Facility, Forth Tasmania to measure root growth, timing of infection and effect of inoculum soil. Root growth will be assessed in commercial crops and the development stage of the crop will also be monitored for all trials.

Environmental data is also required for development of the forecast model and will be collected at all trial sites. Soil temperature and soil moisture will be monitored at various depths in the onion root zone and air temperature and relative humidity data will be collected. Agronomic inputs for the planter bag trials will mirror those used in the commercial field trials and the onion cultivars will be consistent across field and bag trials. Data from the fields will be used to calibrate planter bag data.

People with substantial experience in onion production and research in Tasmania are involved in this project. Dr Jason Dennis initiated the project and has over 20 years' experience in commercial onion production, research and development. The project leader, Dr Calum Wilson, supervised a PhD project (Dean Metcalf 1998) on biological control of onion white rot and has extensive experience in plant pathology research. Tim Groom (Managing Director of Wynyon Pty Ltd) and Julian Shaw (Managing Director of Agronico Pty Ltd) are assisting with selection of, and access to, commercial field sites and agronomic input requirements for the planter bag trials.

The information gained in this project will assist growers and industry stakeholders to optimise the timing of fungicide applications. Improved knowledge of when to apply fungicides will be useful for future research into new potential fungicides and chemical application options. The information will also provide a basis to further develop integrated management strategies.

This project has been funded by Horticulture Innovation Australia Limited using multiple industry levies and funds from the Australian Government.

The Official Newsletter of Onions Australia

LAYERS | AUGUST 2018

CALENDAR

OCTOBER 2018: JOIN US IN ULVERSTONE, TASMANIA!

18 OCTOBER, 2018
Dobmac Tour
Growers Walk
Reg Miller Awards Dinner

19 OCTOBER, 2018
OA AGM
OA Levy Payers Day

Key findings from onion white rot research released

A research project conducted on a serious fungal disease, onion white rot, has uncovered important findings to help Tasmanian onion growers better manage the disease risk.

'Development of an onion white rot forecast model for Tasmania' (VN14001) was managed by Dr Suzie Jones at the Tasmanian Institute of Agriculture. As part of the project data were collected from commercial fields and outdoor planter bag trials over the past two years.

"Because onions are grown over a relatively long period in Tasmania, from May until February, we collected data from three planting windows that will represent the whole season; May as an early crop, July as an intermediate and September as a late crop," Dr Jones said.

Data were collected for the key factors that influence onion white rot development and subsequent bulb infection; namely, time of planting, soil temperature, soil moisture, root biomass and timing of infection. These data should enable the development of separate onion white rot forecast models for each of the three representative planting windows; May, July and September.

"The key findings were that root biomass in the field crops was highest in the top 100 mm of the soil. In the planter bag trials, we found that disease incidence was highest for the early plantings and that disease incidence was higher when inoculum was in the top 100 mm of soil."

"What we can recommend to growers from those key findings is that if a field is likely to be affected by white rot then it's better to plant late, and that the top 100 mm of soil should be targeted with fungicide control.

Onion grower George Griffin and researcher Dr Suzie Jones, UTAS

"That might mean that growers apply the fungicide and water it in so the fungicide reaches that depth in the soil."

The results and recommendations will be presented as a fact sheet detailing the conditions and crop growth stage that signal the likelihood of infection periods for each planting window.

Dr Jones said while the disease control recommendations won't necessarily mean the pathogen will be eliminated altogether, they will provide growers with management strategies to help them control onion white rot and minimise the risk of bulb infections.

Tasmanian onion grower George Griffin, from the north-west coast of the state, said the findings and support resources are welcome benefits to industry.

"We need a lot of research to be done on this problem mainly because it's such a big industry for Tassie growers especially on the north-west coast and other districts in Tassie; and to try and get a handle on it (onion white rot) and some sort of control so we can be profitable in the long term," Mr Griffin said.

Find out more about the Dr Jones' research and George Griffin's experience with white rot via the latest R&D Video available now at the Onions Australia website: http://www.onionsaustralia.org.au/news-updates/rd-videos/

Hort Innovation ONION FUND

This project has been funded by Hort Innovation using the onion research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

T: 08 8725 8862
M: 0458 11 11 26
F: 08 8725 8863
lechelle@onionsaustralia.org.au
PO BOX 9420
Mount Gambier West
SA 5291
www.onionsaustralia.org.au

This project has been funded by Hort Innovation using the onion research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

TASMANIAN INSTITUTE OF AGRICULTURE

utas.edu.au/tia

Managing onion white rot in Tasmania

Key Points

- **Disease symptoms were highest when OWR inoculum was in the top 100 mm of soil.**
- **In commercial fields most onion roots (over 80%) occur in the top 100 mm of the soil profile.**
- **Fungicide applications should target the top 100 mm of the soil profile.**
- **Disease symptoms were highest in trials planted from May to August and least in those planted in September.**
- **Fields considered to be at risk of having OWR would be best planted later in the season. Fungicide management is still recommended.**

Onion white rot (OWR), caused by *Sclerotium cepivorum*, is a widespread and destructive fungal disease of commercial onion crops. Fungicides are a key component of disease management. In this study we looked at how the onion and fungus interact in space and time over a range of different environmental conditions.

Disease expression is influenced by a combination of factors. The depth of the inoculum and onion roots in the soil, interact with environmental factors such as temperature and rainfall. These factors, when combined with the time of planting, can influence disease development. Improving our knowledge in these areas enables development of better integrated control options, and in the case of fungicides, optimised timing and target depths for improved disease management.

This two-year study included multiple commercial onion crop trials from Hagley to Rocky Cape in north-west Tasmania and planter bag studies in both outdoor and controlled environments. We studied the effect of planting date, environmental conditions, inoculum depth and root growth patterns to provide further insight into OWR disease development and management.

Hort Innovation
Strategic levy investment
ONION FUND
onions australia

Onion white rot (OWR) is a persistent soil borne disease of *Allium* species

Onion is a key host of OWR. The fungus also affects related *Allium* species including garlic, leek, chives and spring onion. The fungus infects plant roots and progresses up the roots to the base of the onion bulb. Infection can spread from the roots of one plant to another, resulting in patches of infected plants.

The fungus can **survive in the soil for as long as 20 years** in the form of sclerotia (hard, small poppy seed like structures). Once a field has had OWR, there is always a risk that the disease will infect subsequent crops. This limits the options growers have to avoid the disease with crop rotation.

Timing of onion trials

Onions are grown over a relatively long period in Tasmania (from May until late February). To reflect this we collected data for three planting periods early, intermediate and late crops (May, July and September).

Root growth and OWR

Trials in commercial onion fields showed that the majority of onion roots (over 80%) are in the top 100 mm of the soil profile. The high root biomass in this section of the soil under field conditions, provides opportunity for infection to spread from root-to-root and from one plant to another.

Outdoor trials in planter bags found that the greatest number of infected onions occurred when sclerotia were in the top 100 mm of soil.

Planting date influences infection

The incidence of infected bulbs in the bag trials was highest when onions were planted from May until early August and lowest when onions were planted in September. This relates to soil temperature during the life of the crop and how this influences survival and growth of the fungus.

The finding that 'most root and fungal pathogen activity occurs in the top 100 mm of the soil' indicates that 'fungicide application needs to target this area.'

Soil Temperature and OWR infection

Soil temperature appears to be an important factor in disease development.

In controlled environment studies, soil temperatures between 15 to 20 °C were optimum for fungal activity and onion infection. The number of infections was reduced with sustained temperatures above 20 °C. Soil temperatures recorded at commercial field sites during the project showed that temperatures in the top 100 mm of soil can be above 20 °C periodically from October; and more so from November to February.

Root growth was fastest for the onions planted in September and yet they had the lowest incidence of infected bulbs. The higher temperatures experienced in the top 100 mm of soil from November to February are likely to have reduced the ability of the fungus to reach the base of the onions planted in September.

Fields with a history of OWR and considered to be at risk of infection would be best planted late in the season. However, the fungus appears able to survive in lower cooler soil depths and progress up towards bulbs if soil temperatures decrease towards the end of the season and before harvest. Fungicide management is still recommended, with adjustments to timing, possible inclusion of a late application and compliance with chemical registration guidelines.

Targeted control solutions

Strategic fungicide application

- Target the top 100mm of the soil profile. This is the key zone where the fungus and onion interact. This could be achieved applying before a rain event or by irrigating the fungicide into the soil after application.

Later planting

- If feasible, planting later in the season is recommended for fields known to have a history of OWR and potential soil inoculum. Fungicide management is still recommended to reduce the risk of infection reaching the bulbs.

Hort Innovation | ONION FUND
Strategic levy investment

This project has been funded by Hort Innovation using the onion research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

Dr Suzie Jones
Tasmanian Institute of Agriculture
Suzie.Jones@utas.edu.au
Tel: +61 3 6430 4502

University of Tasmania | Tasmanian Government

TIA is a joint venture of the University of Tasmania and the Tasmanian Government