Project title:	Bulb onions from sets: Control of white rot by set, soil and foliar treatments
Report:	Annual Report (January 1999)
Project number:	FV 4e
Project leader:	Dr C D Paterson HRI-Kirton Kirton Boston Lincs PE20 1NN
Report author:	As above
Location:	Lincolnshire
Project Co-ordinator:	Mr D O'Connor
Date commenced:	1 February 1998
Date completed:	31 January 1999
Keywords:	Onions, white rot, sclerotium cepivorum, tebuconazole, folicur

FV 4e

CONTENTS

PRACTICAL SECTION FOR GROWERS

Objectives and background

This project tested possible uses of Folicur (tebuconazole) to control white rot in onions, concentrating in particular on its use with sets. Three methods of application were trialled; set treating, in-furrow spray application at planting and foliar sprays (2 applications), individually and in combination. Foliar applications of azoxystrobin (Amistar) were also tested.

Summary of results

White rot levels were not as high in this trial as in 1997 with untreated control plots reaching 45% of plants infected by harvest in September. Foliar applications, in-furrow applications and set dips of Folicur were all effective in reducing levels of white rot in onions. There was a small benefit from combining set dips with in-furrow applications. Set dipping was the most consistent treatment, would be easy for growers to use and would reduce operator exposure compared with other treatments. However, Folicur is not currently approved for use as a set dip or an in-furrow application.

Applying Amistar as a foliar spray had a limited effect on white rot levels in this trial.

Action points for growers

In the light of this trial data and the 1997 results, it would seem pertinent to seek off-label approval for set treating and an in-furrow application.

Future work should target:

1. Concentration rates of solution used in set treating.

2. Testing tebuconazole in combination with the industry standard practice of Benlate set dipping for efficacy and phytotoxicity.

3. Using high volume spray later in the season on treated sets to provide better white rot control up to harvest.

4. Testing tebuconazole applications for phytotoxic effects in a non-white rot situation.

If set treating or in-furrow applications prove to be popular methods of white rot control, then the possibility of enhanced degradation should not be overlooked.

Practical and financial benefits from study

The work has clearly demonstrated the potential for white rot control with tebuconazole with set and in-furrow treatments proving more effective than foliar sprays. More work is required to develop appropriate methods of application and rates for the use of this chemical in future.

Experimental Section

Introduction

White rot (*Sclerotium cepivorum*) remains a major disease affecting bulb onions and other members of the allium genus.

HDC sponsored projects FV4b and 4c in 1995 and 1996 investigated seed treatments of tebuconazole (as Raxil – UK 226) supplemented with stem base or foliar sprays of Folicur (tebuconazole). Excellent control was achieved with these treatments in salad onions in experiments carried out in North Kent whilst less effective control was obtained in experiments in Lincolnshire on bulb onions with similar treatments (Davies et al 1998). This work led to the new off-labels for tebuconazole as a seed treatment and stem-based spray.

In New Zealand, a good degree of control of white rot has been achieved from a procymidone (Sumislex) seed treatment supplemented by in-furrow sprays of tebuconazole with or without foliar sprays of procymidone, tebuconazole or triadimenol (Fullerton, Stewart & Slade, 1995). However, procymidone seed treatments are not permitted in the UK and the manufacturer, Sumitomo Chemical Company, has indicated that they do not intend to introduce this produce into the UK because of the limited market size.

In Australia, an in-furrow spray of tebuconazole at sowing was found to be the most effective treatment and was more effective than procymidone (Ryler & Obst, 1995).

In 1997 the use of Folicur as set dips, in-furrow applications and foliar sprays were tested on bulb onions from sets. On a highly infected site 95% of untreated plants developed white rot, all treatments in combination reduced the level to 45% but no treatment gave total control. The set treatment and in-furrow sprays, to a lesser extent, delayed the development of white rot considerably and reduced the final levels by about half.

In this project the effects of varying the rates of set dips and in-furrow sprays on white rot control are tested. In addition a new chemical azoxystrobin (Amistar) is tested for potential as a white rot control agent. Work in Holland is also being carried out using tebuconazole as a set dip and foliar applications (pers. comm de Visser).

There is currently an off-label approval for foliar sprays of 1 l/ha Folicur in a minimum of 200 l/ha water, maximum total dose of 2 l/ha.

Materials and methods

The site was prepared on 28-29 April 1998. The area was power harrowed and then bedded out into 1.83 m beds. A known weight of white rot (*Sclerotium cepivorum*) sclerotia were mixed with an inert carrier (sand), a set amount of this mixture was applied to each plot using a garden lawn spreader. The beds were then raked by hand to mix the sclerotia in to the top 5 cm.

The trial was superimposed on the site of a previous white rot study. Care was taken to position the plots in line with the previous plot areas. However adding the cultured sclerotia was intended to bring all plots up to a high level of white rot infection.

The trial was drilled with sets of Hystar at 20 per m^2. The beds were 10 m long and consisted of four rows at 38.25 cm centred on the bed. There were 14 treatments as outlined below arranged as a three by three factorial of main treatments plus five extra treatments in six replicates.

Treatments

The main aim of this trial was to investigate the effects of dipping sets in a solution of tebuconazole (Folicur) at two rates and combining this with an in-furrow application of Folicur at two rates. Additional treatments investigating foliar applications of Folicur and azoxystrobin (Amistar) alone or in combination and a dipping rate of 0.2% Folicur.

Table 1 Treatments

Set dips	In-furrow (Folicur)	Foliar applications	
Main			
Nil	Nil	Nil	
Nil	0.25 l ai/ha	Nil	
Nil	0.50 l ai/ha	Nil	
0.5% Folicur	Nil	Nil	
0.5% Folicur	0.25 l ai/ha	Nil	
0.5% Folicur	0.50 l ai/ha	Nil	
1.0% Folicur	Nil	Nil	
1.0% Folicur	0.25 l ai/ha	Nil	
1.0% Folicur	0.50 l ai/ha	Nil	
Extras			
Nil	Nil	Folicur	2 sprays at 3 week intervals
Nil	Nil	Amistar – 0.5	6 sprays at 2 week intervals
Nil	Nil	Amistar – 1.0	6 sprays at 2 week intervals
Nil	Nil	Amistar/Folicur	6 sprays in programme
0.2% Folicur	Nil	Nil	

Set dips

The sets were dipped by immersion in Folicur solution for given length of time. The sets were then allowed to drain, and dried by spreading them out in a tray overnight at 15.5-20°C.

Initially two rates, 0.5% and 1.0% Folicur, and three timings, 10, 20 or 30 minutes, were tested. Fifty sets of each treatment were planted in module trays of compost. Root vigour was assessed after six days on a visual 1-5 score.

Table 2 No. sets with root score 4 or 5 (most roots) after six days out of 50 sets

	Length of dip/mins				
	10	20	30	Nil	Mean
Dip					
0.5%	38	27	26		30.3
1.0%	12	9	6		9.0
Untreated				38	38.0

The 1.0% solution suppressed root growth compared with no dipping, 0.5% solution was less harmful to the sets.

The rates 0.5% for 20 minutes and 1.0% for 10 minutes were chosen for the trial. An additional rate of 0.2% for 20 minutes was used as this was reported to be successful in Holland (pers. comm.). The main treatments were dipped on 8 April and left to dry in nets in the glasshouse, the 0.2% dip was dipped on 27 April. Untreated sets were stored at ambient in a shed, from their arrival on site on 25 March. Prior to planting they were slightly damp so they were 'crisped up' by blowing ambient air through them.

In-furrow application

Solutions containing 35.3 ml or 70.6 ml Folicur in 12 l water were made up. This was injected using the starter solution equipment attached to a Stanhay drill. This was set up to deliver 52 ml solution per meter row. These rates equate to 1 or 2 l/ha Folicur (0.25 kg or 0.50 kg ai/ha tebuconazole) in 1136 l water. Plots receiving in-furrow applications first received a pass with the Stanhay drill, (press wheels removed), which delivered the solution approximately 4 cm below the soil surface in four rows 38.25 cm apart centred on the 1.83 m bed. Sets were then drilled at approximately 2.5 cm depth in four rows above the starter solution in a second pass.

Foliar sprays

Foliar sprays were applied to the whole plot using an Oxford precision sprayer on the dates shown. Both Folicur and Amistar were applied in 1000 l water at 2 bar pressure giving medium spray quality. Both the Amistar alone and Amistar/Folicur programmes were intended to include six applications, however as the crop had reached 50% die down by 6 September no further applications were made.

Table 3 Spray treatments

Spray dates	Folicur	Amistar 0.5	Amistar 1.0	Folicur/Amistar
25 June	1.0 l/ha	0.5 l/ha	1.0 l/ha	Folicur @ 1.0 l/ha
10 July	-	0.5 l/ha	1.0 l/ha	-
16 July	1.0 l/ha	-	-	Amistar @ 1.0 l/ha
24 July	-	0.5 l/ha	1.0 l/ha	-
7 August	-	0.5 l/ha	1.0 l/ha	Folicur @ 1.0 l/ha
25 August	-	0.5 l/ha	1.0 l/ha	Amistar @ 1.0 l/ha

Assessments

Crop emergence was monitored and preliminary counts carried out on 1 and 12 June. A final emergence count was carried out on 18 June, 9 m of both central rows was counted as emergence was low, in order to get approximately 100 plants per plot. White rot assessments were made on 2 and 24 July, 18 August and at harvest on 24 September. Plants showing foliar symptoms of white rot were lifted and the roots examined for mycelium or sclerotia, plants with no observable disease were noted. All lifted plants were removed from the plot to prevent double counting.

At harvest, on 24 September, all bulbs from the central two rows were lifted, any white rot infected bulbs were recorded and discarded, healthy bulbs were counted. The two outer rows were also lifted but placed in separate potato chitting trays. The bulbs were dried and then graded on 2 November. At grading trays from the two areas were treated separately. Unmarketable bulbs were removed and the number and weight was recorded according to defects including white rot, thick necks, neck rot and other diseases. Sound marketable bulbs were then passed over the grading line with circular riddles in the following size grades <25 mm, 25-40 mm, 40-50 mm, 50-60 mm, 60-80 mm, >80 mm, the number and weight in each size grade was recorded.

Statistical analysis

Data were subjected to analysis of variance using Genstat 5 programs. Least significant differences are quoted when $p < 0.05$ NS = not significant where $p > 0.05$.

Results

Growing Season

Emergence on the trial was slow and uneven. Planting had been delayed by wet weather, the soil was too wet to plant from 9 to 28 April, after this it became very dry and no significant rain fell in May, not ideal conditions for onion growing. After the emergence counts on 1 June it was realised that an error had occurred in calculating the planting rate and 20 sets/m^2 had been used instead of 20 sets/m row. Taking this into account approximately 70% of untreated sets had emerged by this date. In 1997 around 50% of sets emerged six weeks after planting.

Emergence

Table 4 shows emergence counts on 18 June. There was a significant effect of dips at 0.5% and 1.0% Folicur solution compared with untreated sets and the extra treatments. Untreated sets with no furrow application had the highest emergence level, treatments receiving foliar sprays were identical at this stage but appeared to have lower levels of emergence, however these differences were not significant, reflecting the uneven emergence across the site. Sets receiving a 0.2% Folicur dip showed high levels of emergence compared with 0.5% and 1.0% dips, this probably reflects the fact that these sets came from the untreated stock and were only dipped the day before planting and dried overnight. Compared with the other dip treatments which had been dipped on 8 April and had then been kept in the greenhouse until planting. Under conditions of fluctuating temperatures Rijnsburger sets can lose vigour if the base plates dry out, which has probably happened here (B Smith pers comm). The untreated sets were stored in a cooler area with a more constant temperature and were less affected by the delay in planting.

Table 4 Number of plants emerged on 18 June
Main treatments with Folicur

Main Furrow	Dip Nil	0.5%	1.0%	Mean
Nil	93.7	55.3	53.0	67.3
0.25	66.3	53.7	51.0	57.0
0.50	77.3	51.3	45.7	58.1
Mean	79.1	53.4	49.9	60.8
Extras				
Folicur	85.0			
Amistar – 0.5	75.7			
Amistar – 1.0	88.7			
Amistar/Folicur	82.3			
Dip 0.2%	77.3			
Mean	81.8			
LSD	main v extras	8.35		
	dip/furrow means	12.23		
	dip x furrow	21.18		

Table 5 shows the highest number of plants recorded at any of the subsequent counts. For some treatments this was higher than the figure at the 18 June count. This indicates that on some treatments emergence was delayed, this is most obvious for sets receiving 0.5% dip and untreated sets with or without furrow treatments.

Due to the variation in number of plants per plot between treatments subsequent white rot counts and yield assessments are presented as percentages of total number of plants emerged.

Table 5 Total number of plants emerged – taken from highest counts
Main treatments with Folicur

Main Furrow	Dip Nil	0.5%	1.0%	Mean
Nil	98.3	58.3	53.7	70.1
0.25	70.7	55.3	51.7	59.2
0.50	80.3	62.3	45.7	62.8
Mean	83.1	58.7	50.3	64.0
Extras				
Folicur	84.7			
Amistar – 0.5	76.3			
Amistar – 1.0	87.7			
Amistar/Folicur	79.0			
Dip 0.2%	77.0			
Mean	80.9			
LSD	main v extras	7.24		
	dip/furrow means	10.61		
	dip x furrow	18.36		

White Rot

The untreated control plots developed 45% of infected plants by harvest, the main increase was seen from 2 July to 23 July (Fig 1). The best treatment, 0.5% set dip with 0.25 l a.i. in-furrow, developed only 14% white rot by harvest.

At the first count on 2 July the levels were low, all treatments were below 10% (tables 6, 7). There were no significant treatment effects although untreated sets tended to have more white rot infected plants.

Table 6a White rot as infected plants as % of total plants emerged at separate counts

Treatments			Date of count			
Set dips	In-furrow	Foliar	2/7	23/7	18/8	24/9
Nil	Nil	Nil	5.1	21.7	13.2	4.6
Nil	0.25	Nil	9.5	18.0	4.6	1.4
Nil	0.50	Nil	6.8	10.0	4.1	2.0
0.5%	Nil	Nil	3.8	11.4	5.2	0.5
0.5%	0.25	Nil	2.8	6.8	4.7	0.7
0.5%	0.50	Nil	4.4	10.6	2.6	0.5
1.0%	Nil	Nil	3.3	9.2	1.1	0
1.0%	0.25	Nil	4.8	9.1	7.3	0.7
1.0%	0.50	Nil	5.2	7.3	3.6	1.4
Nil	Nil	Folicur	7.4	8.8	7.0	1.6
Nil	Nil	Amistar 0.5	3.1	19.8	10.5	7.7
Nil	Nil	Amistar 1.0	1.2	16.3	9.4	4.1
Nil	Nil	Amistar/Folicur	1.1	9.1	12.3	3.5
0.2%	Nil	Nil	8.6	12.1	3.4	1.2
LSD 5%			NS	NS	7.65	3.28

Table 6b White rot as infected plants as % of total plants emerged, cumulative counts and healthy plants at harvest

Treatments			Cumulative total of white rot infected plants			% Healthy plants at harvest
Set dips	In-furrow	Foliar	23/7	18/8	24/9	
Nil	Nil	Nil	26.9	40.0	44.6	49.8
Nil	0.25	Nil	27.5	32.1	33.5	56.5
Nil	0.50	Nil	16.7	20.9	22.9	75.1
0.5%	Nil	Nil	15.2	20.4	20.9	77.5
0.5%	0.25	Nil	9.6	14.3	15.0	89.0
0.5%	0.50	Nil	15.0	17.5	18.0	76.5
1.0%	Nil	Nil	12.5	13.6	13.6	84.0
1.0%	0.25	Nil	14.0	21.3	21.9	73.9
1.0%	0.50	Nil	12.5	16.0	17.5	80.8
Nil	Nil	Folicur	16.3	23.3	24.8	61.9
Nil	Nil	Amistar 0.5	23.0	33.4	41.1	50.7
Nil	Nil	Amistar 1.0	17.5	26.9	30.9	60.0
Nil	Nil	Amistar/Folicur	10.3	22.6	26.1	70.8
0.2%	Nil	Nil	20.7	24.1	25.3	71.6
LSD 5%			NS	NS	17.06	19.39

Table 7 White rot infected plants as a percentage of total plants emerged per plot, 2 July 1998

Furrow	Dip			
	Nil	0.5%	1.0%	Mean
Nil	5.1	3.8	3.3	4.1
0.25	9.5	2.8	4.8	5.7
0.50	6.8	4.4	5.2	5.4
Mean	7.1	3.7	4.4	5.1
Extras				4.3
LSD 5%	dip/furrow means	3.98		
	dip x furrow	6.90		

At the second count on 23 July, there was more white rot and the cumulative total from both counts showed significant treatment effects (table 8). Dipped sets at either 0.5% or 1.0% reduced white rot levels compared with untreated sets, the extra treatments (foliar sprays and 0.2% dip) were not significantly different from the untreated sets. Within the untreated sets the 0.5 l a.i. furrow application reduced white rot levels compared with 0.25 l a.i. and untreated.

Table 8 White rot infected plants as a percentage of total plants emerged per plot. Cumulative totals from 2 July plus 23 July

Furrow	Dip Nil	0.5%	1.0%	Mean
Nil	26.9	15.2	12.5	18.2
0.25	27.5	9.6	14.0	17.0
0.50	16.7	15.0	12.5	14.7
Mean	23.7	13.3	13.0	16.7
Extras				17.6
LSD 5%	dip/furrow means	8.37		
	dip x furrow	14.47		

_____ significantly more white rot than other treatments in category

At the third count on 18 August actual amounts of white rot were lower but there was still more than 10% on some treatments (table 6a). The cumulative totals (table 9) again showed significant effects of set dips of 0.5% and 1.0%. With untreated sets a furrow application of 0.5 l a.i. reduced white rot compared with the untreated control, a furrow application of 0.25 l a.i. did not significantly reduce the cumulative level of white rot. At this third count foliar sprays with Amistar at either rate or in combination with Folicur did not reduce the level of white rot compared with the untreated control.

Table 9 White rot infected plants as a percentage of total plants emerged per plot. Cumulative totals from 2 July to 18 August

Furrow	Dip Nil	0.5%	1.0%	Mean
Nil	40.0	20.4	13.6	24.7
0.25	32.1	14.3	21.3	22.6
0.50	20.9	17.5	16.0	18.1
Mean	31.0	17.4	17.0	21.8
Extras				26.1
LSD 5%	dip/furrow means	10.49		
	dip x furrow	18.15		

_____ significantly more white rot than other treatments in category

At the final count at harvest time white rot levels were low, more than 3% of infected plants was found on only four treatments; untreated control, and the three Amistar treatments. The cumulative totals (table 10) show the same pattern as before with untreated sets and extra treatments having more infected plants than sets treated at 0.5% and 1.0%. Within the untreated sets the 0.5 l a.i. furrow application significantly reduced white rot.

Table 10 White rot infected plants as a percentage of total plants emerged per plot. Cumulative totals from 2 July to 24 September

Furrow	Dip Nil	0.5%	1.0%	Mean
Nil	44.6	20.9	13.6	26.4
0.25	33.5	15.0	21.9	23.5
0.50	22.9	18.0	17.5	19.5
Mean	33.7	18.0	17.7	23.1
Extras				29.7
LSD 5%	dip/furrow means	9.85		
	dip x furrow	17.06		

_____ significantly more white rot than other treatments in category

Taking the cumulative total at harvest as the main measure of white rot control it can be shown that set dips all reduced white rot levels significantly compared with untreated sets, the higher the dip strength the lower the level of white rot where no furrow applications were made (Fig 2). The furrow application alone reduced white rot, the 0.5 l a.i. rate was more effective than the 0.25 l a.i. rate, however furrow applications alone were not as effective as in combination with set dips.

Amistar alone 0.5 l or 1.0 l did not reduce white rot compared with the untreated control, although the 1.0 l rate tended to reduce the number of infected plants (Fig 3). Applying Folicur as a foliar spray was not as effective as applying it as a dip plus a furrow application, applied alone the dip and the furrow application were similar to the foliar application (Fig 4). There was little difference between applying 2 Folicur sprays only or in a programme with Amistar. For both programmes the first Folicur went on on 25 June, the second Folicur was applied on 16 July and 7 August respectively. With the pattern of white rot development in 1998 there appeared to be no loss of control experienced by delaying the second application.

Yield

Yield measurements at harvest were made on the outer two rows which had not had diseased plants removed from them. However, straightforward yield measurements are confounded by the effects of the dip treatments on numbers of plants emerging. The number of marketable bulbs at harvest would not necessarily mirror the % white rot recorded as even traces of white rot on a plant was recorded as white rot whereas, especially later on in the season, these plants would not necessarily have died. Thus treatments with a poor emergence but few plants with white rot eg 0.5% dip plus 0.25 l a.i. furrow had a low yield compared with the untreated control which had a high emergence but had high levels of white rot (Table 11).

Comparing the yields of only those treatments using untreated sets and 0.2% set dip which emerged well, the 0.2% dip and the 0.5 l a.i. furrow application had higher yields than other treatments. Where number of marketable bulbs at harvest is calculated as a percentage of emerged plants in centre two rows some general trends can be seen. The lowest % survival was on the untreated control and the foliar applications. Set dips or furrow applications increased survival to at least 90%.

Table 11 Marketable bulbs at harvest and total yield (t/ha) from outer 2 rows

Set dips	In-furrow	Foliar	Number marketable in outer 2 rows	Number marketable as % of plants emerged in counted rows	Total yield t/ha
Nil	Nil	Nil	75.0	75.5	***8.66***
Nil	0.25	Nil	72.2	94.6	***8.43***
Nil	0.50	Nil	83.8	94.4	***9.89***
0.5%	Nil	Nil	56.0	91.7	7.78
0.5%	0.25	Nil	54.7	94.6	7.58
0.5%	0.50	Nil	74.5	114.1	10.59
1.0%	Nil	Nil	49.2	95.6	7.20
1.0%	0.25	Nil	47.5	97.4	5.98
1.0%	0.50	Nil	49.2	101.4	6.98
Nil	Nil	Folicur	69.3	77.7	***7.33***
Nil	Nil	Amistar 0.5	66.7	80.3	***7.81***
Nil	Nil	Amistar 1.0	70.3	75.1	***7.87***
Nil	Nil	Amistar/Folicur	73.8	89.8	***8.25***
0.2%	Nil	Nil	90.5	100.9	***11.95***
LSD 5%			14.4	24.8	2.35

In bold – untreated or 0.2% dip, sets, see text

Discussion

In the 1997 trial sets were dipped in 0.5% solution for 20 minutes, other treatments included 0.50 l furrow application, sprayed onto the opened furrow and a foliar spray all with Folicur. By late July field sprays gave a 5% reduction in white rot compared with the untreated control, furrow spray 37% and set dipping 49%. The combined effect of these treatments was a 52% reduction. By late July the untreated controls had reached 95% white rot infection.

In 1998 the overall level of infection was lower and the untreated control reached 45% white rot infection at harvest. Field sprays of Folicur reduced white rot by 44%, 0.50 l in-furrow application by 48% and the 0.5% dip by 53%. These three treatments were nearly as effective as each other in this lower incidence year. The timing of the field sprays in June and July was much more effective than in 1997 when they were applied in May and June. The combined effect of the set dip and furrow application was a 60% reduction in white rot. The best reductions in white rot were achieved with 1% dip (70%) and 0.5% dip with 0.25 l furrow application (66%).

In 1997 if the first foliar spray had been delayed until mid June over 60% of plants would already have been infected. The difference in application dates between the two years reflects the difference in planting dates; 12 March 1997 and 28 April 1998, rather than a change in timing relative to crop growth. In 1998, the spray volume was increased from 400 l/ha to 1000 l/ha, to improve penetration of the fungicide to the root zone. In addition, in 1998 heavy rain on 2 June re-wetted the soil after a dry spell in May, subsequent rain in June provided a) ideal conditions for white rot development ie cool and damp and b) good conditions for applying the foliar spray ie damp soil to allow fungicide to reach the onion's roots. Both circumstances may have contributed to the improved control of white rot from foliar sprays of Folicur in 1998.

The furrow application was more effective at 0.5 l ai/ha than at 0.25 l ai/ha in 1998. In this year the furrow application was made using a starter fertiliser kit attached to a drill which placed 52 ml/m row solution approximately 4 cm below the surface, 1.5 cm below the sets. In 1997 a 10 cm band spray was applied to the opened furrow delivering 1000 l/ha solution, the starter fertiliser approach delivered 1136 l/ha solution but this was more targetted and more concentrated below the sets than the band spray. This method of delivery was more effective for white rot control than the in-furrow spray.

The set dipping method was effective for white rot control in both years. In 1998 three rates of dip were used 0.2%, 0.5% and 1.0%, the stronger dip tended to reduce the level of white rot more but these differences were not significant. In Holland 0.2% dip has been used successfully in trials to reduce white rot (de Visser 1998). This method of application would be simpler for growers to use, reduce the operator exposure and be less dependent on soil conditions for success. On this basis it would be preferred.

In 1997 there was no benefit from combining set dips with in-furrow and foliar sprays, in 1998 there was a small improvement from combining dipped sets with an in-furrow application, especially where the 0.5% dip was used. In this trial the emergence of the 0.5% and 1.0% dipped sets was significantly reduced compared with untreated sets. This was attributed to the unfavourable storage conditions between dipping and planting caused by the delay in planting. Sets dipped the day before planting at 0.2% in 1998, and 0.5% in 1997 showed no loss of vigour. Sets are routinely dipped commercially in other fungicides without any adverse reactions. There are no reasons to believe that dipping in Folicur would be damaging if carried out commercially.

In 1997 the level of white rot in dipped sets rose from early to late July, four months after planting, up until this stage the level had been low. It appeared that the Folicur had “run out”. Heavy rainfall at the end of June and early July provided moist soil conditions under which white rot development occurs. In 1998 the main activity periods for white rot were from early July until mid August, wet weather in late August and September did not result in any obvious increase in white rot levels on any treatment. The period of peak activity occurred ten weeks after planting, the dips and in-furrow applications both appeared to be effective after this length of time. In both years there was a period of white rot activity in July, however this was probably due to patterns of soil moisture conditions rather than a seasonal effect, as white rot incidence has not previously been associated with the calendar.

Conclusions

Foliar applications, in-furrow applications and set dips of Folicur were all effective in reducing levels of white rot in onions. There was a small benefit from combining set dips with in-furrow applications. Set dipping is the most consistent treatment, would be easy for growers to use and would reduce operator exposure compared with other treatments. However, Folicur is not currently approved for use as a set dip or an in-furrow application.

Applying Amistar as a foliar spray had a limited effect on white rot levels in this trial.

Acknowledgements

Thanks are due to G Clark, G Budge and H Johnson for technical assistance and to S Budge (HRI-Wellesbourne) for providing sclerotia to innoculate the site.

References

Davies, J.M.Ll, Hiron, L.C., Paterson, C.D. and Watling, M. (1998). Evaluation of tebuconazole and prochloraz seed treatments for the control of *Allium* white rot in salad and bulb onions. 6th Int. Workshop on Allium White rot, Irapuato, Mexico. In Press.

Fullerton, R.A., Stewart, A. and Slade, E.A. (1995). Use of demythylation inhibiting fungicides (DMIs) for the control of onion white rot (*Sclerotium cepivorum* Berk.) in New Zealand. new Zealand J. of Crop & Hort. Sci **23**, 121-125.

Ryler, M.J. and Obst, N.R. (1995). Control of onion white rot (*Sclerotium cepivorum*) with fungicides in Southern Queensland, Australia. 5th Int. Workshop on Allium White rot, Cordoba (1994). Eds Entwistle and Melero Vara.

de Visser C.L.M. (1998) Research into the possibilities for chemical and biological control of Onion White rot in the Netherlands in 1997. PAV Lelystad internal report.

APPENDIX 1 - Crop diary

Soil Type	Silt Loam	
Previous cropping	1995 bulb onions 1996 bulb onions 1997 bulb onions	
Soil analysis	pH 7.6 P index 5 K index 3 Mg index 3	
Fertiliser	90 kg/ha N as Nitram	
Cultivation	Ploughed February 1998 Power harrowed immediately pre-planting	
Planted	28-29 April 4 rows @ 0.3825 m in 1.83 m bed	
Herbicides	20 May	propachlor as 9 l/ha Ramrod plus Chlorthal dimethyl 6 kg/ha Dacthal in 450 l/ha water
	22 June, 16 July	ioxynil as 1.4 l/ha Totril in 450 l/ha water
	3 July	cycloxydim as 2.25 l/ha Laser in 200 l/ha water
Irrigation	14 May, 22 May	0.5-0.75" (12.5-18 mm)
	27 May	1.0" (25 mm)
Fungicides	26 June-25 Aug	Foliar treatments as per schedule
	22 June, 16 July	Chlorothalonil as 2 l/ha Bravo 500 in 200 l/ha water
Insecticides	19 August	malathion as 2.1 l/ha Malathion 60 in 600 l/ha water
Harvest	24 September	

APPENDIX 2

Monthly meteorological sheets for HRI Kirton for May, June, July, August and September 1998.

WROTFV4E.DOC (CDP)