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| Final Report to: | Horticultural Development Council<br>18 Lavant Street<br>PETERSFIELD<br>Hants GU32 3EW |
| Year | 1995/96 |
| Project No: | FV 4b (ADAS Project XHADR/A) |
| Project Title: | **EVALUATION OF SEED TREATMENTS FOR THE CONTROL OF WHITE ROT IN ONIONS** |
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| Date Project Commenced: | February 1995 |
| Date Completion due: | February 1996 |
| Keywords: | Salad onions, bulb onions, fungicide seed treatments, white rot. |
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**Authentication**

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

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Date ..... 1/4/96 .....



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**Summary**

Prochloraz (Prelude) and tebuconazole (UK229) seed treatments, and tebuconazole seed treatments supplemented with tebuconazole (Folicur) stem base sprays applied 5 and 10 weeks post-sowing, were compared for the control of white rot disease and for effects on crop yield in salad onions in Kent and in bulb onions in Bedfordshire and Lincolnshire.

Severe disease developed in the salad onions. Very good control of white rot and increased yields were achieved with the tebuconazole seed treatment. There was a slight additional benefit from supplementing the tebuconazole seed treatment with tebuconazole stem base sprays. Prelude seed treatment had no effect on white rot or yield compared to the untreated.

At the Bedfordshire bulb onion site, where moderate levels of white rot were recorded, the tebuconazole seed treatment was applied at only 1/10th target rate but some control was achieved when supplemented by tebuconazole stem base sprays. Prelude seed treatment had no effect on white rot. There was no significant effect of any treatment on yield, but the tebuconazole seed treatment supplemented by tebuconazole stem base sprays gave the greatest total yield. No further diseases had developed after storage.

At the Lincolnshire bulb onion site, where moderate levels of white rot were recorded, there was no effect of any treatment on the control of white rot nor on yield. Very low levels of neck rot (*Botrytis allii*) and white rot developed after storage.

There were no phytotoxic effects of treatment recorded in any of the above experiments. However, yields of bulb onions were poor probably because of the deep and late drilling, and the summer drought.

## Introduction

Onion white rot disease, caused by the fungus *Sclerotium cepivorum*, remains a major disease affecting members of the genus *Allium* i.e. garlic, onions, shallots, leeks and chives. It is of increasing importance in all the main areas where these crops are grown. The cropping areas and values of onions crops in the UK in recent years are given below.

Areas and values of Allium crops in the UK 1989/93 (Source: MAFF (1993))

| Year | 1989/90 | | 1992/93 | | 1993/94 | |
|---|---|---|---|---|---|---|
| | ha | £m | ha | £m | ha | £m |
| Salad onions | 2128 | 23.5 | 2085 | 24.9 | 2125 | 28.6 |
| Dry bulb onions | 6893 | 34 | 7364 | 23.7 | 7367 | 41.3 |
| Leeks | 3083 | 29.4 | 3496 | 26.0 | 3411 | 30.8 |

Salad onions are mainly grown in the West Midlands (Worcestershire, Hereford and Warwickshire) and in Kent, with smaller areas in Lincolnshire, Essex, Hertfordshire and the Thames Valley.

Spring-sown dry bulb onions are mainly grown in East Anglia and Lincolnshire, with some in Kent. Autumn-sown dry bulb onions are grown in similar areas but with a greater proportion in Lincolnshire.

There is no fungicide commercially available in the UK for the control of white rot and therefore farmers grow *Allium* crops only on land thought to be white rot free, i.e. land that has not grown onions in living memory. Growers of both dry bulb and salad onions are having increasing difficulty in finding white rot free land, and in some areas, e.g. Lincolnshire, there is a tendency for the crop to be grown on sandier soil types away from the traditional areas. The majority of growers now have several fields with high white rot inoculum where they would face large losses if they cropped with onions. (Davies 1990).

The majority of UK bulb onion crops are direct-sown and in these crops fungicide treatments have been of limited value (Gladders et al., 1984). Tradimenol and tebuconazole, applied as foliar sprays prior to irrigation, have given good white rot control in trials in Southern Germany

(Krauthausen, 1990). However, these treatments, should they be approved, are dependent on irrigation and are likely to have limited usage in the UK. More recently, Kosters and Hofstede in Holland obtained promising results with cyproconazole seed treatment on cv. Jumbo bulb onions; white rot infection was reduced from 26% to 5% in one experiment and from 17% to 1% in another. (Davies 1995). Encouraging results were given by fluazinam at rates of 0.5 to 2 litres a.i./ha as drenches or as sprays on direct-sown bulb onions in Ontario Canada, (Anon 1992) and as pre-planting drenches in module-raised onions in the UK (Davies and Savinelli 1995).

At present, therefore, there is no effective fungicidal control of white rot in drilled onions.

The aim of this work was to evaluate prochloraz and tebuconazole seed treatments and tebuconazole seed treatment supplemented with tebuconazole stem base sprays for the control of white rot in salad and bulb onions.

## Materials and methods

*Salad Onions*

Site: J J Barker Ltd
Hook Place Farm
Southfleet
Kent

Design: The experiment was arranged in a randomised block design with four treatments and six replicates. Each plot measured 8 m x 1.83 m with 4 rows of drilled onion drilled 36 cm apart. Treatments were compared with the untreated control.

Husbandry: Cultivar: White Lisbon

Sowing date: 12 April 1995

Harvest date: 19 July 1995

All subsequent crop husbandry was according to local practice (see Appendix 4).

*Bulb Onions*

Sites:
1) I Rook, Broom, Bedfordshire
2) HRI-Kirton, Boston, Lincolnshire.

Design: At the Bedfordshire site, the experiment was arranged in a randomised block design with four treatments and six replicates. Each plot measured 8 m x 1.52 m with five rows of onions drilled 30 cm apart. Treatments were compared with the untreated control.

At the Lincolnshire site the experiment was arranged in a randomised block design with four treatments and six replicates. Each plot measured 8.9 m x 1.83 m with five rows of onions drilled 36 cm apart. Treatments were compared with the untreated control.

Husbandry: Cultivar: Hysam
Sowing date: 27 March 1995 (Bedfordshire) 3 April 1995 (Lincolnshire)
Harvest date: 14 September 1995 (Bedfordshire) 9 October 1995 (Lincolnshire)

All subsequent crop husbandry was according to local practice (see Appendix 4).

*Treatments*

Salad and Bulb Onions:

1) Untreated
2) Tebuconazole seed treatment (UK229) 1.0 g a.i./250,000 seeds
3) Prochloraz seed treatment (Prelude) 1.0 g a.i./250,000 seeds
4) Tebuconazole seed treatment (UK229) 1.0 g a.i./250,000 seeds plus tebuconazole (Folicur) stem base sprays 250 g a.i./l

Seed treatments were applied by Seed Cote Systems. In Bedfordshire the seed was treated with tebuconazole at only 1/10th target rate, i.e. 0.1 g a.i./250,000 seeds.

Levington Agriculture Ltd. sowed the onions at all sites.

In Kent and Bedfordshire, Levington Agriculture Ltd. applied the Folicur (2 l/ha) stem base sprays in a 10 cm band, sprayed at 3.66 ml product in 5 l water per plot at 0.1 litres/m length row using a $CO_2$ knapsack sprayer at 150 kPa with red floodjet nozzles.

In Lincolnshire, HRI-Kirton staff applied the stem base sprays at 0.1 litres/m of row band, using a $CO_2$ knapsack sprayer at 150 kPa with floodjet nozzles.

Spray treatment application dates

| Spray | Kent | Bedfordshire | Lincolnshire |
|---|---|---|---|
| First | 2 June | 19 May | 16 June |
| Second | 7 July | 4 July | 26 July |

*Assessments*

Salad Onions

Disease incidence on the salad onions was assessed by recording the number of live plants in five fixed quadrats per plot, each of 1.0 m length of row. The loss of plants between assessments was attributed to white rot and expressed as 'calculated' white rot incidence. At harvest, all plants were harvested from five fixed quadrats of 1.0 m length and total fresh weight recorded. Plants were inspected for phytotoxicity and vigour in the field.

Bulb Onions

In Bedfordshire, disease incidence was assessed by recording the number of white rot affected plants in five fixed quadrats per plot, each of 1.0 m length of row and expressed as 'observed' white rot incidence. In the absence of other diseases, the loss of plants between assessments was attributed to white rot and expressed as 'calculated' white rot incidence. At harvest, the onions were sorted into marketable and unmarketable grades; the latter including white rot affected bulbs. The fifty largest sound bulbs were set aside for storage. Bulbs from Bedfordshire were stored on-site as part of the normal farm crop and were collected and assessed on 11 January. Plants were inspected for phytotoxicity and vigour on 26 April, 17 May and 6 June.

In Lincolnshire, disease incidence was assessed by recording the number of plants showing visual symptoms of white rot in five fixed quadrats per plot, each of 1.0 m length of row. Such affected plants were not pulled up but representative plants from adjacent guard areas were lifted and the presence of white rot confirmed. On 25 August the plots were scored for foliage colour on a scale of 1 to 9, 1 = yellow, dying foliage, 9 = healthy dark green foliage. At harvest on 9 October, all bulbs were lifted leaving only 0.5 m of plot at each end as a guard. The bulbs were dried and then graded on 27 October. At grading, unmarketable bulbs were removed and the number and weight recorded according to defects including white rot, other diseases and thick necks. Sound marketable bulbs were then passed over a grading line with circular riddles into the following size grades <25 mm, 25-40 mm, 40-50 mm, >50 mm and the number and weight of bulbs in each size grade was recorded. The fifty largest sound bulbs were set aside for storage. After grading, store temperature was dropped from 15 °C to 1 °C over a period of 3 weeks as in commercial practice. The store was held at 1 °C until 8 January when the bulbs were assessed. Plants were inspected for phytotoxicity and vigour in the field.

After storage, 50 bulbs from each untreated plot were cut in half vertically through the neck and inspected for neck and basal rots.

*Statistical analysis*

Data were subjected to analysis of variance. Standard errors of differences between means are quoted when probability $P<0.05$. NS = not significant where $P>0.05$. All SEDs quoted have 21 df.

**Results**

Results of final disease assessments and yields for the three sites are given in Tables 1-3.

Results of the other assessments are in Appendices 1 to 3.

*Salad onions - Kent*

Table 1. Effect of seed treatment on white rot and total numbers of plants at harvest and yield.

| Seed treatment | % of plants with white rot at harvest | Total no. of plants at harvest ('000/ha) | Yield t/ha |
|---|---|---|---|
| 1. Untreated | 81.67 | 250 | 2.33 |
| 2. UK229 | 23.07 | 1050 | 9.83 |
| 3. Prelude | 68.25 | 413 | 4.05 |
| 4. UK229 + Folicur | 14.28 | 1151 | 11.97 |
| *P* | <0.001 | <0.001 | <0.001 |
| SED | 3.584 | 54.1 | 0.957 |
| CV% | 13.3 | 13.1 | 23.5 |

When assessed as total accumulated disease, all fungicide treatments reduced the percentage of plants with white rot at harvest compared with the control ($P<0.001$) (Table 1). The least disease and higher yields ($P<0.001$) were found in treatments which included UK229 seed treatment.

All fungicide treatments increased the total number of plants at harvest ($P<0.001$). The greatest increases were from treatments which included UK229 seed treatment.

Table 2. Effect of seed treatment on white rot and yield

| Seed treatment | Accumulated % of plants with "observed" white rot | Accumulated % of plants with "calculated" white rot | Total yield t/ha | Marketable yield t/ha | Unmarketable yield t/ha |
|---|---|---|---|---|---|
| 1. Untreated | 19.34 | 33.51 | 13.16 | 0.51 | 12.65 |
| 2. UK229 | 16.39 | 34.12 | 13.66 | 0.00 | 13.66 |
| 3. Prelude | 18.75 | 33.93 | 13.51 | 0.46 | 13.05 |
| 4. UK229 + Folicur | 7.58 | 19.88 | 17.05 | 0.30 | 16.75 |
| *P* | 0.015 | 0.056 | NS | NS | NS |
| SED | 3.510 | 5.56 | - | - | - |
| CV% | 39.2 | 31.7 | 20.3 | 124.2 | 20.0 |

Only the UK229 seed treatment plus Folicur sprays gave reductions in white rot affected plants when recorded as accumulated "observed" ($P = 0.015$) or "calculated" ($P = 0.056$) at harvest (Table 2). There was no significant effect of treatment on total, marketable or unmarketable yield.

After storage, fifty bulbs from each untreated plot were assessed for neck rot (*Botrytis allii*) and for basal rots. None were found and no further assessments were made on the other plots.

Table 3. Effect of seed treatment on white rot and yield

| Seed treatment | % of plants with "observed" white rot at harvest | Total yield t/ha | Marketable yield >50mm t/ha | Marketable yield >25 mm t/ha |
|---|---|---|---|---|
| Untreated | 17.0 | 15.6 | 6.1 | 14.6 |
| UK229 | 14.6 | 14.4 | 4.8 | 13.2 |
| Prelude | 19.0 | 14.6 | 5.2 | 13.7 |
| UK229 + Folicur | 12.5 | 15.4 | 6.1 | 14.6 |
| *P* | NS | NS | NS | NS |
| SED | - | - | - | - |
| CV % | 34.0 | 12.8 | 33.7 | 13.9 |

There was no effect of treatment on white rot at harvest, or on total and marketable yields.

After storage, fifty bulbs from each untreated plot were assessed for neck rot (*Botrytis allii*) and for basal rots. Two per cent of bulbs had neck rot (*Botrytis allii*) and 2.7 % had white rot. No basal rot was recorded. As these levels were both below 5 % , no further assessments were made.

**Discussion**

All the experiments were drilled at approximately 3 cm, double the normal depth. This must have had an adverse affect on speed of emergence and establishment. Also the growing season was hot, with very little rain during the summer months. The bulb onion experiments were drilled very late, and with the hot dry summer this resulted in poor yields despite some irrigation at all sites. No symptoms of phytotoxicity were seen at any site.

*Salad Onions - Kent*

Severe white rot disease developed at this site with very good control obtained from the UK229 seed treatment. There was additional benefit from supplementing UK229 seed treatment with tebuconazole stem base sprays although these were applied later than intended. The numbers and yields of salad onions at harvest reflected the disease assessment scores. The Prelude seed treatment had no effect on disease control or yield.

*Bulb Onions - Bedfordshire*

White rot developed mainly in June and July with disease control given only by the UK229 seed treatment supplemented by tebuconazole stem base sprays. It was unfortunate that the UK229 seed treatment was applied at 1/10th rate. However, this work has shown the value of supplementary stem base sprays which gave the greatest disease control at this site. Plants lost between assessments were approximately double the number of 'observed' plants affected with white rot and in the absence of other diseases these losses were attributed to white rot. There was no significant effect of any treatment on yield with extremely low marketable yields reflecting adverse weather with insufficient irrigation. However, the greatest total yield was obtained from the UK229 seed treatment supplemented with tebuconazole stem base sprays. Prelude seed treatment had no effect on disease or yield.

*Bulb Onions - Lincolnshire*

There was no effect of treatment on the number of plants at 100% emergence nor at any of the other assessments. There was a loss of 15% (UK229 seed treatment) to 22% (in the untreated) of plants over the growing season. There was no effect of treatment on the colour of foliage in late August nor on white rot or yield. Yields were low and mainly made up of small onion bulbs reflecting late drilling and adverse weather.

After storage, low levels of neck rot were found from the untreated control plots.

As no diseases were recorded after storage in Bedfordshire and the same seed lot was used for both experiments, it is likely that the source of neck rot infection in Lincolnshire was from the surrounding crops.

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**Appendix 1 Supplementary data**

*Salad Onions - Kent*

Table 4. Effect of seed treatment on plant emergence and white rot

| Seed treatment | "Maximum" no. of plants emerged by 7 June | % of plants with "calculated" white rot 7 June | % of plants with "calculated" white rot 28 June | % of plants with "calculated" white rot 18 July |
|---|---|---|---|---|
| 1. Untreated | 49.8 | 25.1 | 54.0 | 2.53 |
| 2. UK229 | 50.0 | 1.7 | 22.3 | -0.92 |
| 3. Prelude | 49.4 | 12.5 | 49.0 | 6.75 |
| 4. UK229 + Folicur | 51.1 | 2.7 | 15.2 | -3.68 |
| *P* | NS | <0.001 | <0.001 | 0.004 |
| SED | - | 4.46 | 3.64 | 4.20 |
| CV% | 4.2 | 42.2 | 18.0 | 360.4 |

There was no effect of treatment on plants emerged by 7 June. All fungicide treatments gave a reduction in white rot on 7 June. Treatments which included UK229 gave a reduction in white rot on 28 June. There was no effect of treatment on white rot on 18 July.

"Maximum" no. of plants was calculated because of the delayed emergence due to deep drilling by which time some earlier emerged plants were dying off as a result of white rot.

**Appendix 2 Supplementary data**

*Bulb Onions - Bedfordshire*

Table 5. Effect of seed treatment on white rot

| Seed treatment | % of plants with "observed" white rot 6 June | % of plants with "observed" white rot 5 July | % of plants with "observed" white rot 1 August | % of plants with "observed" white rot 4 September | % of plants with "calculated" white rot 17 May | % of plants with "calculated" white rot 6 June | % of plants with "calculated" white rot 5 July | % of plants with "calculated" white rot 1 August | % of plants with "calculated" white rot 4 September |
|---|---|---|---|---|---|---|---|---|---|
| 1. Untreated | 2.0 | 10.11 | 5.42 | 1.82 | -0.55 | 1.61 | 6.13 | 14.35 | 11.98 |
| 2. UK229 | 1.0 | 8.92 | 5.29 | 1.18 | 2.21 | 1.93 | 3.65 | 13.07 | 13.27 |
| 3. Prelude | 0.58 | 8.98 | 7.22 | 1.96 | 1.12 | 2.95 | 4.18 | 10.29 | 15.39 |
| 4. UK229 + Folicur | 0.72 | 3.11 | 2.05 | 1.69 | 2.13 | -0.96 | 5.33 | 7.53 | 5.85 |
| *P* | NS | 0.021 | NS | NS | NS | NS | NS | 0.054 | 0.030 |
| SED | - | 2.135 | - | - | - | - | - | 2.403 | 2.97 |
| CV% | 118.0 | 47.5 | 61.3 | 82.0 | 355.3 | 314.1 | 99.5 | 36.8 | 44.3 |

There was no effect of treatment on white rot on 6 June. The UK229 plus Folicur treatment gave a reduction in white rot on 5 July.

There were no effects of treatment on "observed" or "calculated" white rot on 1 August, 4 September, 7 May, 6 June or 5 July. The UK229 plus Folicur treatment gave reductions in white rot on 1 August and 4 September.

**Appendix 2** **continued**

Table 6. Effect of seed treatment on numbers of onions at harvest

| Seed treatment | | Total number of onions at harvest '000/ha | Number of marketable onions at harvest '000/ha | Number of unmarketable onions at harvest '000/ha |
|---|---|---|---|---|
| 1. | Untreated | 369 | 5566 | 364 |
| 2. | UK229 | 390 | 0 | 390 |
| 3. | Prelude | 362 | 5060 | 357 |
| 4. | UK229 + Folicur | 439 | 3542 | 435 |
| *P* | | NS | NS | NS |
| SED | | - | - | - |
| CV% | | 13.2 | 130 | 13.4 |

There were no effects of treatment on total number of onions at harvest, or on the number of marketable or unmarketable onions. No differences were recorded between treatments for the number of marketable onions even though no marketable onions were recorded in the UK 229 treatment. This was attributed to the high coefficient of variation.

## Appendix 3 Supplementary data

*Bulb Onions - Lincolnshire*

Table 7. Effect of seed treatment on the number of plants

| Seed treatment | Number of plants per 5m of row 5 June | Number of plants per 5m of row 28 June | Number of plants per 5m of row 6 July | Number of plants per 5m of row 25 August | Number of plants per 5m of row 22 September | Number of plants per $m^2$ at harvest 9 October |
|---|---|---|---|---|---|---|
| 1 Untreated | 85.5 | 74.2 | 73.8 | 72.3 | 71.5 | 66.8 |
| 2 UK229 | 78.0 | 73.3 | 69.7 | 68.7 | 67.7 | 66.0 |
| 3 Prelude | 82.3 | 73.5 | 73.8 | 72.2 | 69.2 | 65.7 |
| 4 UK229 + Folicur | 79.0 | 70.7 | 73.2 | 70.2 | 69.7 | 66.3 |
| *P* | NS | NS | NS | NS | NS | NS |
| SED | - | - | - | - | - | - |
| CV% | 9.4 | 9.7 | 9.7 | 9.1 | 10.7 | 9.5 |

There were no effects of treatment on plant number at any assessment date.

**Appendix 3** **continued**

Table 8. Effect of seed treatment on white rot, foliage colour and number of onions at harvest

| Seed treatment | % of plants with "observed" white rot 28 June | % of plants with "observed" white rot 6 July | % of plants with "observed" white rot 25 August | % of plants with "observed" white rot 22 September | % bulbs with white rot at grading 27 October | Colour score of foliage 25 August | Number of onions at harvest No. per/$m^2$ |
|---|---|---|---|---|---|---|---|
| 1. Untreated | 6.5 | 5.1 | 5.0 | 7.4 | 2.6 | 4.2 | 37.1 |
| 2. UK229 | 4.4 | 5.8 | 6.8 | 8.3 | 2.6 | 4.2 | 38.0 |
| 3. Prelude | 6.4 | 6.2 | 6.1 | 5.8 | 1.3 | 4.5 | 36.2 |
| 4. UK229 + Folicur | 4.3 | 2.7 | 6.5 | 6.6 | 1.0 | 4.3 | 37.4 |
| *P* | NS | NS | NS | NS | NS | NS | NS |
| SED | - | - | - | - | - | - | - |
| CV% | 45.3 | 63.2 | 66.0 | 77.9 | 71.1 | 23.1 | 5.7 |

Treatments had no effect on "observed" white rot at any assessment date. There was no effect of treatment on white rot in bulbs at grading, on the colour of foliage on 25 August 1995 or on the number of onions at harvest.

**Appendix 4** **continued**

*c) Lincolnshire*

| | | | |
|---|---|---|---|
| Soil Type: | Silt Loam, 40 acres | | |
| Previous Cropping: | 1993 Grass cut for silage<br>1994 Fallow | | |
| Soil Analysis: | pH 7.5, N index 0, K index 3 | | |
| Cultivations: | 22 February Ploughed<br>3 April Kuhn rotovator | | |
| Sown: | 3 April | | |
| Fertilisers: | 11 March | Nitram | 90 kg/ha N |
| Herbicides: | 10 April | Sovereign | 1 l/ha |
| | 10 April | PDQ | 2 l/ha |
| | 21 April | PDQ | 2 l/ha |
| | 2 June | Totril | 1.4 l/ha |
| | 12 June | Alicep | 1 kg/ha |
| | 16 June | Alicep | 2.8 kg/ha |
| Insecticides: | 22 July | Malathion | 2 l/ha |
| Irrigation: | 25 May | 15 mm applied | |
| | 30 June | 20 mm applied | |
| | 4 July | 20 mm applied | |
| | 16 August | 15 mm applied | |
| Harvest: | 9 October | | |