Project Title:	**Bulb and salad onions: evaluation of tebuconazole seed treatments and supplementary sprays for the control of white rot**
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PRACTICAL SECTION FOR GROWERS

Objectives and background

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. 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. in Lincolnshire, there is a tendency now for the crop to be grown away from the traditional areas on sandier soil types. The majority of growers now have several fields with high white rot inoculum where they would face large losses if they cropped with onions.

The aim of the current work was to evaluate the efficacy of tebuconazole seed treatments with or without supplementary tebuconazole sprays for the control of white rot in salad and bulb onions. Supplementary stem base sprays were evaluated on salad onions and foliar sprays on bulb onions.

Summary of results

The effects of fungicide treatments were evaluated on white rot disease and yield in salad onions (Kent) and in bulb onions (Lincolnshire). The fungicide treatments were tebuconazole (UK226) seed treatment at two rates alone or supplemented with tebuconazole (Folicur) stem base sprays (salad onions) and foliar sprays (bulb onions) applied 5 and 10 weeks post-sowing,

In Kent, moderate to severe disease developed in the salad onions. Very good control of white rot and an increased plant count at harvest were achieved with the tebuconazole seed treatment. There was no additional benefit from supplementing the tebuconazole seed treatment with tebuconazole stem base sprays and there was no effect of seed treatment fungicide rate.

At the Lincolnshire bulb onion site, low to moderate levels of white rot were recorded. There was a reduction in white rot from late July onwards mainly from the effect of the seed treatment. There was no additional effect from the supplementary tebuconazole foliar sprays apart from fewer white rot affected bulbs at grading following the spray treatment. The lower seed treatment fungicide rate increased plant count at emergence and at harvest compared with the higher rate.

There were phytotoxic effects of fungicide seed treatment at full plant emergence. In salad onions, fungicide seed treatment resulted in less vigorous plants but increased plant numbers at harvest. However, decreasing white rot infection out-weighed the detrimental effects on vigour . In bulb onions, there was reduced plant establishment following the higher rate of fungicide seed treatment but even at this rate there were slight yield benefits.

Action points for growers

1. An off-label approval is sought for the use of tebuconazole (UK 226) as a seed treatment supplemented by two sprays of tebuconazole (Folicur). This combined treatment has been shown to be very effective previously in salad onions but not in bulb onions, but in this work the main effects were from the seed treatment.
2. The above refers to spring sown onions. It is likely that the treatments will not be effective in the overwintered crop and may not be as effective on salad onions sown later in the year.
3. More experimental work is required on the control of white rot in spring sown bulb onions
4. Bulb onions should be grown in white rot free fields.

Practical and financial benefits from study

The work has shown that good control of white rot can be achieved in spring sown salad onions. This will enable growers to grow salad onions on white rot infested land and thus will give them more flexibility in their choice of field and may obviate the need to rent land.

EXPERIMENTAL SECTION

Introduction

The majority of UK bulb onion crops are direct-sown. Work in Holland showed promising results with cyproconazole seed treatment on bulb onions cv. Jumbo; white rot infection was reduced from 26% to 5% in one experiment and from 17% to 1% in another. In New Zealand, the greatest degree of control was from a procymidone seed treatment supplemented by foliar sprays of either procymidone, tebuconazole or triadimenol. In Holland, procymidone (Sumisclex) is approved as a soil and foliar treatment only. However, procymidone seed treatments are not permitted in the EC. NB the use of procymidone treatment of sets is also not permitted. Excellent control was achieved in HDC project FV4b in 1995 with seed treatments of tebuconazole (UK 226) supplemented with stem base sprays of tebuconazole (Folicur) in salad onions. However, disappointing results were obtained in bulb onions with similar treatments and rates as above.

Materials and methods

Salad Onions

Site

The experiment was sited at J J Barker Ltd, Southfleet, Kent.

Design

The experiment was arranged as a two by two factorial randomised block design plus untreated control. There were five treatments and six replicates. Each plot measured 8 m x 1.83 m with 4 rows of drilled onion drilled 36 cm apart.

Husbandry

Cultivar: White Lisbon

Sowing date: 28 March 1996

Harvest date: 25 July 1996

All subsequent crop husbandry was according to local practice. Details are given in Appendix 6.

Treatments

All seed supplied was treated with a standard thiram seed treatment 3.0 g a.i./250,000 seeds. Seed treatments were applied by Seed Cote Systems.

1) Untreated
2) Tebuconazole seed treatment as UK 226 1.0g a.i./250,000 seeds
3) Tebuconazole seed treatment as UK 226 1.5g a.i./250,000 seeds
4) Tebuconazole seed treatment as UK 226 1.0g a.i./250,000 seeds supplemented with Folicur as a stem-base spray.
5) Tebuconazole seed treatment as UK 226 1.5g a.i./250,000 seeds supplemented with Folicur as a stem-base spray.

Folicur (1 l/ha) stem-base sprays were applied in a 10 cm band, sprayed at 1.46 ml product in 4 litres water per 8 m plot @ 0.125 litres/m length of row. The first spray was applied 28 May (soil temperature 12.3 °C) and the second spray was applied 19 June. The site was irrigated soon after the spray was applied. On both occasions the soil conditions were moist prior to application.

Assessments

At 100% emergence of the untreated plots, plant counts and phytotoxicity of the seed treatments were recorded from 5 fixed one metre lengths of row in all plots. Plant vigour was assessed where 1 = poor and 5 = good. These assessments were repeated after 2 and 4 weeks together with a disease assessment on each occasion and subsequently at three week intervals until harvest. At each disease assessment the numbers of white rot affected plants and live plants remaining in the fixed one metre lengths of row were recorded in each plot. At harvest, the numbers of live plants from the same fixed metre lengths of row used for disease assessment were counted, and the total fresh weight of live plants recorded.

Bulb Onions

Site

The experiment was sited at Horticultural Research International, Kirton, Boston, Lincs.

Design

The experiment was arranged as a two by two factorial randomised block design plus two untreated controls (natural and artificial inoculum). There were six treatments and six replicates. Each plot measured 10 m x 1.83 m with five rows of onion drilled 36 cm apart.

Husbandry

Cultivar: Hysam
Sowing date: 29 March 1996
Harvest date: 24 September 1996

Beds were formed on 29 March and sclerotia of *Sclerotium cepivorum* mixed with an inert carrier were applied to all plots except for one of the untreated controls. These untreated control plots had an untreated guard bed on either side to prevent cross contamination of sclerotia. The sclerotia plus carrier were lightly hand raked into the top 5 cm. The sclerotial inoculum and application technique were prepared by Dr A Entwhistle of HRI-Wellesbourne.

All subsequent crop husbandry was according to local practice. Details are given in Appendix 7

Treatments

1) Untreated (natural *S. cepivorum* infection)
2) Untreated (artificially inoculated with *S. cepivorum*)
3) Tebuconazole seed treatment as UK 226 1.0g a.i./250,000 seeds
4) Tebuconazole seed treatment as UK 226 1.5g a.i./250,000 seeds
5) Tebuconazole seed treatment as UK 226 1.0g a.i./250,000 seeds supplemented with Folicur as a foliar spray.
6) Tebuconazole seed treatment as UK 226 1.5g a.i./250,000 seeds supplemented with Folicur as a foliar spray.

Folicur foliar sprays were applied to whole plots using an Oxford precision sprayer, sprayed at 1.0 l/ha in 400 l/ha water. The first spray (7 June) was applied after irrigation and followed by thunderstorms. The second spray (5 July) was applied in the early morning following overnight showers. On both occasions the soil conditions were moist prior to application.

Assessments

At full emergence of the untreated plots, plant counts and phytotoxicity of the seed treatments were recorded from 5 fixed two metre lengths of row in all plots. These assessments were repeated after 2 and 4 weeks together with a disease assessment on each occasion and subsequently at monthly intervals until harvest. At each disease assessment the numbers of white rot affected plants and live plants remaining in the fixed one metre lengths of row were recorded in each plot

At harvest all onions were lifted in each plot, sorted into marketable (>50 mm size) and unmarketable grades (<50 mm size) including white rot affected onions and the weight and number of onions in each grade recorded.

Statistical analysis

Data were subjected to analysis of variance. Standard errors of differences between means are quoted when $P<0.05$. NS = not significant where $P>0.05$. All SEDs quoted have 25 df.

Results

Salad Onions

Establishment and plant vigour

On 3 May, treated plants were less vigorous than the untreated but there was no effect of treatment on plant numbers (Table 1). From 28 May until harvest there were more plants in the treated. The main effect was that of the seed treatment with no additional benefits of the supplementary stem base sprays. There was no effect of seed treatment fungicide rate or of stem base spray (Appendix 1).

Table 1 Effect of treatment on vigour and surviving plants per metre row - Kent

Treatment	Vigour score 3 May	Mean number of plants per metre row				
		3 May	28 May	19 June	10 July	25 July
Untreated	4.67	61.17	45.03	37.63	36.83	35.60
Treated	3.00	55.75	60.70	64.82	64.69	62.28
P	<0.001	NS	0.004	<0.001	<0.001	<0.001
SED (treated v untreated)	0.314	NS	4.977	5.307	5.144	5.133
CV %	20.8	23.5	18.9	19.6	19.1	19.7

White rot incidence

White rot was first recorded on 28 May in untreated plots with 27% plants affected and on 19 June in treated plots at a very low incidence (Table 2). There was an effect of treatment on 28 May and 19 June only, after which there was little further infection. The main effect was that of the seed treatment with little additional benefits of the supplementary stem base sprays. There was no effect of seed treatment fungicide rate or of stem base sprays (Appendix 2). There was little development of white rot in July with no effect of treatment.

Table 2 Effect of treatment on % plants affected with white rot - Kent

Treatment	Mean % of plants with white rot per metre row				
	28 May	19 June	10 July	25 July	Total
Untreated	26.88	15.07	1.64	1.06	44.65
Treated	0.00	0.50	1.45	1.17	3.12
P	<0.001	<0.001	NS	NS	<0.001
SED (treated v untreated)	NS	3.000	NS	NS	NS
CV %	76.4	192.4	97.3	189.1	79.8

Harvest

There was an effect of treatment on the final plant count at harvest with approximately double the number of plants in the treated compared with the untreated (Table 3). The main effect was that of the seed treatment with no additional benefits of the supplementary stem base sprays. There was no effect of seed treatment fungicide rate or of basal spray (Appendix 3). There was no effect of treatment on fresh weight yield (Table 3).

Table 3 Effect of treatment on final plant count and harvest yield - Kent

Treatment	Plant count at harvest 25 July	Mean fresh weight (t/ha) 25 July
Untreated	35.60	1.81
Treated	62.28	2.08
P	<0.001	NS
SED (treated v untreated)	5.133	NS
CV %	19.7	25.2

Bulb Onions

Emergence and plant population

Plant emergence was slow and uneven despite irrigation applied on three occasions. There was no overall effect of treatment on final plant emergence compared with the untreated controls but emergence was greater with lower seed treatment compared with the higher rate (Table 4). Fewer treated plants had white rot but there was no effect of seed treatment fungicide rate or of foliar sprays (Appendix 4).

Table 4 Effect of treatment on % plants affected with white rot - Lincs.

Treatment	Rate g a.i./250,000 seeds	Plant count at emergence 29 May	Mean number of plants with white rot per 10 metre row				
			1 July	26 July	23 Aug	20 Sept	Total
Untreated		123.2	1.0	0.7	1.8	14.8	18.3
Untreated with added sclerotia		130.0	1.7	5.0	4.5	16.0	27.2
Treated		130.0	0.4	1.4	4.3	14.7	20.7
P		NS	0.030	<0.001	NS	NS	0.056
SED (untreated v treated)		5.9	0.47	0.79	-	-	2.92
Seed treatment	1.0	135.8	0.3	1.6	4.3	14.4	20.6
Seed treatment	1.5	124.3	0.4	1.3	4.3	14.9	20.9
P		0.024	NS	NS	NS	NS	NS
SED (treated means)		4.8	-	-	-	-	-
CV %		9.1	148.8	92.0	68.9	33.4	29.9

White rot incidence

There was a slight increase in white rot incidence during July and a large increase between late August and mid-September. Cumulative counts of white rot incidence showed a treatment effect at all assessment dates but this reflected the main effect of seed treatment (Table 5). There was no effect of seed treatment fungicide rate or of foliar sprays on white rot but there were fewer white rot affected bulbs at grading without additional foliar sprays (Appendix 5).

Table 5 Effect of treatment on cumulative number and % plants affected with white rot - Lincs.

Treatment	Counts of cumulative white rot plants per 10m row				Total as % of initial plants	% at grading	Total % white rot
	1 July	26 July	23 Aug.	20 Sept.			
Untreated	1.0	1.7	3.5	18.3	15.0	10.1	25.1
Untreated with added sclerotia	1.7	6.7	11.2	27.2	20.8	14.4	35.2
Treated	0.4	1.8	6.1	20.7	16.1	13.3	29.4
P	0.030	<0.001	0.008	0.056	NS	0.044	0.031
SED (untreated v treated)	0.47	0.95	1.83	2.92	-	1.40	2.84
CV %	148.8	80.7	61.5	29.9	27.6	23.6	21.0

Harvest

There was an effect of treatment on plant counts at harvest with higher counts following the lower rate of fungicide seed treatment rate and with foliar sprays (Table 6). There was an effect of treatment on marketable yield. Foliar sprays produced an approximate 10% increase in yield. There was no effect of seed treatment fungicide rate on yield. There was no interaction between seed treatment fungicide rate and foliar sprays for final plant counts

Table 6 Effect of treatment on final plant population and harvest yield - Lincs.

Treatment	Rate g a.i./250,000 seeds	Plant count per m^2 24 Sept.	Marketable yield (t/ha) 25 July
Untreated		25.7	14.7
Untreated with added sclerotia		25.1	13.4
Treated		29.0	15.5
P		0.005	0.046
SED (untreated v treated)		1.31	0.79
Seed treatment	1.0	30.4	15.9
Seed treatment	1.5	27.6	15.0
Seed treatment means		27.7	14.9
P		0.027	NS
SED (treated means)		1.17	-
Seed treatment + foliar spray	1.0	31.0	16.5
Seed treatment + foliar spray	1.5	29.5	16.2
Seed treatment, - foliar spray		27.7	14.9
Seed treatment, + foliar spray		30.3	16.4
P		0.042	0.018
SED (sprayed means)		1.17	0.71
SED (untreated v sprayed means)		1.43	0.87
CV %		10.3	8.5

Discussion

The growing season was late in starting due to the cold spring: there was slow, uneven and delayed emergence especially of the bulb onions. Although both salad and bulb onion experiments were irrigated, little rain fell from April to July although August rainfall was near average.

High summer temperatures affected the pattern of infection differently in the two crops. In the salad onions, infection was mainly during May and to a slightly lesser extent in early June with very little during the rest of June and up to harvest in mid-July. Most infection in the bulb onions was in late August and September when there was no effect of treatment. There was little infection prior to July and this may be attributed to the late establishment of the crop and high soil temperatures.

Moderate to severe disease developed in the salad onions. Very good control of white rot and increased plant numbers at harvest were achieved with the tebuconazole seed treatment. There was no additional benefit from supplementing the tebuconazole seed treatment with tebuconazole stem base sprays. This was probably due to climatic conditions at that time not being conducive for infection.

At the Lincolnshire bulb onion site, low to moderate levels of white rot developed. The plant populations were low reflecting conditions for germination. There was some reduction in white rot from late July onwards mainly from the seed treatment with no additional effect from the supplementary tebuconazole foliar sprays. Treatments had no effect on the increase in white rot during late summer having by that time lost their persistence.

Phytotoxic effects of fungicide seed treatment were recorded at full plant emergence. In the salad onions, fungicide seed treated plants at both rates were less vigorous and in bulb onions there was a reduced number of plants established at the higher rate of fungicide seed treatment.

CONCLUSIONS

In conclusion, in salad onions the benefits of the fungicide seed treatment in decreasing white rot infection out-weigh the detrimental effects on vigour. There was no additional benefit of the supplementary stem base sprays reflecting the hot dry summer.

However in the bulb onions, poor control was obtained with the seed treatment. There was a similar situation in that there was no additional benefit of the supplementary foliar sprays except that conditions conducive to infection occurred in late August and in September by which time treatments had lost their persistence.

RECOMMENDATIONS

1. That an off-label approval is sought for the use of tebuconazole(UK 226) as a seed treatment supplemented by two stem base sprays of tebuconazole (Folicur) on salad onions. In a season more conducive to white rot development the sprays may have a beneficial effect.
2. The above refers to spring sown salad onions. It is likely that the treatments will not be effective in the overwintered crop. New experimental work is required to evaluate the control of white rot in overwintered salad onions
3. More experimental work is required on the control of white rot in bulb onions. Other fungicides and different methods of application should be evaluated. Work carried out in Australia and New Zealand on tebuconazole and the Dutch approved use of Sumisclex should be evaluated.
4. It would be prudent to give strong consideration to evaluate non triazole fungicides for the control of white rot in mixtures or as alternating programmes of fungicides from different chemical groups. The use of triazoles is extensive in some arable crops especially cereals and it is not known if this group of fungicides is a candidate for enhanced degradation. This occurred with the dicarboximide fungicides, Rovral and Ronilan, in the late 1980s and the manufacturers' recommendation was withdrawn for the control of white rot. In limited experimental work, there was no evidence of enhanced degradation of Sumisclex.

ACKNOWLEDGEMENTS

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APPENDIX

Appendix 1 Effect of treatment on vigour and surviving plants per metre row - Kent

Treatment	Rate g a.i./250,000 seeds	Vigour score 3 May	Mean number of plants per metre row				
			3 May	28 May	19 June	10 July	25 July
Untreated		4.67	61.17	45.03	37.63	36.83	35.60
Treated		3.00	55.75	60.70	64.82	64.69	62.28
Seed treatment	1.0	3.00	55.23	61.17	65.90	65.93	62.93
Seed treatment	1.5	2.83	53.03	58.37	62.57	62.57	60.97
Seed treatment + base spray	1.0	2.83	59.77	64.17	68.17	68.37	67.20
Seed treatment + base spray	1.5	3.17	54.97	59.10	62.63	61.90	58.03
P		<0.001	NS	0.004	<0.001	<0.001	<0.001
SED (treated v untreated)		0.314	NS	4.977	5.307	5.144	5.133
SED (treated v rate)		NS	NS	NS	NS	NS	NS
SED (treated v spray)		NS	NS	NS	NS	NS	NS
SED (treated v rate v spray)		NS	NS	NS	NS	NS	NS
CV %		20.8	23.5	18.9	19.6	19.1	19.7

Appendix 2 Effect of treatment on % plants affected with white rot - Kent

Treatment	Rate g a.i./250,000 seeds	Plant count at emergence 3 May	Mean % of plants with white rot per metre row				
			28 May	19 June	10 July	25 July	Total
Untreated		61.17	26.88	15.07	1.64	1.06	44.65
Treated		55.75	0.00	0.50	1.45	1.17	3.12
Seed treatment	1.0	55.23	0	0	1.32	1.87	3.19
Seed treatment	1.5	53.03	0	0.48	1.43	0.25	2.16
Seed treatment + base spray	1.0	59.77	0	1.02	0.94	1.57	3.53
Seed treatment + base spray	1.5	54.97	0	0.50	2.12	0.98	3.60
P		NS	<0.001	<0.001	NS	NS	<0.001
SED (treated v untreated)		NS	1.875	3.000	NS	NS	NS
SED (treated v rate)		NS	NS	NS	NS	NS	NS
SED (treated v spray)		NS	NS	NS	NS	NS	NS
SED (treated v rate v spray)		NS	NS	NS	NS	NS	NS
CV %		23.5	76.4	192.4	97.3	189.1	79.8

Appendix 3 Effect of treatment on final plant count and harvest yield - Kent

Treatment	Rate g a.i./250,000 seeds	Plant count at harvest 25 July	Mean fresh weight (t/ha) 25 July
Untreated		35.60	1.81
Treated		62.28	2.08
Seed treatment	1.0	62.93	1.89
Seed treatment	1.5	60.97	2.12
Seed treatment + base spray	1.0	67.20	2.07
Seed treatment + base spray	1.5	58.03	2.18
P		<0.001	NS
SED (treated v untreated)		5.133	NS
SED (treated v rate)		NS	NS
SED (treated v spray)		NS	NS
SED (treated v rate v spray)		NS	NS
CV %		19.7	25.2

Appendix 4 Effect of treatment on % plants affected with white rot - Lincs.

Treatment	Rate g a.i./250,000 seeds	Plant count at emergence 29 May	Mean number of plants with white rot per 10 metre row				
			1 July	26 July	23 Aug	20 Sept	Total
Untreated		123.2	1.0	0.7	1.8	14.8	18.3
Untreated with added sclerotia		130.0	1.7	5.0	4.5	16.0	27.2
Treated		130.0	0.4	1.4	4.3	14.7	20.7
P		NS	0.030	<0.001	NS	NS	0.056
SED (untreated v treated)		-	0.47	0.79	-	-	2.92
Seed treatment	1.0	135.8	0.3	1.6	4.3	14.4	
Seed treatment	1.5	124.3	0.4	1.3	4.3	14.9	
P		0.024	NS	NS	NS	NS	NS
SED (treated means)		4.8	-	-	-	-	-
Seed treatment means, - spray		126.5	0.2	1.3	4.3	13.4	19.2
Seed treatment means, + spray		133.5	0.6	1.5	4.3	15.9	22.2
P		NS	NS	NS	NS	NS	NS
CV %		9.1	148.8	92.0	68.9	33.4	29.9

Appendix 5 Effect of treatment on cumulative number and % plants affected with white rot - Lincs.

Treatment	Rate g a.i./250,000 seeds	Counts of cumulative white rot plants per 10m row				Total as % of initial plants	% at grading	Total % white rot
		1 July	26 July	23 Aug.	20 Sept.			
Untreated		1.0	1.7	3.5	18.3	15.0	10.1	25.1
Untreated with added sclerotia		1.7	6.7	11.2	27.2	20.8	14.4	35.2
Treated		0.4	1.8	6.1	20.7	16.1	13.3	29.4
P		0.030	<0.001	0.008	0.056	NS	0.044	0.031
SED (untreated v treated)		0.47	0.95	1.83	2.92	-	1.40	2.84
Seed treatment	1.0	0.3	1.9	6.2	20.6	15.3	13.1	28.3
Seed treatment	1.5	0.4	1.7	6.0	20.9	16.8	13.6	30.4
P		NS	NS	NS	NS	NS	NS	NS
SED (treated means)		-	-	-	-	-	-	-
Seed treatment means, - spray		0.2	1.5	5.8	19.2	15.4	14.9	30.3
Seed treatment means, + spray		0.6	2.1	6.3	22.2	16.7	11.8	28.5
P		NS	NS	NS	NS	NS	0.02	NS
SED (means)		-	-	-	-	-	1.25	-
CV %		148.8	80.7	61.5	29.9	27.6	23.6	21.0

Appendix 6 Routine Cultural Field Treatments

Site: Southfleet Kent.

Soil Type:	Sandy Silt Loam	
Previous Cropping:	1995 Salad onions	
	1994 Wheat	
	1993 Iceberg Lettuce	
	1992 Iceberg Lettuce	
	1991 Wheat	
Soil Analysis:	pH 7.9, P index 4, K index 3, Mg index 2.	
Seed Bed Preparation:	Winter ploughed/deep cultivation, bed formation	
Drilling:	12.4.96	
Fertilisers:	6.4.95 Landforce 12:4:7:4	502.4 kg/ha
	1.6.95 Thomas Elliot Notrel	251.2 kg/ha
Herbicides:	16.4.95 CP	10.0 l/ha
	16.4.95 CIPC	1.0 l/ha
	12.5.95 CP	2.5 l/ha
Fungicides:	2.6.95 Folicur	3.66 l/ha
	7.7.95 Folicur	3.66 l/ha
Harvest:	19.7.95	

Appendix 7 Routine Cultural Field Treatments

Site:	**HRI-Kirton**
Soil Type:	Silt Loam, 40 acres (1)
Previous Cropping:	1993 Grass cut for silage 1994 Fallow 1995 Onions
Soil Analysis:	pH 7.6, N index 0, P index 5, K index 3
Cultivations:	Ploughed December 1995 Worked with Kuhn rotovator pre drilling 29 March
Drilling:	29 March
Fertilisers:	50 kg/ha K_2O applied 23 February 90 kg/ha N applied as Nitram 17 April
Herbicides:	propachlor at 9 l/ha plus pendimethalin (Sovereign) at 1.2 l/ha in 300 l/ha water applied 2 April
Insecticides:	Malathion at 2.1 l/ha in 600 l/ha water applied 22 July, 8 August
Irrigation:	15 mm applied 29 April 15 mm applied 8 May 15 mm applied 15 May 15 mm applied 6 June 15 mm applied 22 June
Harvest:	24 September