VG97024
Implementation of an onion downy mildew forecasting service in the Lockyer Valley

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Queensland Horticulture Institute

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VG97024

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FINAL REPORT

Implementation of an onion downy mildew forecasting service in the Lockyer Valley

Project No: VG 97024

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Queensland Fruit and Vegetable Growers

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Purpose of Report: This project presents the findings of the project "Implementation of an Onion Downy Mildew Forecasting Service in the Lockyer Valley".

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1. Media Summary

Onion downy mildew occurs each season throughout the Queensland onion growing districts. It is arguably the single biggest constraint to continued onion production in Queensland and in severe cases can result in complete crop loss. The severity of the disease depends on weather patterns, particularly during the period from mid June through to late September. At this time ideal environmental conditions for the proliferation of the disease are experienced. These conditions are high relative humidity during the pre-dawn hours, low temperatures during the previous twenty-four hours and extended heavy dewy periods up until 10am. Disease forecasting and improved pesticide application techniques are two areas that were investigated in the fight against onion downy mildew.

Disease forecasting is seen as an effective tool to aid in the control of leaf diseases in a number of vegetable crops. If you can predict when a disease will occur then you can time your chemical application more effectively with improved economic and environmental benefits. The onion downy mildew forecasting model 'Downcast®' was used in conjunction with a number of weather stations to develop a forecasting service for onion growers in the Lockyer Valley, Queensland. This forecasting service was made available, free of charge, to growers in the Lockyer Valley during the 1999 growing season. The service was used extensively during the growing season with mixed results. These results are due to the unusually high disease pressure experienced in 1999.

A number of pesticide application techniques were investigated. Parameters such as application volume, nozzle orientation and size, air assistance and the use of surfactants was investigated. The use of hollow cones at high volume (375 L/ha) and Spraying Systems Twinjet nozzles proved to be the most efficient nozzle types. Spray penetration into the crop was diminished by the upright nature of the onion plant thereby reducing the effectiveness of the pesticide. The waxy coating of the onion leaf is also of concern because it is difficult to get the chemical to stick to the leaves. The use of stickers (Xtend, DC-Tron) has proved to be beneficial in making sure the pesticide sticks to the plant.

A number of QDPI Notes have been released as a result of work carried out. These notes outline in detail (i) the disease life cycle; (ii) the forecasting service and (iii) management: trouble shooting. Future work will target the commercialisation of the forecasting service outlined in the second of the DPI Notes.

2. Technical Summary

Onion down mildew, caused by the pathogen *Peronospora destructor,* is perhaps the most widespread and debilitating disease of onions throughout the world. Onion downy mildew occurs each season in Queensland and the severity of outbreaks varies from season to season. Studies have determined that the pathogen responds to a specific set of environmental conditions. Optimum conditions for disease outbreaks are cool, overcast, moist conditions when the relative humidity during pre-dawn hours is > 95%, with extended heavy dew periods up until 9:00 to 10:00am. During the 1980's, Canadian researchers developed the disease prediction model 'Downcast' based on these factors.

This project was instigated at the request of the Queensland onion industry to determine a strategy to combat this debilitating disease that in some seasons can result in total crop loss. Control of this disease was made more imperative due the development of fungicide resistant strains of the disease. Following on from a project conducted by the University of Queensland and Queensland DPI in adopting the 'Downcast' system for the forecasting of onion downy mildew in the Lockyer Valley this project was developed to extend the system into a grower service.

In the Lockyer Valley, where 80% of Queensland onions are grown, four weather stations were established in the four growing areas of Tenthill, Gatton, Laidley and Lowood. Each of these areas has distinct microclimates. Data collected from each weather station was manipulated using an Excel Visual Basic macro developed to perform disease prediction calculations. These predictions were then used to provide either a blanket forecast for the Lockyer Valley or individual forecasts for each of the growing areas. The nature of these forecasts indicated when spraying was required to control downy mildew. The forecasts indicated either the use of a protectant or an eradicant. The use of the 'Downcast' model gave an accurate understanding of the disease's life cycle such that the use of eradicant and protectant fungicides can be timed to target the critical stages of the disease life cycle. This targeting of fungicide application allows better disease control through critical timing of application and can reduce the resistance pressure on eradicant fungicides. The application of protectant fungicides can be timed, under low-pressure situations, to coincide with the anticipated date of sporulation due to the fact that there is 10 to 14 days between infection and sporulation. This improves protection against subsequent infections.

Additional to the forecasting service, field trials were conducted during the 1998 and 1999 growing seasons on grower properties to compare the grower's normal spray program with a spray program based on the forecast service. Trial plots consisted of an unreplicated plot 20m x 20m on grower properties in each of the growing districts within the Lockyer Valley. The trial plots were incorporated into the grower's onion field and sprayed on the recommendations of the forecasting system. This regime of sprays was then compared to the grower's own spray program. Results from the 1998 trials indicate that there was a saving of three to five sprays without loss of disease control in early planted onions. The incidence and severity of onion downy mildew in 1999 for the late season crop was extremely high. There were no differences in control of the disease between the two spray methods for this crop. There would have been a cost saving under the forecast system due to the fact that five sprays (one protectant and four eradicants (systemic)) applied by the forecast system and seven eradicant sprays applied by the non-forecast method.

In the 1997/98 season a series of spray application trials were conducted on growers' properties in the Lockyer Valley. The aim of these trials was to evaluate equipment performance in terms of spray recovery on onion foliage and losses to the ground. Spray deposits were quantified on the leaves as well as the ground using fluorescent tracers. Investigations showed that Lockyer Valley onion growers are applying fungicides and insecticides in water volumes ranging from 200-450 L/ha. Spray losses to the ground are high and account for up to 30% of the applied volume. In 1999 a replicated trial was conducted to look at the efficiency of three nozzle types at a number of different spray volumes. Results indicated that hollow cones at high volume (375 L/ha) and Twinjets deposited up to 65% more spray than the hollow cone nozzles at low volume and flat fan nozzles.

There is great potential to improve existing application methods and reduce pesticide use by:

- Adoption of the forecasting service will aid in targeting the critical stages of the disease cycle thereby reducing pesticide usage
- Specific targeting of fungicide application will reduce the resistance pressure on eradicant fungicides
- Selection of appropriate nozzles that maximise the spray deposits on the plant surface and minimise ground contamination.

Future work needs to look at expanding the forecasting service into other onion growing areas and possibly other crops and diseases. This will make the provision of a forecasting service more economically viable. There is also scope to do further work investigating reduced chemical rates as a result of improvements made in the targeting of pesticides.

3. Introduction

The Queensland onion industry grows about 800 ha of onions per annum at an average yield in excess of 40 tonne/ha and earns revenue of over 19 million dollars. The single biggest constraint on production is the devastating effect of onion downy mildew on crop growth, which in severe cases can result in a total crop loss. Disease outbreaks are strictly dependent on a particular set of weather parameters. The disease becomes most prevalent under conditions of high relative humidity, cool or mild temperature and extended periods of dewy or wet conditions. Indeed, disease outbreaks are strictly dependent on these conditions, thus in some seasons the disease is far more prevalent than in others. Nonetheless, since onions are a high valued crop most growers are faced with no alternative but to adopt a calendar-spraying program irrespective of whether conditions are favourable for disease development. Spraying generally begins in the early to middle season growth stage thus more than 12 sprays are generally applied over the duration of the crop.

This project was undertaken at the request of the Queensland onion industry and closely follows on from a previous HRDC funded project *"Development of an onion downy mildew forecasting system"* (Project VG 402) which investigated the benefits of using a forecasting system to predict onion downy mildew outbreaks. Results of this project demonstrated that through using a disease forecasting system, based on critical weather parameters, the total number of spray applications can be reduced from more than 12 down to only 6 with no loss in yield.

Under a forecasting system, where fewer fungicide applications are made, improved coverage and spray application technique will be critical. Onion foliage characteristics (an erect waxy leaf surface) make spray droplet capture and retention extremely difficult. A further part of the project investigated onion pesticide application parameters, and consequently provide recommendations to growers that will enable them to improve fungicide and insecticide coverage

It is anticipated that the use of a forecasting service and improved spray application will save the onion industry over $300,000 through reduced chemical and application costs in a year of average disease incidence. Further financial benefits can be gained through increased production as a result of more specific targeting of sprays. The use of a forecasting system will reduce the reliance on existing fungicides and decrease the potential for resistance to develop (there is already resistance to one important onion fungicide in Queensland). Intangible benefits include reduced grower and worker exposure to chemicals. The work will also demonstrate industry commitment to reducing pesticide usage and to presenting a cleaner product in the market place. It is anticipated that the work developed in this project will easily be transferred into other vegetable crops to provide forecasts on pest and disease outbreaks

4. Materials and Methods

4.1. Forecasting

Four EnvironData weather stations were purchased and established in each of the key growing districts within the Lockyer Valley. The Lockyer Valley, for the purposes of this project, is divided up into the growing districts of Gatton, Tenthill, Laidley and Lowood. Over a period of twelve months all weather stations were equipped with mobile phones and established in each of these key districts. Due to mobile coverage problems two different carriers were used, namely, Vodaphone in the remote zones of Laidley and Tenthill and Telstra in the Gatton and Lowood districts. The use of mobile phones was required to ensure that data from the stations was downloaded once the critical time parameters were concluded (*viz.* 10:00 AM) allowing for a timely broadcast of the forecast for each of the districts. The data was downloaded to a laptop computer via a modem. The laptop computer was also used to manually download data from the weather stations when there were problems with the mobile service as prior to the installation of mobile phones in two of the weather stations.

The weather stations used were supplied by Environ Data. Initially a Metos weather stations was evaluated, however, technical problems arose that could not be resolved. In the summary or elsewhere you could mention the issue of weather station backup service for readers as this is important. Environmental data collected included relative humidity, ambient temperature, soil temperature at 10cm, leaf wetness, daily rainfall and solar radiation. Once the data was collected from each of the sites it was manipulated and a prediction and subsequent forecast was made using a set of Visual Basic macros embedded in an Excel spreadsheet.

4.2. Forecast Spray Program vs Conventional Spray Program

A group of seven growers was selected to participate in a series of on-farm trials to investigate the effectiveness of current spray application technology being used by growers in the Lockyer Valley. This assessment was a prelude to a series of trials that investigated the effectiveness of the forecast spray program versus the grower's own spray program. Five growers were selected from the original list of seven to participate in these trials. The growers came from the following districts, one in Gatton, one in Tenthill, two at Lowood and one in Laidley. Trials at each grower site consisted of two strips, one using the recommendations of the forecast service and the other strip being their conventional spray program. A comparison was then made between each system. This comparison looked at number of sprays applied and the level of disease control to determine the overall value of the forecast system.

4.3. Pesticide Application

A number of strategies were utilised to investigate the effectiveness of current spray application practices amongst growers. The use of a quantitative dye technique proved to be invaluable in determining the amount of spray reaching the desired target (foliage), off target movement (drift) and losses to the ground.

In 1998/99 season, two replicated small plot, spray application trials were conducted in the Lockyer Valley, S.E. QLD using a hand held spray boom. The purpose of these trials was to (i) evaluate in detail the effect of different nozzle types and volume on spray recovery on onion foliage and (ii) evaluate the effect of several adjuvants on spray recovery. In both trials a fluorescent tracer was used to evaluate the spray deposit.

The adjuvant trial evaluated seven products (X-tend, X77, LI700, DC-Tron, Agral, Codacide and Bond), these were compared with a treatment consisting of water and fluorescent tracer only. All treatments were applied using an application volume of 375L/ha. The sprayer was fitted with hollow cone nozzles (Albuz orange) and operated at 6 bar pressure

4.4. Grower Survey

Research and extension staff at the Gatton Research Station maintains a list of onion growers in the Lockyer Valley. This list was used as the basis for the grower survey investigating the usage and possible future of the forecasting service. A list of questions (Appendix 2) was drawn up and a telephone interview was conducted. The survey consisted of six questions. These questions were formatted to ensure that adequate information could be obtained from growers to determine the future of the forecasting service. The format of the survey was designed to minimise the time required to interview the grower and thereby reduce the inconvenience to the grower. All growers on the list were contacted and asked to give five to ten minutes of their time to answer the questions.

5. Results

5.1. Forecasting

Disease Forecast Criteria

The cycle of the disease has two distinct phases namely, sporulation where spore production and release occur, and infection where these spores infect the leaf. The Downcast system is briefly summarised as follows for Queensland growing conditions and may vary in other states under summer production systems.

Sporulation occurs when

- the previous average daily temperature is less than 24°C
- Temperature during the night is within the range 4-24°C
- No rainfall is received between the hours 2300 and 0400
- The relative humidity is greater than 95% continuously for 4 hours after the hour 0000

Infection will occur on the same day as sporulation if leaf wetness persists for at least 3 hours after sunrise typically about 0900 hrs under Queensland conditions. If infection does not occur at this time, spores can infect on the next day provided dew deposition is very rapid. If dew deposition is slow spores die. In general spores remain viable for about 3 days.

5.1.1. 1997

Initially it was planned to establish the forecasting service using the Metos weather station with its predictive software. Due to technical problems with the Metos weather stations the establishment and subsequent testing of the forecasting service was delayed. Subsequently, weather stations were purchased from Environ Data. These weather stations did not possess software capable of making predictions on disease outbreaks. Consequently, a series of macros using the programming capacity of Microsoft Excel were written to predict the outbreaks.

Due to this unavoidable delay the forecasting service was not available for the 1997 growing season. This time delay offered an excellent opportunity to develop and test the systems predictive capabilities. The developed 'software' is capable of accurately predicting the likelihood of onion downy mildew outbreaks.

The forecasting service is designed to download data from the weather stations to a laptop computer with a modem attached via digital mobile telephones installed in the weather stations. Difficulties arose downloading the data via the digital mobile phones as the weather station manufacturers had previously only used analogue technology. Consequently only two weather stations were fitted with digital down load technology. Due to the variability of the digital coverage the system used the carrier Vodaphone as it supplied the best coverage in remote areas. Data from the remaining two stations was downloaded manually.

5.1.2. 1998

The off-season between 1997 and 1998 was spent ensuring that all four weather station were equipped with mobile telephones and operating efficiently. During the 1998 growing season all four weather stations were set up in early season onion crops.

The data (Table 1) of infection events highlights that this year has been of relatively low pressure with most sites having reasonable periods in between major infection events. Apart from the Lowood site in July, there appeared to be no overlap in infection cycles.

Table 1.Major downy mildew infection events at four locations in the Lockyer Valley.

Date.	Gatton	Laidley	Lowood	Tenthill
01/05/1998	✓		✓	✓
17/05/1998			✓	✓
31/05/1998		✓		
03/06/1998	✓		✓	✓
29/06/1998		✓	✓	
05/07/1998	✓	✓	✓	✓
13/07/1998			✓	
20/07/1998	✓	✓	✓	✓
28/07/1998		✓		✓
03/08/1998	✓			✓
10/08/1998	✓			
26/08/1998	✓	✓	✓	✓

✓ Denotes a positive major infection on this date

The Downcast model confirmed that there were no early season infection periods (from March to middle April). During this early period the average temperature on the previous day was greater than the criteria range. This was particularly so for the 1998 season as atypical hot conditions continued well into April.

When this average temperature for the previous day finally dropped within the critical range, conditions were often favourable for sporulation but not favourable for simultaneous reinfection. Conditions for reinfection were not met for between one to three days later. Even at this, these predicted infections did not appear to be favourable for disease development. It is believed leaf wetness conditions on the days following the predicted sporulation were not adequate to promote the disease. These events are nominally called "Minor infection events".

Events where both sporulation and reinfection occurred in the one day or where dew deposition persisted until at least 9:00 on the following day are presented in Table 1 and these are nominally called "Major infection events". Field observations of infected crops throughout the district clearly confirmed that positive infection events had occurred on at least some of these dates, particularly those dates where all four sites indicated a positive forecast.

5.1.3. 1999

The forecasting service commenced on 30th June 1999 with the first positive forecast being recorded on 5th July. The final positive forecast was made on the 27th September with the conclusion of the service on the 30th September. Usage figures indicate good usage in July decreasing through August to September. This highlights the fact that July and August recorded the greatest number of positive forecasts.

The use of the forecasting system in 1999 highlighted some limitations in the system. The major limitation is determination of leaf wetness. Leaf wetness is highly variable and is greatly influenced by the stage of growth of the crop and the rate of dew deposition. Furthermore, the value of leaf wetness used as a critical value in the forecasting program needed to be calibrated against a field value required to allow sporulation.

5.2. Forecast Spray Program vs Conventional Spray Program

5.2.1. 1998

In 1998, the implementation of the forecasting system was done as unreplicated trial plots of about 20m x 20m on growers early planted onions only. The trial plots were sprayed based on the recommendations of the forecasting system and compared with the growers own spray program. Importantly, the forecasting system can more accurately target sprays to coincide with critical stages in the disease development.

In Queensland spraying generally begins in the early to middle season growth stage and under a calendar spray program more than 12 sprays can be applied over the duration of the crop. In this trial a total of 9 sprays was used at the Gatton site, 5 at Laidley, 9 at Lowood and 8 at Tenthill. No plants in either the grower's block or the trial block showed evidence of downy mildew.

5.2.2. 1999

Tenthill Trial.

The Tenthill grower's trial was sown on 6 July. On 27 August, just prior to bulbing, this crop was severely damaged by a hailstorm. It was subsequently ploughed in eight weeks later due to poor growth and anticipated uneconomic returns. Each of the treatments had received five sprays, comprising two protectants and three systemics, applied at different times. There were no obvious differences between the forecast spray program and the sprayer's program. Both provided good disease control.

Gatton Research Station Trial.

A number of onion varieties (whites, brown and red) were sown on 17 June on which the two different spray schedules were compared. A minor outbreak of the disease was first observed at the site on 23 July. In all there were seven systemic sprays applied by the non-forecast method compared to five sprays (one protectant and four systemics) with the forecast method. This trial was harvested prematurely because of severe damage to the crop from downy mildew. This was attributed to very high inoculum levels and a missed spray during one of the critical periods, which favoured disease development. [It should be noted that the incidence and severity of downy mildew across the Valley for the late season crop was extremely high with failure to provide adequate levels of control being quite common]. There were no obvious visual differences between the two spray methods but there would have been a cost-saving with the forecast method with two less sprays overall and with the cheaper protectant being used for one of the sprays.

5.3. Pesticide Application

A fluorescent tracer applied at 60g/ha was used to quantify the amount of spray that was deposited on the plant and on the ground. The crop was at the 10 to 12 leaf stage. Plots were 1.5m wide and 10.5m long. Whole plants were sampled and cut into four sections to enable the spray distribution to be mapped within the canopy. Plate 1 shows a plant cut into four sections (zone 1 was at the bottom and zone 4 at the top of the plant).

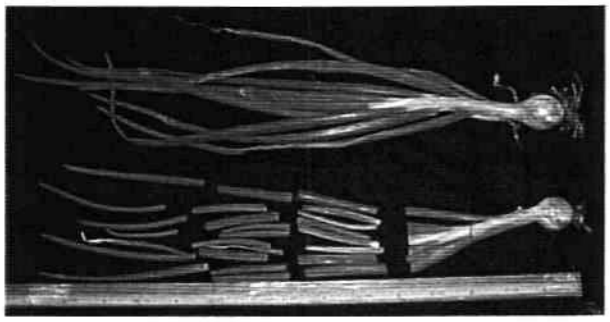

Plate 1. Whole onion plant and plant cut in sections showing the 4 zones where deposit measurements were made (bottom zone = 1 and top = 4).

The spray deposited within each of the four zones for the seven treatments are shown in Figure 1. The results can be compared directly as they have been adjusted to compensate for the differences in volume. There are some distinct differences in the spray recovered in the 4 zones and also between the nozzle types. With all treatments zone 2 had the lowest average deposit. At this zone the leaves are tightly clustered and hence spray penetration into this region is reduced. Zone 4, the top of the plants received the highest average deposit.

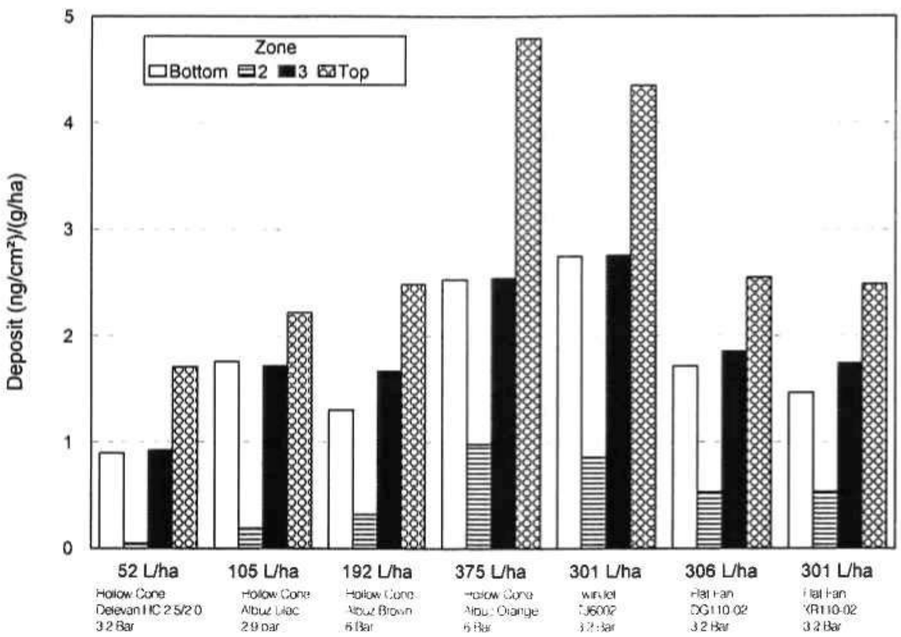

Figure 1. Tracer deposit (ng/cm²)/(g/ha) for different hydraulic nozzle and spray volume treatments.

5.4. Grower Survey

From a total of 144 growers in south-east Queensland a total of eighty-six growers were selected to be contacted. Subsequently, forty-five growers were contacted and interviewed. This resulted in approximately 30% of growers in south-east Queensland being contacted.

The survey yielded the following results:

- 97% of growers were aware that the service exists.
- only 10% of growers used the service in 1999
- the majority of growers (57%) would not use the service if it was a commercial service ie provided by resellers or consultants.
- 63% of growers would use the service in 2000 if it was available in its current form ie provided free of charge by the QDPI.
- 20% of growers said that more stations were needed to ensure confidence in the system.
- 30% of growers were no longer growing onions.

6. Discussion

A downy mildew forecasting service in the Lockyer Valley can offer onion growers substantial benefits by giving them information that will ultimately lead to improved timing of protectant or eradicant fungicide sprays. In some seasons this could also translate to fewer fungicide sprays being applied. There are however a number of factors that growers need to consider in order to obtain the maximum benefit from an applied spray. Such factors not only relate to product efficacy and include issues such as food safety and compliance with pesticide maximum residue limits and environmental issues relating to off-target pesticide movement. As has already occurred with the insecticide Endosulfan, legislative restrictions are likely to become more stringent with pesticides. This will place greater onus on the applicators to use them as responsibly as possible.

6.1. Forecasting Service

In the Lockyer Valley where 80% of Queensland's onions are grown, the Queensland Department of Primary Industries offers onion growers a forecasting service to assist in the management and control of onion downy mildew for the current season. This service is based on the Canadian 'DOWNCAST' model, which has been modified for local conditions. It accurately pinpoints critical periods conducive to onion downy mildew outbreaks thus allowing more precise timing of appropriate fungicide applications.

Forecasts are given for the four important onion growing districts of the Lockyer Valley, namely, Gatton, Laidley Valley, Upper Tenthill and Lowood

The Onion Downy Mildew Forecasting Service was accessed by simply phoning the Onion Downy Mildew Hotline number 5466 2207 (for the cost of a local call) on which a recorded message was played giving a forecast and fungicide recommendation for each of the four districts. If a positive prediction was recorded at each site a single blanket forecast for the Lockyer Valley will be made. The forecast was updated on Monday, Wednesday and Friday.

In 1999, the service was officially launched on Wednesday 30 June after all registered growers and local agri-chemical resellers had each received three extension bulletins covering in detail the disease lifecycle, the forecasting service and management recommendations. Additionally, they were advised of the service at an Onion Field Walk at the Gatton Research Station on 12 May and through the local newspaper. This service was well received with 234 calls recorded in the first month of operation.

6.2. Forecast Spray Program vs Conventional Spray Program

The first positive forecast event for Gatton was recorded on 7 July and subsequent infection noticed on 23 July, which is within the typical incubation period of 9-16 days. As inoculum increases logarithmically with subsequent over-lapping disease cycles this incubation period is typically reduced. Being able to accurately pin-point the conditions which favour disease, using the forecast system, particularly the first few disease cycles, allows for timely intervention with systemic sprays and hence reduce the build-up of inoculum. The ultimate success or failure of the spray program is very much dependant on keeping the disease in check during the early outbreaks

The forecast method was comparable to that of the grower's in the Tenthill trial, both in terms of providing good control and costs of application. In the Gatton trial the forecast method resulted in cost savings, both in the number and type of fungicide sprays, despite poor control being given by both treatments.

The 1999 trials and previous research by QDPI and University of Queensland Gatton personnel has shown that the forecast method is an economically viable alternative to the conventional calendar spray program.

6.3. Pesticide Application

The application component in this project aimed to assess current practices for spraying onion crops in the Lockyer Valley, QLD and examine some of the "newer" technologies available such as air-assisted equipment and nozzle technology.

Calibration

Calibration is an essential step that must be undertaken prior to applying pesticides to the crop. Even the most sophisticated and technologically advanced sprayer can produce a poor efficacy result if the calibration is incorrect and the wrong pesticide dose is applied. Unknown or incorrect calibration can lead to underdosing or overdosing on the crop canopy thus lead to poor efficacy or potential residue problems or an adverse crop response resulting in reduced yields. Most, if not all growers these days are required to keep calibration records and a spray diary as part of quality assurance programs. It is essential that sprayers are calibrated often as nozzles do wear and will require replacing

Volumes

Onion growers in the Lockyer Valley are applying fungicides and insecticides in water volumes ranging from 200-450 L/ha. Some growers often increase their application volumes throughout the season as the onion canopy cover increases.

For a protectant fungicide to offer maximum protection good coverage is required. The onion foliage is a difficult target to retain spray droplets given the waxy and upright leaves. It is essential to use a wetter as recommended by the product label. Sprays applied in the early stages of crop development have very little crop canopy to intercept and significant losses can occur to the soil surface. Trials conducted investigating spray fate have demonstrated spray losses of up to 30-40% can occur to the soil surface. The loss depends on crop stage, nozzle type and spray volume applied.

Nozzle Types

Trials conducted with booms fitted with hollow cone nozzles have consistently provided higher levels of recovery than flat fan nozzles applying the same volume. Although the new technology available in spray equipment can offer significant advantages there are cheap and simple alternatives that can be considered on existing spray units such as nozzle selection.

Spray nozzles are the most important component of a boom sprayer. They not only meter the pesticide mixture emitted and hence determine the application volume and pesticide dose per hectare but also produce droplets of an appropriate size for obtaining good coverage. Nozzles also come in a range of types (ie. hollow cone, flat fan, twin-fan patterns and many more). All nozzles are designed for a specific job and this often relates to the spray quality they produce. When off-target drift is a concern then spray quality (drop sizes produced) will be of primary importance when setting up a boom sprayer. It is important that growers familiarize themselves with the product literature available when purchasing nozzles so that the correct nozzle type and pressure is used for a particular job. This is particularly important if there is a need to obtain a specific spray quality for drift sensitive area.

A small plot replicated trial was conducted to evaluate the efficiency of several nozzle types by means of assessing the spray recovered in various defined zones on the onion plant. The findings in this trial were very interesting as two of the nozzle treatments, hollow cones at 375L/ha and TwinJets at 301 L/ha deposited 55 to 65% more spray than the other equivalent volumes applied using standard XR or DG flat fan nozzles. The Twinjet nozzle, is basically a flat fan nozzle that produces two sheets of liquid, separated by a 60 degree angle gave exceptional deposit results. The XR and DG nozzles produced a coarser droplet spectrum and would be appropriate for use in a drift sensitive situation however this would be at the expense of obtaining good crop coverage. The product not recovered on the crop with the DG and XR flat fan nozzles was recovered on ground.

Evaluation Techniques for Determining Pesticide Application Accuracy

Numerous techniques are available to assess the efficiency of a spray job. From a growers perspective the method to avoid is signs of disease running ramped in the crop late in the season. The fluorescent tracer, Uvitex, was successfully used to provide quantifiable data on spray volume recoveries and tracer doses on specific sections of the onion plant. In field trials the fluorescent tracer was applied at at rates up to 60g/ha. Whole plants were sampled and cut into four sections to enable the spray distribution to be mapped within the canopy using a quantitative technique called fluorometry.

Another useful tracer for visual assessment that was utilised in night walks is a tracer fluorescent tracer visible under black lights. This enables the spray deposit and distribution on the plant and ground to be visualized and crude comparisons can be made between machine or nozzle types.

Air assisted sprayers

An air assisted boom tested showed that air improved spray deposition compared with no air, however excessive air resulted in lower recovery on leaves. Air-assistance will enable booms to be operated under slightly adverse conditions with regard to windspeed and offer greater flexibility in manipulating the direction of the air curtain to maximise coverage in the crop. Excess air can induce greater losses when the air curtain bounces from the soil and moves droplets above the crop canopy. This is most likely to occur early in season when there is minimal crop canopy cover to intercept spray droplets. There is scope to fine tune the recommendation relevant to the use of air in onion crops so that full advantage of this technology is utilised.

6.4. Grower survey

The grower survey was useful from a number a viewpoints. In the first instance it highlighted the decline in growers currently growing onions in Queensland. This number has declined due to the poor prices received for and the difficulty experienced in trying to sell Queensland onions.

Secondly, it is interesting to note that although the majority of growers knew about the existence of the service only 10% used the service in 1999. This is disappointing considering the severity of the downy mildew outbreaks during the 1999 season. Of major concern to the growers is the small number of weather stations used to provide the service. Only four weather stations are used to deliver the service. Growers consider this number insufficient to provide an adequate service when taking into account the vast number of onion growing microclimates that exist throughout south-east Queensland.

7. Technology Transfer

Field Days

A workshop was conducted on the 26th November 1998 on the Onion Downy Mildew Forecasting Service and spray application techniques. Growers were updated on the project findings to date. This workshop concentrated on educating growers about the critical stages of disease development. A draft copy of the farmnote was also presented at this meeting. Growers were presented with the information gathered during a series of spray application trials that compared and calibrated grower boom sprays. Growers were also informed of the methodology of the forecasting service and its availability.

A grower field day was held on 24th September 1999. The results from the forecasting service and the spray application trials were presented and discussion followed in regards to the future of the forecasting service. Some growers had doubts as to the usefulness of the service and perhaps the money would be better spent elsewhere during the 2000 season. A number of growers felt that the service allowed them to feel confident in planning their own spray program and aided in a reduction of the number of sprays used.

This discussion was followed by an inspection of the Gatton Research Station trial site. The severity of the disease in the Lockyer Valley during the 1999 season was highlighted at this site. It was evident that neither the forecast-sprayed site nor the conventionally sprayed site gave adequate control of the disease. Although control was poor, this trial highlighted the benefits of the forecasting system in allowing more accurate timing of sprays and reducing the number of sprays applied.

Publications

A number of articles (Appendix 1) were published throughout the life of the project. Articles were published in *"Onions Australia"* from 1997 to 1999. Progress reports were presented to QFVG during the life of the project.

Other Media

Three QDPI Notes were published during the life of the project.

8. Recommendations

- This project has purchased a number of weather stations. It is recommended that these weather stations form an integral part of any future onion research project particularly for projects concerning sweet onions.

- It is recommended that the onion downy mildew forecasting service be maintained by the QDPI. To maintain the service an injection of funds is needed. To ensure the viability of the service there is a need for (i) a minimum of four extra weather stations ($12,000 to $15,000) to cover the growing areas of Helidon, the Darling Downs, Flagstone Creek and the Fassifern Valley and (ii) employment of personnel ($70,000 annually) to (a) develop a user friendly program for the service and (b) maintain the service on a full-time basis. It is possible to expand the service to include other crops eg target spot in potatoes.

- The importance of the findings in regard to spray application technology including on farm boom calibration needs to be passed on to growers via workshops and education programs

There appears to be great potential to improve existing application methods and reduce pesticide use by (1) ensuring application equipment are well calibrated and nozzles replaced when worn (2) select appropriate nozzles that maximise the spray deposits on the plant surface and minimise ground contamination, but this may not always be possible in drift sensitive situations.

A full evaluation of all commercially available application systems was beyond the resources available for the application component in this project. It was evident from the on farm calibration and trials conducted that growers are interested in ideas and techniques that promote efficiency in spraying. There is a need to continue the extension of the latest updates in spray technology so that growers can continually fine tune their equipment for optimal performance. Night walks utilising fluorescent tracers are valuable tools for demonstrating differences between equipment and or nozzles configurations.

This work has highlighted there is potential to improve pesticide targeting to onion crops. This, in conjunction with the forecasting service could be followed up with large scale trials on farm with growers to quantify the efficacy and yield benefits that could be gained from optimum spray targeting.

9. Acknowledgements

The financial assistance of the peak industry bodies HRDC, and QFVG is gratefully acknowledged. The cooperation of the following Lockyer Valley onion growers is appreciated: Mr Glenroy Logan (Tenthill), Mr Shane Litzow (Mulgowie), Mr Ian Zischke (Gatton), Mr Maurice Sippel (Gatton), Mr Selwyn Sippel (Lowood), Mr Danny Hood (Gatton), Mr Shane Osborne (Laidley), Mr Andrew Steinhardt (Tenthill) and Mr John Berlin (Laidley). The assistance of Mr. David Schofield and farm staff at the Gatton Research Station is acknowledged.

The assistance of Mr Rob Battaglia (formerly QDPI), Field Scientist, Syngenta Crop Protection Pty Limited in the pesticide application component of this project is gratefully acknowledged.

Appendix 1
Publications

Field Days

1998: 26th November – Field Walk pesticide application, boom calibration and preliminary forecast data.

1999: 12th May - Release of QDPI Notes and commencement of Forecasting Service at grower field walk.

Publications

Battaglia, R (1998). Hitting the Tagret. *Onions Australia* 15 : 24.

Battaglia, R (1999). Which Nozzle is that?. *Onions Australia* 16 : 33-34.

Harper, S (1997). Onion downy Mildew Forecasting Service to Commence in the Lockyer Valley. *Onions Australia* 14 : 35.

Harper, S (1998). Forecasting Downy Mildew. *Onions Australia* 15 : 39-43.

Mac Manus, G, and Harper, S (1999). Onion Downy Mildew Forecasting Service for the Lockyer Valley. *Onions Australia* 16 : 27.

Other Media

Harper, S, O'Brien, R and Mac Manus, G. (2000). Onion Downy Mildew in the Lockyer Valley – 1. Disease Life-Cycle. QDPI Note. Agdex 256/633.

Harper, S, O'Brien, R and Mac Manus, G. (2000). Onion Downy Mildew in the Lockyer Valley – 2. Forecasting Service. QDPI Note. Agdex 256/633.

Harper, S, O'Brien, R and Mac Manus, G. (2000). Onion Downy Mildew in the Lockyer Valley – 3. Management: Trouble Shooting. QDPI Note. Agdex 256/633.

Appendix 2
Grower Survey

Implementation of an Onion Downy Mildew Forecasting Service in the Lockyer Valley

VG 97024

Grower Phone Survey June 2000

Question 1

Have you heard of the Onion Downy Mildew forecasting service provided by the QDPI Gatton for growers in 1999?

YES NO

If **YES** got to **Question 2**, If **NO** got to **Question 4**

Question 2

Did you use this service in 1999? **YES** **NO**

If **YES**, Approximately how many times?
If **NO**, go to **Question 5**

Question 3

Did you find the information useful? **YES** **NO**

Question 4

Did you use the information provided to modify your spray program for the control of onion downy mildew during the 1999 season?

YES NO

Question 5

If the service was available this year would you use it? **YES** **NO**

Question 6

Would you use this service if it was provided by private consultants or resellers?

YES NO

Implementation of an Onion Downy Mildew Forecasting Service in the Lockyer Valley

VG 97024

Grower Phone Survey June 2000

1. *Introduce yourself and say where you are from.*
2. *Explain reason for phone call: a survey to determine the extent to which the forecasting service was utilised during the 1999 season and how the information was used.*
3. *Explain that survey will only take approximately five minutes of their time with only six questions.*
4. *Perform survey.*
5. *Thank them for their time.*

Appendix 3
QDPI Notes

Agdex 256/633

Onion Downy Mildew Hotline 5466 2207

DPI note Department of Primary Industries QUEENSLAND

Onion Downy Mildew in the Lockyer Valley

1. Disease Life-Cycle

Stephen Harper (Horticulturist – Heavy Vegetables), Rob O'Brien (Principal Plant Pathologist) and Gerry Mac Manus – Queensland Horticulture Institute

Introduction

Onion Downy Mildew, caused by the pathogen *Peronospora destructor*, is perhaps the most widespread and debilitating disease of onions throughout the world. Studies conducted in Canada during the 1980s have determined the pathogens' response to specific environmental conditions (ie. temperature, relative humidity, light, rainfall and leaf wetness). Outbreaks are strictly dependent on these factors and Canadian researchers have developed a disease prediction model called 'Downcast'.

In the Lockyer Valley, Queensland Department of Primary Industries and University of Queensland researchers have shown the 'Downcast' model can accurately pinpoint critical periods conducive to onion downy mildew outbreaks. This will not only improve fungicide timing and in some seasons reduce the number of fungicide applications, but also reduce the pressure on the use of eradicant fungicides and thus minimise potential for resistance.

The QDPI offers Lockyer Valley onion growers a disease forecasting service that will assist them in managing onion downy mildew. However, before using the forecasting service it is important that you have a basic understanding of how the disease develops and the stages in its development.

The disease life cycle

The disease becomes most prevalent under conditions of high relative humidity (≥95%), cool or mild temperatures and extended dewy or wet periods. Outbreaks of the disease are strictly dependent on these conditions, thus in some seasons the disease is far more prevalent than in others.

Onion downy mildew produces two types of spores, thin-walled spores (conidia) which are short-lived and infect during the growing season and thick-walled spores (oospores) which allow survival between seasons in crop residues incorporated into the soil. The thick-walled-oospores are likely to provide the source of inoculum for the first infection for the season otherwise known as the ***'primary infection'***. In the

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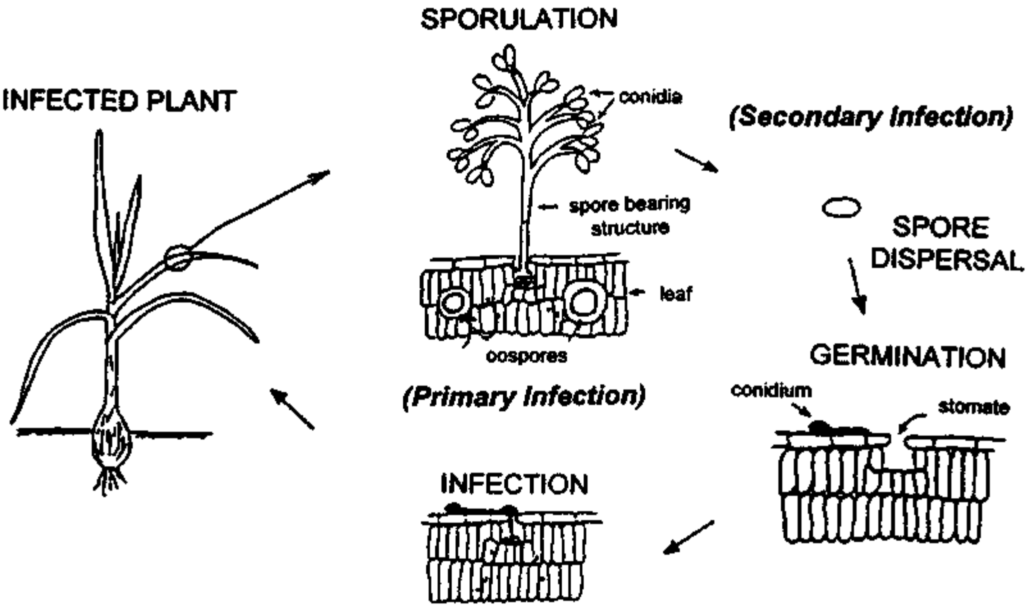
absence of a host, the thin-walled spores of the pathogen do not survive for long, usually about 3 days.

The disease has two important phases in its life cycle, infection and sporulation. Infection occurs when spores which have settled on the leaf surface germinate and enter pores in the leaf called stomata. After infection the pathogen appears to be latent (inactive) for the next 9-16 days, but is in fact growing within the leaf preparing to produce the first cycle of spores.

After the latent period, the pathogen is capable of sporulating if weather conditions are suitable. Sporulation (spore production and release) is seen as a blue/grey, downy or cottony fungal growth on the leaf surface. If environmental conditions are favourable, the next infection phase immediately follows this sporulation event, and generally occurs either on the same day as sporulation or during the next 1-2 days. Periods of dry weather at this time will prevent further infection.



Life cycle of downy mildew (*Peronospora destructor)* in onions.

The disease forecast criteria

The disease has very specific weather requirements in order for sporulation and infection to be successful. Sporulation and infection occurring on the same morning is referred to as a ***'Major Infection'***.

Sporulation

Sporulation occurs when:

1. The mean hourly daytime temperature on the previous day was $\leq 24°$ C;
2. The temperature during the night was within the range 4-24° C;
3. There was ***no*** rainfall (> 1 mm) between 11pm and 4am;
4. The relative humidity was $\geq$ 95% for at least 4 hours (continuously) between midnight and 6am.

Infection

Infection occurs on the same day as sporulation when leaf wetness (dew) persists until 3 hours after sunrise, typically about 9am in Queensland.

If these conditions are not met on the same day as sporulation, spores will survive for up to 3 days and are capable of infecting on any night provided the following conditions are met:

1. Dew deposition is rapid;
2. Leaf wetness is maintained for more than 3 hours at 6-22° C;
3. Little or no dew had formed on the previous night (slow or light dew deposition causes spore death).

Typically, the high risk period for onion downy mildew is from July to mid September. It is not normally a problem early in the season (from February to April) or later (in October), when mean daytime temperatures exceed the forecast criteria.

Further information

- Agrilink Onion Information Kit (1997) – Queensland Department of Primary Industries.

- Compendium of Onion and Garlic Diseases (1995). Schwartz, H.F. and Mohan, S.K. American Phytopathological Society Press.

- Field Guide to Cream Gold Onion Disorders and Their Control (1997). Tasmanian Department of Primary Industries and Fisheries.

- Various articles of interest can be found in *Onions Australia*, an annual Onion Industry Journal.

- Other notes in the *Onion Downy Mildew in the Lockyer Valley* series include:
  2. Forecasting Service
  3. Management: Trouble Shooting ■

Agdex 256/633

Onion Downy Mildew Hotline 5466 2207

DPI note

Department of Primary Industries QUEENSLAND

Onion Downy Mildew in the Lockyer Valley

2. Forecasting Service

Stephen Harper (Horticulturist – Heavy Vegetables), Rob O'Brien (Principal Plant Pathologist) and Gerry Mac Manus - Queensland Horticulture Institute

The forecast service

In the Lockyer Valley, the Queensland Department of Primary Industries offers onion growers a forecasting service to assist in the management and control of onion downy mildew. Weather stations have been established in four important onion growing districts of the Lockyer Valley (ie. Gatton, Laidley Valley, Upper Tenthill and Lowood). This service is based on the Canadian 'Downcast' model, which can pinpoint critical periods conducive to onion downy mildew outbreaks and allow more precise timing of appropriate fungicide applications. The service can be accessed by phoning **5466 2207** on which a recorded message will be played giving a prediction and fungicide recommendation.

Using the onion downy mildew forecast service

How do I access the service?

The Onion Downy Mildew Forecasting Service can be accessed simply by phoning **5466 2207** and you will receive a recorded message giving a forecast and recommendation for each of the four districts. If a positive prediction is recorded at all four sites, a single blanket forecast for the Lockyer Valley will be made. The forecast will be updated on Monday, Wednesday and Friday at midday.

If you notice a downy mildew outbreak in your area early in the season, please advise the downy mildew unit at DPI Gatton Research Station on 5466 2222. The first infection event for the season will be highlighted in the local media (radio and newspapers) and this will signal the commencement of the service for the season.

Which site will give the best forecast for me?

If you are in a region that is not specifically covered, then choose the site with weather most closely related to your area. For example, the weather for Mortonvale district is probably more closely related to the Lowood district than to Gatton.

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Remember that certain geographical features can affect the incidence of the disease. If you are particularly close to a major water source (eg. Lake Clarendon, Wivenhoe Dam or large farm dams), you may need to be conservative in using the forecast as dews may be considerably heavier and persist for longer than in other areas. If this is the case choose the forecast site which tends to have higher disease pressure. For example, Lowood's close proximity to Wivenhoe Dam results in heavy dew formation, longer periods of leaf wetness and consequently higher disease pressure.

How do I use the forecast?

A forecast description will be made for each site where different forecasts are recorded.

Low pressure seasons

In seasons where conditions are favourable for the disease only once in a 14 day period, single disease cycles occur and this is a low pressure season. In the Lockyer Valley, there will often be quite long periods of unsuitable weather (westerly winds), interspersed with a few weeks of high disease risk (still, dewy conditions). By following the forecasts, substantial reductions in the number of sprays may be achieved in a low pressure season.

High pressure seasons

In some seasons, particularly wet seasons or seasons of continuous heavy dews, severe disease pressure will occur. Where conditions are favourable for the disease on a regular short-term basis (eg. every 5-7 days) a high disease pressure season will result. Since the disease takes about 14 days to complete its cycle, disease cycles may overlap each other. In such seasons there is usually no reduction in fungicide use compared with calendar spraying.

The forecast will advise whether the disease pressure is high or low.

When to use or ignore the forecast

- **Use an eradicant spray when a sporulation and infection have been predicted and you have not applied a protectant fungicide in the previous 5 days**
- **Ignore the forecast if you have applied a protectant fungicide in the previous 5 days.**
- **If there is evidence of onion downy mildew in your onions but you have applied a protectant within 5 days then use an eradicant**
- **In a low pressure season apply your next protectant 10 days after the infection**
- **In a high pressure season apply your next protectant in 5-7 days**

Which fungicides will I use?

A ***Protectant*** fungicide is applied to plants **before** disease infection and hence protects plant surfaces by preventing spores from germinating. Good coverage is essential with repeated applications required to protect new growth. Examples include mancozeb and chlorothalonil.

An ***Eradicant*** fungicide is applied after spore germination and during the early stages of disease infection. The chemical is absorbed into the plants' sap system and acts from within to arrest or eradicate infection. Coverage is not as critical as it is for protectant fungicides. Examples include Ridomil® MZ and Acrobat® MZ.

Table 1. Fungicides registered for onion downy mildew control in Queensland.

Protectants	**Trade Name**
Chlorothalonil	Chlorothalonil, Fungonil, Rover
Copper	Copper fungicide, Blue-side Copper, Kocide, Copper hydroxide, Nordox, Copperneb
Mancozeb	Mancozeb, Manzate, Penncozeb, Dithane
Propineb	Antracol
Zineb	Zineb, Cyneb
Eradicants	**Trade Name**
Phenylamide *group*	
Benalaxyl + mancozeb	Galben M
Metalaxyl + mancozeb	Ridomil MZ
Oxadixyl + Mancozeb	Recoil
Oxadixyl + propineb	Fruvit
Morpholine *group*	
Dimethomorph + mancozeb	Acrobat MZ

Fungicide resistance management

1. Do not apply more than 2 consecutive sprays of any one eradicant fungicide
2. Alternate between the groups of eradicant fungicides e.g. phenylamides and morpholine.

Benefits of using the forecasting service

- More accurate timing of application;
- Reduced fungicide use (in low pressure seasons);
- Better fungicide resistance management.

Further information

- Agrilink Onion Information Kit (1997) – Queensland Department of Primary Industries.

- Compendium of Onion and Garlic Diseases (1995). Schwartz, H.F. and Mohan, S.K. American Phytopathological Society Press.

- Field Guide to Cream Gold Onion Disorders and Their Control (1997). Tasmanian Department of Primary Industries and Fisheries.

- Various articles of interest can be found in *Onions Australia*, an annual Onion Industry Journal.

- Other notes in the *Onion Downy Mildew in the Lockyer Valley* series include:
    1. Disease Life-Cycle
    3. Management: Trouble Shooting ■

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Onion Downy Mildew Hotline 5466 2207

DPI note Department of Primary Industries QUEENSLAND

Onion Downy Mildew in the Lockyer Valley

3. Management: trouble shooting

Stephen Harper (Horticulturist – Heavy Vegetables), Rob O'Brien (Principal Plant Pathologist) and Gerry Mac Manus - Queensland Horticulture Institute

Why isn't my spray working?

Many factors affect the control of onion downy mildew. One of the major reasons why good control is not achieved is that an initial spraying, to target the first major disease cycle, has been missed. By the time you see a large patch of onion downy mildew (eg. about 4-10 m^2) in your onions it is likely that at least 3 generations of the disease have been realised and it is in the process of going through a fourth generation.

Since the disease takes about 14 days per generation it is likely the very first or primary infection had occurred about 40 days before. Remember that you don't see the downy growth until about 10-14 days after the infection has taken place. By the time you see a major problem in the field it is likely that a further infection has occurred, the results of which will only be evident in a further 10-14 days. The Queensland Department of Primary Industries' forecasting service (accessed through the Onion Downy Mildew Hotline on 5466 2207) will allow you to precisely time spray application to target critical stages in the disease cycle and in particular target the initial infections.

Westerly wind changes

There is often confusion about the effects of westerly winds on onion downy mildew. These winds typically are of very low relative humidity and provide conditions that are very unfavourable for the disease to develop. If good control of the disease has been achieved, dry westerly changes will help in keeping the disease in check.

However, if the disease has become firmly established in an onion patch, a westerly change will spread spores throughout the patch and with subsequent favourable conditions, a larger outbreak will occur.

Check your spray equipment

Your application of fungicides and thus control of onion downy mildew is only as good as your spray equipment. Use ceramic hollow cone nozzles and calibrate your equipment at the start of the season and again half way through the season to ensure it is giving even application. Replace nozzles when their flowrate (output volume per minute) is more than 10% above or below the manufacturer's specification.

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Downy mildew is favoured by high relative humidity which becomes greater within the crop as it approaches maturity. This combined with the increased crop canopy means higher volumes of application should be considered later in the season. A typical example would be an increase from 300 L/ha to 450 L/ha.

Crop health

As with many diseases, the severity of the disease is often related to the health of the crop. Healthy plants are more resistant to disease infection or can better tolerate a certain amount of the disease. Adopt management practices which ensure a healthy crop (eg. optimise nutrition, manage thrips, schedule irrigation and avoid crop damage when applying herbicides).

Irrigation

It is often unclear for growers how irrigation affects the incidence of onion downy mildew. Rainfall of greater than 1 mm and hence overhead irrigation washes spores off the leaves and prevents infection. Also, rainfall at critical stages during sporulation prevents the disease from producing spores. There is a common belief that trickle irrigation reduces the incidence of disease. This is not necessarily the case with onion downy mildew. In a season of consistently dewy conditions but low or nil rainfall crops grown under trickle irrigation may have a higher incidence of onion downy mildew.

Further information

- Agrilink Onion Information Kit (1997) – Queensland Department of Primary Industries.

- Compendium of Onion and Garlic Diseases (1995). Schwartz, H.F. and Mohan, S.K. American Phytopathological Society Press.

- Field Guide to Cream Gold Onion Disorders and Their Control (1997). Tasmanian Department of Primary Industries and Fisheries.

- Various articles of interest can be found in *Onions Australia*, an annual Onion Industry Journal.

- Other notes in the *Onion Downy Mildew in the Lockyer Valley* series include:
    1. Disease Life-Cycle
    2. Forecasting Service ■

Appendix 4
Onions Australia Publications

Onions Australia – 1997

Onion Downy Mildew Forecasting Service to Commence in the Lockyer Valley.

In a project jointly funded by QFVG (Queensland Fruit and Vegetable Growers) and HRDC the Queensland Department of Primary Industries will establish an Onion Downy Mildew forecasting service to Lockyer Valley farmers.

Onion Downy Mildew is perhaps the single biggest constraint to onion production in Queensland and in severe cases can result in total crop loss. The disease becomes most prevalent under conditions of high relative humidity, low temperature and extended periods of dewy or wet conditions. Disease outbreaks are strongly dependent on these conditions, thus in some seasons the disease is far more prevalent than in others. However, since onions are a high valued crop many growers are faced with no option other than to adopt a calendar spray program irrespective of whether the conditions are favourable for disease development.

Following on from research conducted by the University of Queensland and Queensland DPI in developing a forecasting system for onion downy mildew, a project to extend this system into a grower service has received funding. In the Lockyer Valley, where 80% of Queensland's onions are grown, there are four important growing regions (Tenthill, Gatton, Laidley and Lowood) and each of these has quite different microclimates. Weather stations will be established in each of these regions and weather data will be collected and used as a basis to forecast when spraying is required to control downy mildew. A simple spreadsheet macro has been written to assist in performing disease prediction calculations.

Under a forecasting system where fewer fungicide applications are made improved coverage will be critical. Conventional fungicide and insecticide applications to onion crops in the Lockyer Valley involve the use of hydraulic nozzles using water volumes of up to 600L/Ha. Poor leaf coverage often results due to the foliage characteristics of onions (an upright and waxy leaf surface) which makes droplet capture and retention difficult. The project will also investigate pesticide application parameters associated with onion spraying and provide recommendations to growers that enable them to improve coverage from fungicide and insecticide applications. Parameters such as application volume, nozzle orientation and nozzle type, air assistance and the use of surfactants will be investigated.

Onions Australia – 1998

Pesticide Application

Hitting The Target
(Robert Battaglia and Stephen Harper)

Mr Robert Battaglia is a Horticulturist (pesticide application technology) at the Queensland Horticulture and Stephen Harper is a Horticulturist (Heavy Vegetables) at the Queensland Horticulture Institute.

Background

Pesticide related issues are very topical and subject to much publicity when negative events occur. Many horticultural industries are committed to minimising pesticide usage and maximising the efficiency of spray application systems, this never seems to get the same level of coverage. This work is being undertaken as part of a HRDC project "Implementation of an onion downy mildew forecasting service in the Locker Valley". In the 1997/98 season a series of spray application trials were conducted on growers properties in the Locker Valley, S.E. QLD using conventional boom sprayer equipment as well as an air assisted boom sprayer.. In addition, a selection of growers collaborating in the project has had their boom sprayers calibrated. The purpose of the application trials was to evaluate the equipment performance in terms of spray recovery on onion foliage and losses to the ground. Baseline data is being collected to allow an objective assessment and comparison to be made of different spraying systems currently in use by growers. Spray deposits are being quantified on the leaves as well as the ground using fluorescent tracers.

Results

Onion growers in the Lockyer Valley are applying fungicides and insecticides in water volumes ranging from 200-450 L/ha. Some growers increase their application volumes as the onion canopy cover increases.

Spray losses to the ground are high and account for up to 30% of the applied volumes. Such losses are not surprising, as the canopy is a difficult target for spray droplets to impact upon given the waxiness of leaves and their upright structure. Trials conducted with booms fitted with hollow cone nozzles have consistently provided higher levels of recovery than flat fan nozzles applying the same volume. The air assisted boom tested also showed that air improved spray deposition compared with no air, however excessive air resulted in lower recovery on leaves.

Conclusion

This work is only just beginning to scratch the surface. Their appears to be great potential to improve existing application methods and reduce pesticide use by (1) ensuring application equipment are well calibrated and nozzles replaced when worn (2) selected appropriate nozzles that maximise the spray deposits on the plant surface and minimise ground contamination. A full evaluation of all commercially available application systems is beyond the scope of this project but it is hoped the work will identify areas for future research directions in pesticide application.

Caption (Conventional Boom sprayer spraying onions)

Onions Australia – 1998

Forecasting Onion Downy Mildew In The Lockyer Valley

Stephen Harper – Horticulturist –
Gatton Research Station
Queensland Horticulture Institute
Queensland Department of Primary Industries-

In the Lockyer Valley, where 80% of Queenslands onions are grown, downy mildew represents one of the major production problems. Within the region there are four important onion-growing districts (Tenthill, Gatton, Laidley and Lowood) each having slightly different microclimates. Weather stations have been established in each district to monitor weather differences and make regional forecasts for onion downy mildew outbreaks. The "Downcast" (Jesperson and Sutton 1987) model for predicting onion downy mildew outbreaks is being validated as a tool for timing spray applications.

Disease forecast criteria

The cycle of the disease has 2 distinct phases namely, sporulation where spore production and release occur, and infection where these spores infect the leaf. The Downcast system is briefly summarised as follows for Queensland growing conditions and may vary in other states under summer production systems.

Sporulation occurs when

- the previous average daily temperature is less than 24°C
- Temperature during the night is within the range 4-24°C
- No rainfall is received between the hours 2300 and 0400
- The relative humidity is greater than 95% continuously for 4 hours after the hour 0000

Infection will occur on the same day as sporulation if leaf wetness persists for at least 3 hours after sunrise typically about 9:00 AM under Queensland conditions. If infection does not occur at this time, spores can infect on the next day provided dew deposition is very rapid. If dew deposition is slow spores die. In general spores remain viable for about 3 days.

The 1998 season

Because the incidence of the disease is dependent on the above set of conditions some seasons result in far greater prevalence than do others.

The Downcast model confirmed that there were no early season infection periods (from March to middle April). During this early period the average temperature on the previous day was greater than the criteria range. This was particularly so in this year's season as atypical hot conditions continued well into April.

When this average temperature for the previous day finally dropped within the critical range conditions were often favourable for sporulation but not favourable for simultaneous reinfection. Conditions for reinfection were not met for between one to three days later. Even at this, these predicted infections did not appear to be favourable for disease development. It is believed leaf wetness *conditions on the days following the predicted sporulation were not adequate to promote the disease. These events are nominally called "Minor infection events".*

Events where both sporulation and reinfection occurred in the one day or where dew deposition persisted until at least 9:00 on the following day are presented in table 1 and these are nominally called "Major infection events". Field observations of infected crops throughout the district clearly confirmed that positive infection events had occurred on at least some of these dates, particularly those dates where all four sites indicated a positive forecast.

Table 1. Major downy mildew infection events at four locations in the Lockyer Valley.

Date.	Gatton	Laidley	Lowood	Tenthill
01/05/1998	✓		✓	✓
17/05/1998			✓	✓
31/05/1998		✓		
03/06/1998	✓		✓	✓
29/06/1998		✓	✓	
05/07/1998	✓	✓	✓	✓
13/07/1998			✓	
20/07/1998	✓	✓	✓	✓
28/07/1998		✓		✓
03/08/1998	✓			✓
10/08/1998	✓			
26/08/1998	✓	✓	✓	✓

✓ denotes a positive major infection on this date

The data above highlights this year (to the time of writing) has been of relatively low pressure with most sites having reasonable periods in between major infection events. Apart from the Lowood site in July there appeared to be no overlap in infection cycles which offers the potential to reduce fungicide applications. Where there is overlapping of infection cycles frequency of protectant fungicide application needs to be increased. This season has been characterised by phases of strong drying westerly winds, which provide unfavourable conditions for the disease. Notwithstanding, if inoculum is present in crops, westerly winds rapidly spread spores and if subsequent conditions are favourable for the disease a more widespread infection results.

1998 trial results

The implementation of the forecasting system has been done as unreplicated trial plots of about 20m x 20m on growers early planted onions only. The trial plots were sprayed based on the recommendations of the forecasting system and compared with the growers own spray program. Final data to compare the number of sprays applied has not been collated at this time, however, it is anticipated that a saving of 2-3 sprays may have been achieved through using the forecasting system. Importantly, the forecasting system can more accurately target sprays to coincide with critical stages in the disease development.

In Queensland spraying generally begins in the early to middle season growth stage and under a calendar spray program more than 12 sprays can be applied over the duration of the crop. In this trial a total of 9 sprays was used at the Gatton site, 5 at Laidley, 9 at Lowood and 8 at Tenthill. No plants in either the growers block nor the trial block showed evidence of downy mildew.

Summation

The use of the Downcast model gives an accurate understanding of the diseases cycle such that the use of eradicant fungicides can be timed to target the critical stage in the disease cycle. The specific targeting of fungicide application can potentially reduce the resistance pressure on the eradicant fungicides, allow better disease control through critical timing of application and in low pressure seasons reduce fungicide use. Furthermore, given that the time between infection and sporulation is between 10 and 14 days there is the opportunity in low pressure seasons to time the application of protectant fungicides to coincide with the anticipated date of sporulation, thereby affording better protection against subsequent reinfection.

In the 1999 season the forecast system will be trialed on middle season onions when conditions are likely to be more favourable for the disease. An onion downy mildew forecasting service will also be available for growers wanting to obtain the forecast recommendations. This will be supplied via a hotline pre-recorded message.

This work forms part of project VG97024 "Implementation of an onion downy mildew forecasting service in the Lockyer Valley". The assistance of Queensland Fruit and vegetable Growers and HRDC is gratefully acknowledged.

Onions Australia – 1999

Which Nozzle and What Volume? Getting the most out of your fungicide sprays.

Robert Battaglia (Horticulturist specialising in Pesticide Application Technology)
Queensland Horticulture Institute.

Improving the efficiency of spraying in most crops including onions may include (i) minimising off-target losses and (ii) maximising within canopy deposits. Following the article in last years issue of Onions Australia titled, "Hitting the Target" we have run several small plot trials in commercial onions crops investigated the efficiency of different spray volumes, nozzle types and some spray adjuvants. An overview of the nozzle type and spray volume trial results are presented in this article.

Spray nozzles are the most important component of your boom spray. They not only meter the pesticide mixture emitted and hence determine the application volume and pesticide dose per hectare but also produce droplets hopefully of an appropriate size for obtaining good coverage. Unfortunately nozzles wear, which means they need replacing. The frequency depends on the products used through them, the nozzle material and the amount of use they get. Nozzles also come in a range of types (ie. hollow cone, flat fan, twin-fan patterns and many more). All nozzles are designed for a specific job and this often relates to the spray quality they produce. If off-target drift is a concern then you will be particularly interested in the spray quality of a nozzle and this relates to the range droplet sizes produced especially at the fine end of the droplet spectrum.

What did we do?

As part of a small plot replicated field trial conducted at the Gatton Research Station, we tested three nozzle types for their efficiency in applying pesticides to the onion canopy. We had seven treatments, these consisted of hollow cone nozzles at four volumes (52, 105, 192 and 375 L/ha), the spraying systems TwinJet® nozzle at 300L/ha, and the Spraying Systems drift guard (DG) and extended range (XR) flat fan nozzles at approximately 300 L/ha. There was a large buffer between the sprayed plots. The windspeed during spraying ranged from 0.5 to 3.0 m/s. All treatments were applied using a motorised knapsack.

Spray Deposit Measurements

A fluorescent tracer applied at 60g/ha was used to quantify the amount of spray that was deposited on the plant and on the ground. The crop was at the 10 to 12 leaf stage. Plots were 1.5m wide and 10.5m long. Whole plants were sampled and cut into four sections to enable the spray distribution to be mapped within the canopy. Figure 1 shows a plant cut into four sections (zone 1 was at the bottom and zone 4 at the top of the plant).

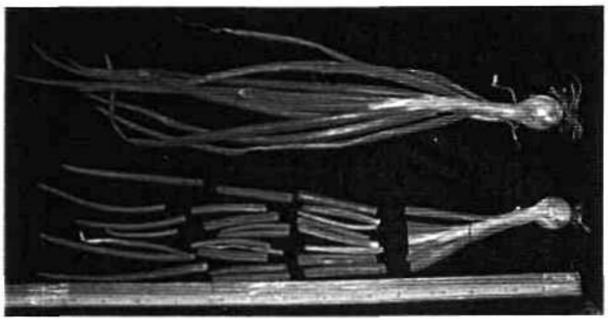

Figure 1. Whole onion plant and plant cut in sections showing the 4 zones where deposit measurements were made (bottom zone = 1 and top = 4).

What did we find?

The spray deposited within each of the four zones for the seven treatments are shown in Figure 2. The results can be compared directly as they have been adjusted to compensate for the differences in volume. There are some distinct differences in the spray recovered in the 4 zones and also between the nozzle types. With all treatments zone 2 had the lowest average deposit. At this zone the leaves are tightly clustered and hence spray penetration into this region is reduced. Zone 4, the top of the plants received the highest average deposit.

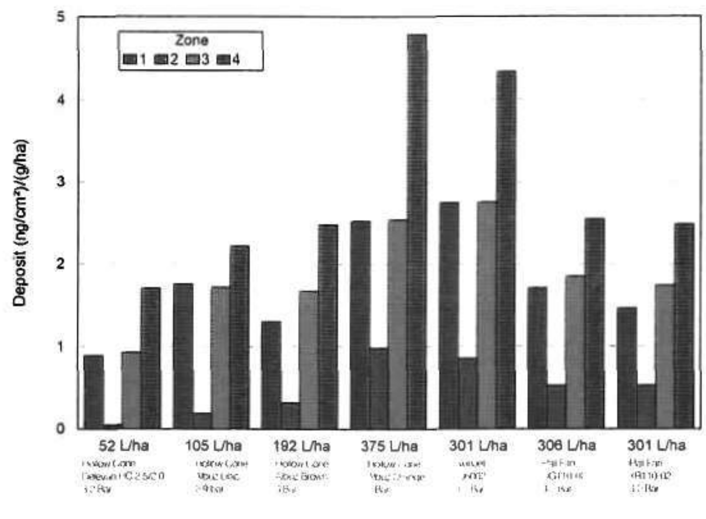

Figure 2. Tracer deposit (ng/cm²)/(g/ha) for different hydraulic nozzle and spray volume treatments.

What do these results mean to you as a grower?

The findings in this trial are very interesting as two of the nozzle treatments, the hollow cones at the higher volume (375L/ha) and the TwinJets deposited 55 to 65% more spray than the other nozzle treatments. The Twinjet nozzle, which is basically a flat fan nozzle that produces two sheets of liquid, separated by a 60 degree angle (Figure 3) gave exceptional results. There was no difference between the hollow cone at the highest volume, 375 L/ha and the TwinJet nozzle at 300 L/ha.

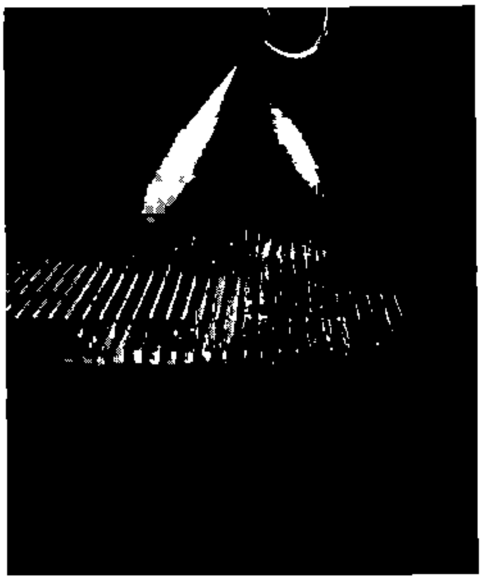

Figure 3. A TwinJet nozzle in operation positioned over a patternator (nozzle viewed from the side)

Further Work

This work has been undertaken as a component part of project VG97024, "Implementation of an onion downy mildew forecasting service in the Lockyer Valley". The spray technology trials were a small component of this project. The work has highlighted there is scope to do further work investigating reduced chemical rates as a result of improvements made in the targeting of pesticides.

Acknowledgments

The assistance of the Queensland Fruit and Vegetable Growers and HRDC is gratefully acknowledged. In addition I would like to thank Mr Glenn Geitz for his technical assistance in the field trials undertaken.

For further information on this topic please contact Mr Robert Battaglia at Gatton Research Station (Qld) on (07) 546012255.

Onions Australia – 1999

Onion Downy Mildew Forecasting Service For The Lockyer Valley

Gerry Mac Manus (Technical Officer), Stephen Harper (Horticulturist – Heavy Vegetables) and Rob O'Brien (Principal Plant Pathologist) - Queensland Horticulture Institute

The Forecast Service

In the Lockyer Valley where 80% of Queensland's onions are grown, the Queensland Department of Primary Industries offers onion growers a forecasting service to assist in the management and control of onion downy mildew for the current season. This service is based on the Canadian 'DOWNCAST' model, which has been modified for local conditions. It accurately pinpoints critical periods conducive to onion downy mildew outbreaks thus allowing more precise timing of appropriate fungicide applications.

Forecasts are given for the four important onion growing districts of the Lockyer Valley, namely, Gatton, Laidley Valley, Upper Tenthill and Lowood.

Accessing The Onion Downy Mildew Forecast Service

The Onion Downy Mildew Forecasting Service can be accessed by simply phoning the **Onion Downy Mildew Hotline** number **5466 2207** (for the cost of a local call) on which a recorded message is played giving a forecast and fungicide recommendation for each of the four districts. If a positive prediction is recorded at each site a single blanket forecast for the Lockyer Valley will be made. The forecast is updated on Monday, Wednesday and Friday.

Commencement Of The Service

The service commenced officially on Wednesday 30 June after all registered growers and local agchemical resellers had each received three extension bulletins covering in detail the disease lifecycle, the forecasting service and management recommendations. Additionally, they were advised of the service at an Onion Field Walk at the Gatton Research Station on 12 May and through the local newspaper. This service has been well received with 234 calls recorded in the first month of operation.

The Future

It is envisaged that in the near future that this service would be commercialised.

Associated Research

In continuing research being conducted, fungicide programmes based on the forecast service will be compared to that of growers' own spray programmes, on late-planted onions that are exposed for a longer duration to conditions which are more conducive to the disease. In similar unreplicated field trials in 1998 Stephen Harper demonstrated that there was a saving of between 3 to 5 sprays without loss of disease control in early-planted onions.

This work is part of project VG97024 'Implementation of an onion downy mildew forecasting service in the Lockyer Valley'. The assistance of Queensland Fruit and Vegetable Growers and HRDC is gratefully acknowledged.