VG209
Interactions between time of planting, inoculum levels and fungicides on onion white rot

Dr M Ryley
Queensland Department of Primary Industries

Know-how for Horticulture™

VG209

This report is published by the Horticultural Research and Development Corporation to pass on information concerning horticultural research and development undertaken for the vegetable industry.

The research contained in this report was funded by the Horticultural Research and Development Corporation with the financial support of the Queensland Fruit & Vegetable Growers.

Cover Price $20.00

HRDC ISBN 1 86423 316 8

Published and Distributed by:

Horticultural Research and Development Corporation
Level 6
7 Merriwa Street
Gordon NSW 2072

Telephone: (02) 9418 2200
Fax: (02) 9418 1352

CONTENTS

INDUSTRY SUMMARY

White rot caused by the fungus, *Sclerotium cepivorum* Berk., is a serious disease of onions and garlic in the Lockyer Valley in southern Queensland. It has become so widespread that there is now a shortage of white rot - free land in the district. Options for controlling the disease are limited. The pathogen produces resting bodies (sclerotes) which can survive in the soil in the absence of a host plant for at least 20 years, making rotations an impractical control option. Although differences in resistance (tolerance) to *Sclerotium cepivorum* among onion lines have been found, there is currently no variety with acceptable levels of resistance being grown commercially. Other forms of control, such as the use of microorganisms which attack the sclerotes, and biofumigation using *Brassica* species are being investigated, but no practical technology has been developed. Fungicides remain the only practical method of control. The fungicide procymidone (as Sumisclex 275 Flocol; 27.5%) is registered for white rot control as a seed dressing, soil surface spray at planting, and as a plant basal spray starting at 70 days after planting. Poor control in recent years led to a study aimed at improving the effectiveness of fungicide application. Experiments and trials were conducted to determine the effect of planting time on disease appearance, the relative effectiveness of applying fungicides before infection and after infection, the influence of different irrigation strategies on disease severity, and the interaction between the numbers of sclerotes in the soil and yield losses, with the aim of predicting potential yield losses in a particular field before planting.

Time of planting studies revealed that the time of appearance of white rot changes from year to year. In 1992 white rot appeared in mid June-early July for both March and April - planted onions, in 1993 the first symptoms were seen in early-mid July for the March and May plantings and in mid July - early August for the April planting while in 1994 the disease was evident in mid July - mid August for all plantings. Climatic data indicate that soil temperature plays an important role in the appearance of white rot, with a soil temperature at 10cm of less than 14°C for at least 2 weeks being necessary for symptom development. These findings have important implications for fungicide application. A separate trial in 1992 showed that for effective control of white rot, fungicides should be applied before the disease is observed. If the current recommendation of applying the first plant basal spray 70 days after planting was adhered to, it would have been applied after the disease was observed in the 1992 April planting and in the 1993 May planting. In both cases control of white rot would have been poor. These findings suggest that in commercial situations the first plant basal spray should be applied in early June, before the disease is observed.

The relationship between sclerote numbers and yield loss was studied by setting up paired plots, one of which was regularly sprayed with an effective fungicide to control the disease and the other which was left unsprayed. The numbers of sclerotes in each plot were determined before the trials were planted. In two trials conducted during the project, there was a statistically significant correlation between the numbers of healthy plants and yield. Although there was a trend of decreasing yield as the number of sclerotes increased, the correlation between the numbers of sclerotes in the soil and yield was not statistically significant. The trial results indicate that the measurement of sclerotes numbers in soil prior to planting is not a reliable predictor of potential yield losses. Further research may lead to the development of a better predictive system.

TECHNICAL SUMMARY

White rot caused by the fungus, *Sclerotium cepivorum* Berk., is a serious disease of onions and garlic in the Lockyer Valley in southern Queensland. It has become so widespread that there is now a shortage of white rot - free land in the district. At present fungicides remain the only practical method of control. The fungicide procymidone (as Sumisclex 275 Flocol; 27.5%) is registered for white rot control as a seed dressing, soil surface spray at planting, and as a plant basal spray starting at 70 days after planting. Poor control in recent years led to a study aimed at improving the effectiveness of fungicide application. Trials were conducted over three seasons to determine when white rot appeared in onions planted in March, April and May and to determine the influence of soil temperature on the disease's appearance to soil. These data, together with information from a trial designed to determine the most effective method of application, were used to ascertain how and when fungicides should be applied during the growing season. The potential of using the numbers of sclerotes the soil before planting as a predictor for the likely yield loss in a particular field was investigated. The establishment of a relationship between sclerote numbers and yield loss would enable appropriate strategies for the timing and number of applications of fungicides to be formulated.

Time of planting studies revealed that the time of appearance of white rot changes from year to year. In 1992 white rot appeared in mid June-early July for both March and April - planted onions, in 1993 the first symptoms were seen in early-mid July for the March and May plantings and in mid July - early August for the April planting, and in 1994 the disease was evident in mid July - mid August for all plantings. Climatic data indicated that soil temperature played an important role in the appearance of white rot, with a soil temperature at 10cm of less than 14°C being necessary for symptom development. These findings have important implications for fungicide application. A separate trial in 1992 showed that for effective control of white rot, fungicides should be applied before the disease is observed.. In the Lockyer Valley the first plant basal spray should be applied in early June. Further research on the influences of critical environmental factors such as soil temperature on symptom appearance may lead to the development of a white rot warning system which would enable further refinement of the timing of fungicide applications. There is also scope for some farmer fungicide application practices to be investigated. For example, the more frequent application of procymidone at rates less than the current recommended rates appears worthy of further testing.

The relationship between sclerotes numbers and yield loss was studied by setting up paired plots, one of which was regularly sprayed with an effective fungicide to control the disease and the other which was left unsprayed. The numbers of sclerotes in each plot was determined before the trials were planted. In two trials conducted during the project, there was a statistically significant correlation between the numbers of healthy plants and yield, but there was no such correlation between the numbers of sclerotes in the soil and yield or % yield reduction. As a result, the measurement of sclerotes numbers in soil prior to planting does not appear to be a reliable predictor of potential yield losses. The natural variation in sclerote numbers and perhaps in the level of parasitism of sclerotes in a relatively small area, let alone in an entire commercial field, may account for the apparently poor correlations. Further pursuit of this avenue of research is not recommended, because although more intensive sampling and changes in experimental procedure may result in a good correlation being established, it seems likely that the use of the procedures in commercial crops would be impractical.

INTRODUCTION

White rot, caused by the fungus *Sclerotium cepivorum* Berk., is one of the most serious diseases of onions and garlic in the world (Entwistle, 1990). The disease was first recorded in Australia in 1928 at Moorabbin, Victoria and since then it has spread to most of the major onion growing districts in the country (Porter et al., 1991). White rot is endemic in the Lockyer Valley of southern Queensland where over 75% of the state's onions are grown, and there is now a shortage of white rot - free land in the Valley. The fungus produces small (0.3 - 0.6 mm) black sclerotes which can survive in the soil for at least 20 years (Coley-Smith, 1990), and which germinate and infect susceptible host plants when exposed to exudates from roots of *Allium* species, such as, onions (*Allium cepa* L.) and garlic (*Allium sativum* L.). Sclerote germination and infection is favoured by soil temperatures between 9°C and 24°C with an optimum of 15°C-18°C, and relatively moist soil (-85 to -300mb) with an optimum at field capacity (Crowe and Hall, 1980).

Although some onion genotypes with higher levels of resistance than current commercial cultivars have been identified (Coley-Smith, 1990), fungicides remain the best option for disease control. Two fungicides in particular, procymidone (as Sumisclex 275 Flocol®) and tebuconazole (as Folicur®) have been shown to provide good control overseas (Fullerton et al., 1995) and in Australia (Ryley and Obst, 1995). The former is now registered in Australia for white rot control on onions as a seed dressing, soil surface spray at planting and follow-up plant basal sprays during the growing season. The seed dressing has been shown to be ineffective in the Lockyer Valley, where early infection rarely occurs. In southern States, white rot attacks onions from emergence onwards, so a seed dressing is effective (Porter et al., 1991),. The current recommendation for follow-up sprays of procymidone is that it should be applied 70 days after sowing, but preliminary trials in the Lockyer Valley indicated that white rot could appear earlier, depending on the date of sowing of the crop.

Control of white rot in onions using the recommended rates and methods of application of procymidone has been poor in many crops in the Lockyer Valley over the past five seasons. Possible causes of the poor control include poor application techniques, prolonged periods of high soil moisture, and high sclerote numbers in the soil. Entwistle (1990) reported that in some cases there was a clear relationship between the numbers of sclerotes at the beginning of the season and the incidence of white rot at the end of the season, but in other situations no relationship could be found. In some overseas trials sclerote levels of >20 sclerotes/kg soil were reported to cause high losses (Crowe et al 1980); Entwistle, 1987 ; Resende et al., 1987). Porter (1990) stated that in Victorian onion growing areas fields with 5-50 sclerotes/kg soil would suffer some disease, while those with 60-400 sclerotes/kg would be unsuitable for onion growing. There are several reports of low sclerotes populations resulting in high incidence. Growers in the Salinas Valley of California are advised against growing garlic in fields with >1 sclerote/kg soil (Hall and Somerville, 1983). However this population number is close to the practical limit of detection using current extraction techniques, the inadequacies of which are demonstrated by the occurrence of white rot in fields where no sclerotes could be extracted (Entwistle, 1990).

It was recognised that there was a need to obtain information on several aspects of the onion - white rot system in the Lockyer Valley with the overall aim of improving the effectiveness of fungicide applications. Trials were conducted over three seasons to determine when white rot appeared in onions planted in March, April and May and to relate the disease's appearance to soil temperature. These data, together with information from a trial designed to determine the most effective method of application, were used to ascertain how and when fungicides should be applied during the growing season. Overseas reports suggested that there would be a close relationship between the numbers of sclerotes of *S. cepivorum* in the soil and yield. If such a relationship could be established, it would be possible to use sclerote numbers in the soil before planting as a predictor for the potential yield loss in a particular field. Appropriate strategies for the timing and number of applications of fungicides could then be formulated. Two trials were conducted during the project to determine if such a relationship could be identified. In addition, the interaction between soil moisture levels and disease severity was studied in a replicated field trial in 1993.

MATERIALS AND METHODS

Extraction of sclerotes

To quantify the numbers of sclerotes in trial plots at the Gatton Research Station and on farmers properties, soil samples were collected and mixed and a 400g subsample was blended in 500mL water then washed through a 0.25mm steel mesh sieve using running water. The residue on the 0.25 mm sieve was washed in to a measuring cylinder with 500mL water. The floating residue was decanted onto the 0.25mm sieve, washed into a bottle, spread out in 100mm diameter Petri dishes and the sclerotes counted with the aid of a dissecting microscope (sample 1), while the remaining residue was left in the measuring cylinder. Two hundred and fifty millilitres (250mL) of a 50% w/v sucrose suspension was poured onto the residue in the measuring cylinder, stirred for 20 seconds and the suspension was then decanted onto the 0.25mm sieve and washed into a bottle before counting (sample 2). The numbers of the sclerotes in samples 1 and 2 were added.

Time of planting trials

Plots of cv. Early Lockyer White consisting of three 3m rows and replicated three times were sown in mid March, April and May in a trial area at Gatton Research Station in every season between 1992 and 1995. At emergence rows were thinned to 60 ± 5 healthy seedlings and thereafter the numbers of healthy plants were counted at fortnightly or monthly intervals. Soil temperature was monitored at a depth of 10cm during the trials to determine the interaction between symptom appearance and soil temperature.

Efficacy trial

A trial was conducted in 1992 to determine the efficacy of three fungicide treatments for the control of white rot and which treatments would be suitable for the trials on the relationships between inoculum number and yield losses. The treatments, all applied in a 10cm band in 200L water/ha were (i) tebuconazole (as Folicur®) as a preplant in-furrow spray and plant basal sprays 50 and 79 days after sowing all at 2L product/ha, (ii) procymidone (as Sumisclex 275 Flocol) as a postplant soil surface spray after planting and a plant basal spray 50 days after sowing, all at 4L product/ha, and (iii) procymidone as a plant basal spray 50 days (4L product/ha) and 79 days (2L product/ha) after sowing (a treatment used by some growers in the Lockyer Valley). The trial was sown in a randomised complete block design with 20 replicates, and plots consisted of 3 x 3m rows with the centre row as datum. Seedlings were thinned to 60 ± 5 per row, and the numbers of healthy plants in each datum row were counted at monthly intervals. The numbers and weights of bulbs were measured at harvest.

Effect of soil moisture in the severity and incidence of white rot

A trial was conducted at Gatton Research Station in 1993 to study the influence of two soil moisture regimes on the severity and incidence of white rot. The trial was planted on 15 April using seed of cv. Early Lockyer White and the seedlings thinned to 60 ± 5 per 3m row 4 weeks later. Thirty paired plots, each plot consisting of 3 x 5m rows with the centre row as datum, were set up in the trial area, with one of the paired plots being subjected to a high water regime and the other a low water regime. The plants were watered by trickle irrigation using T-Tape®, with each plot being able to be watered separately. Soil water potential was measured with Loktronic™ tensiometers (5 per treatment set randomly across the trial site). In the high water regime irrigation was applied when the average water potential reached -300mb and in the low water regime irrigation was applied when the average water potential reached -500mb. The numbers of healthy plants in each datum row were counted at monthly intervals and the number and weight of bulbs determined at harvest. Trials planned for 1994 were not conducted due to a severe water shortage at the Research Station.

Relationships between sclerote number, fungicide efficacy and yield

Research Station trials. Three trials were conducted at Gatton Research Station in 1993, 1994 and 1995 to study the relationship between the number of sclerotes in the soil and yield losses by utilising paired plots, one treated with fungicides to control white rot and the other untreated. Table 1 outlines the details of the trials. The 1993 and 1994 trials were planted in mid April, while in 1995 three planting dates were used. Procymidone (as Sumisclex 275 Flocol) was applied in 1993 at 4L product/200L water/ha, and in 1994 and 1995 tebuconazole (as Folicur) was applied at 2L product/200L water/ha, all as a preplant banded in-furrow spray and thereafter as banded plant basal sprays at monthly intervals. The cultivar Early Lockyer White was used in all trials. Rows were thinned to 20 ± 2 per m of row approximately 30 days after sowing, at which time four 1kg soil samples were taken from each plot, mixed, and two 400g subsamples were taken for determination of sclerote numbers. The numbers of healthy plants were counted in each datum row at monthly intervals, and the number and yield of bulbs were determined at harvest.

Table 1. Details of trials to relate sclerote numbers to fungicide efficacy and yield.

	1993	1994	1995
Planted	16 April	21 April	22 March, 20 April, 16 May
Plot size (datum)	3 x 3m (1 x 3m)	2 x 3m (2 x 3m)	4 x 2.5m (2 x 2.5m)
Replicates	31	90	32
Fungicide, rate [1]	procymidone, 4L/ha	tebuconazole, 2L/ha	tebuconazole, 2L/ha
Sclerotes/kg soil	3 - 118	10 - 560	13 - 709

[1] procymidone as Sumisclex 275 Flocol (27.5% a.i.) and tebuconazole as Folicur (25% a.i.)

Farmer's trials. A total of four trials were conducted in 1993 and 1994 in fields where white rot had been a problem in the past 5 years to monitor the interactions between inoculum levels, disease incidence and yields under farmer practices. In the 1993 trials, 10 plots each consisting of 3 double rows, 5m long were selected in two fields and the numbers of healthy plants were counted after emergence, 60 days after sowing, and just before harvest. At emergence three 1kg soil samples were collected from each plot, mixed, and two 400g subsamples were used to determine the numbers of sclerotes. In the 1994 trials, 20 points on a 20m grid pattern were selected and two 400g soil subsamples from a bulk of four 1kg samples were used for sclerotes number determinations. The numbers of healthy plants were counted in the three double rows for 5m on both sides of the point on three occasions. above.

RESULTS

Time of planting trials

Table 2 and Figures 1a, 2a and 3a summarise the results of the time of planting trials. In 1992 white rot appeared in mid June - early July in the first two plantings (March and April) (88-106 days after planting and 56-74 days after planting respectively), while the May planting was abandoned because of poor emergence. In 1993 the first symptoms were seen in early - mid July in March - and May - planted onions (106-119 days after planting and 48-61 days after planting respectively) and in late July in the April - planted onions (79-91 days after planting). In this trial the levels of white rot were very low. In 1994 the first signs of infection were not seen until mid July - mid August (112-146, 84-118 and 55-88 days after planting for the March, April and May plantings respectively) for all three planting dates. No information on the effects of planting times on the appearance of white rot in 1995 was obtained because white rot levels were very low throughout the trial due to low rainfall and limited irrigation. In the 1992 and 1993 trials there was a trend for better survival as the planting date became later, but in the 1994 trial the trend was reversed. In earlier trials differences in the date of appearance of white rot were also noted. In 1990 and 1991 white rot first appeared in March - and April - planted onions in late June while in the onions planted in mid May or early June the disease was not seen until late July.

Table 2. Appearance of white rot in onions planted on different dates in 1992, 1993 and 1994.

		Symptom appearance	
	Planting date	**Date**	**Days after sowing**
1992			
1st planting	23 March	19 June - 7 July	88 - 106
2nd planting	24 April	19 June - 7 July	56 - 74
1993			
1st planting	23 March	7 July - 20 July	106 - 119
2nd planting	20 April	20 July - 3 August	78 - 91
3rd planting	20 May	7 July - 20 July	48 - 61
1994			
1st planting	24 March	14 July - 17 August	112 - 146
2nd planting	21 April	14 July - 17 August	84 - 118
3rd planting	20 May	14 July - 17 August	54 - 88

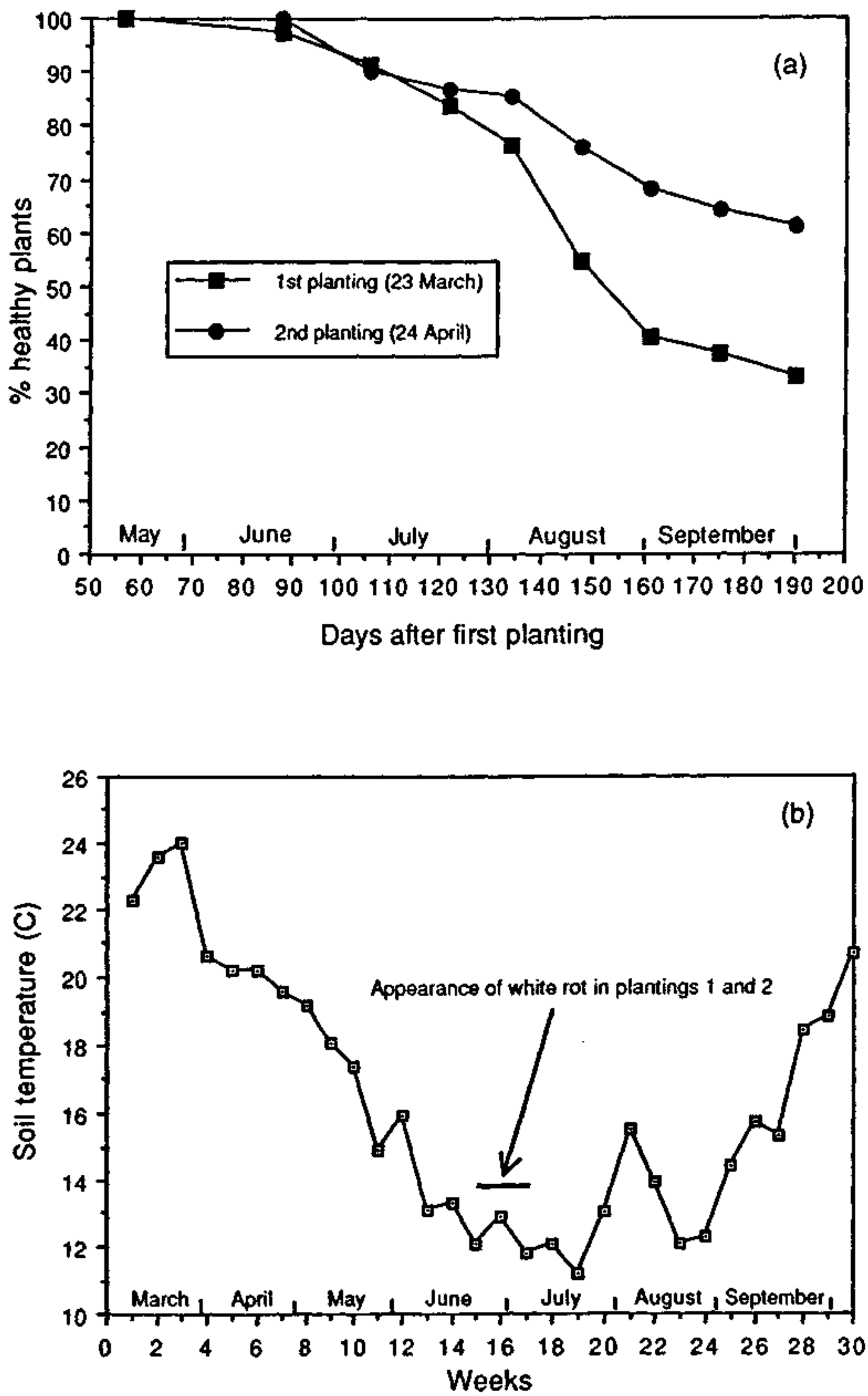

Figure 1. (a) Development of white rot in onions planted on two occasions , and (b) soil temperature at 10cm, in the 1992 time of planting trial.

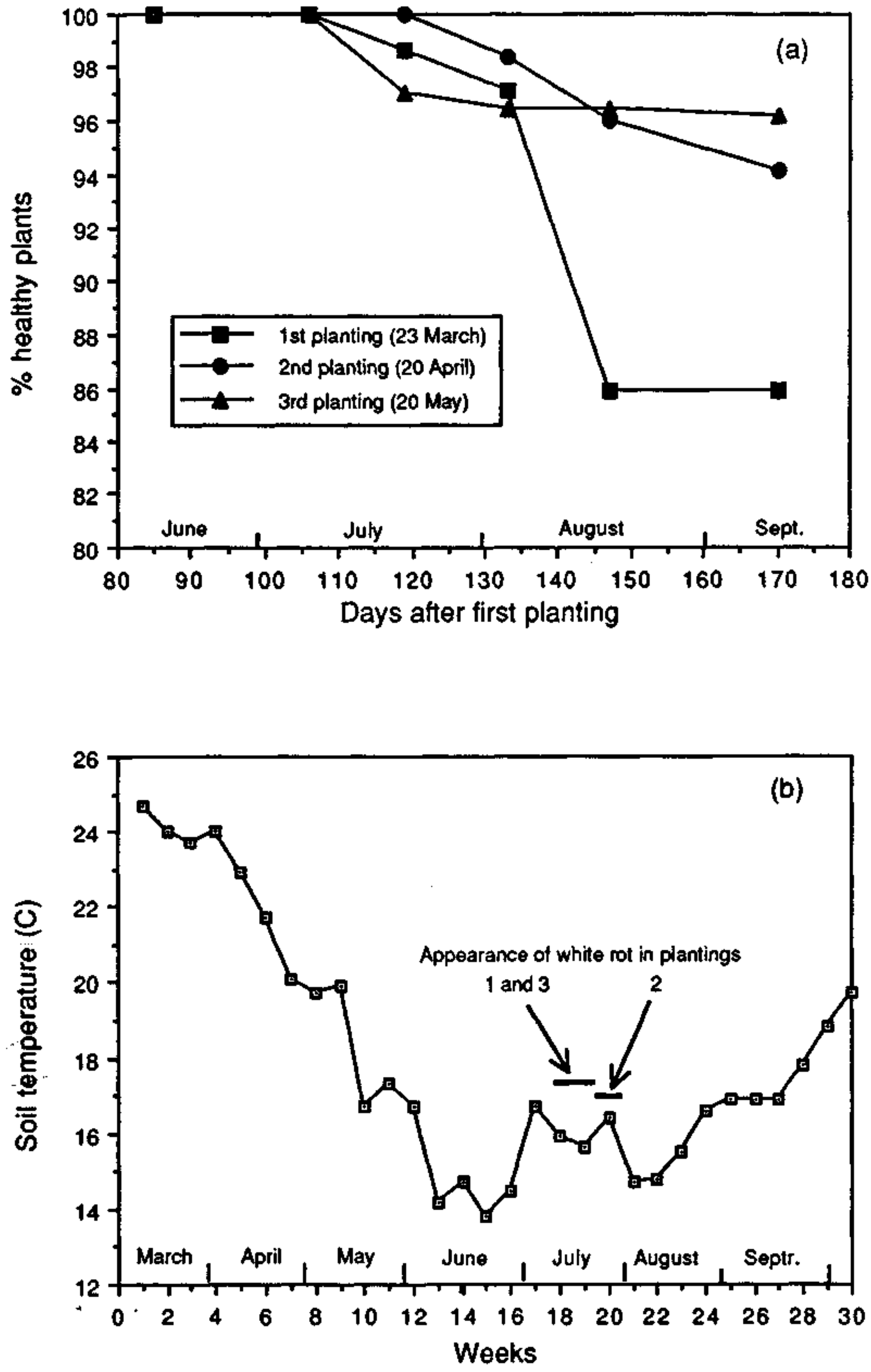

Figure 2. (a) Development of white rot in onions at planted on three occasions, and (b) soil temperature at 10cm, in the 1993 time of planting trial.

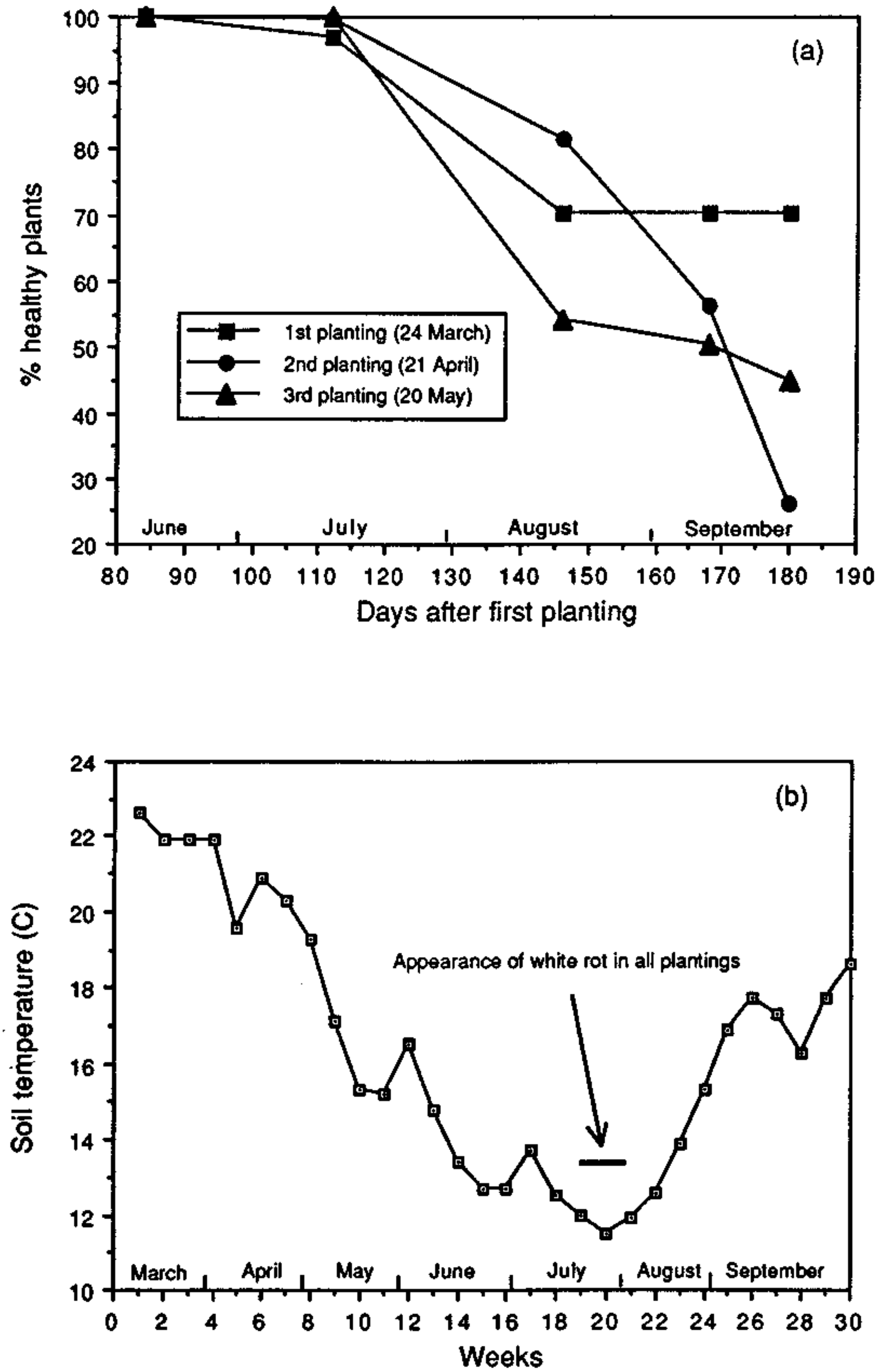

Figure 3. (a) Development of white rot in onions at planted on three occasions, and (b) temperature at 10cm, in the 1994 time of planting trial.

The mean weekly soil temperatures at 10cm measured during the trial periods are displayed in Figures 1b, 2b and 3b. In 1992 the temperature fell below 14°C between early June and late July (8 weeks), corresponding with the appearance of white rot in both plantings. In 1993 the average weekly soil temperature dropped below 14°C during one week only (late June), with white rot being first evident in early July. In 1994 the soil temperature reached 14°C in late June and remained at that temperature or lower for 10 weeks, but white rot symptoms were not seen until mid July. This information suggests that the appearance of white rot was influenced by soil temperature.

Efficacy trial

Disease levels in this trial were lower than anticipated due to the late planting date (5 May) and the dry conditions experienced during the trial period. The three fungicide treatments significantly increased (P=0.05) the % plants healthy at harvest, the total bulb number/ha and yield over the no fungicide treatment (Table 3). The procymidone soil surface spray and plant basal spray was significantly better than the other procymidone treatment in all parameters, and the tebuconazole treatment was significantly better than the procymidone plant basal spray with respect to % healthy plants and bulb numbers. It was apparent that none of the fungicide treatments completely controlled the disease, even under relatively low disease pressure.

Table 3. Effects of different treatments on survival, bulb numbers and bulb yield of onions in a white rot - infested area at Gatton Research Station, 1992.

Treatment	**% healthy plants**	**No. bulbs x 10000 /ha**	**Total yield (t/ha)**
tebuconazole *IF+BS* [1]	77.7	35.9	41.8
procymidone *SS+BS* [2]	83.2	37.7	43.1
procymidone *BS* [3]	62.6	26.9	34.2
no fungicide	42.3	20.1	24.5
L.S.D. (P=0.05)	12.4	6.3	7.7

[1] tebuconazole as Folicur applied as a banded preplant in-furrow spray (*IF*) and a banded plant basal spray at 50 and 79 days (*BS*), all at 2L product/ha

[2] procymidone as Sumisclex 275 Flocol applied as a banded postplant soil surface spray (*SS*) and a banded plant basal spray at 50 days (*BS*), all at 4L product/ha

[3] procymidone as Sumisclex 275 Flocol applied as a banded plant basal spray (*BS*) at 50 days at 4L product/ha and at 79 days at 2L product/ha

Effect of soil moisture on the severity and incidence of white rot

The high soil moisture regime was maintained during the trial by applying water for 1-1.5 hours when the water potential reached -300mb, which occurred every 5 to 7 days, while the low moisture regime was maintained by applying water for 0.5 hours every 7 to 10 days, when the water potential reached approximately -500mb. White rot first appeared in the trial in July 1993 and progressively increased in severity for the remainder of the trial. At harvest there were no significant differences in % healthy plants between the two irrigation regimes (49.2% for the low moisture regime and 48.8% for the high moisture regime), or in yield (25.2 t/ha for the high moisture regime and 22.1 t/ha for the low moisture regime). The higher yield in the high moisture regime was probably due to a direct effect of high soil moisture levels on yield.

Relationship between inoculum number and yield loss

Research Station trials. In the 1993 trial the inoculum level (numbers of sclerotes/kg soil) across the trial site ranged from 3 to 118 per kg soil. Over the whole trial the fungicide sprays significantly increased (P=0.05) the % healthy plants (64% for the untreated plots and 94% for the treated plots) and yield (25.1 t/ha for the untreated plots and 58.1 t/ha for the fungicide-treated plots). There was a highly significant positive correlation (r^2 =0.89) between % healthy plants and yield. Although there was a trend of a decrease in yield as the sclerote numbers increased, no significant correlation could be established. Figure 4 displays the relationship between yield and inoculum levels for both fungicide-treated and untreated plots.

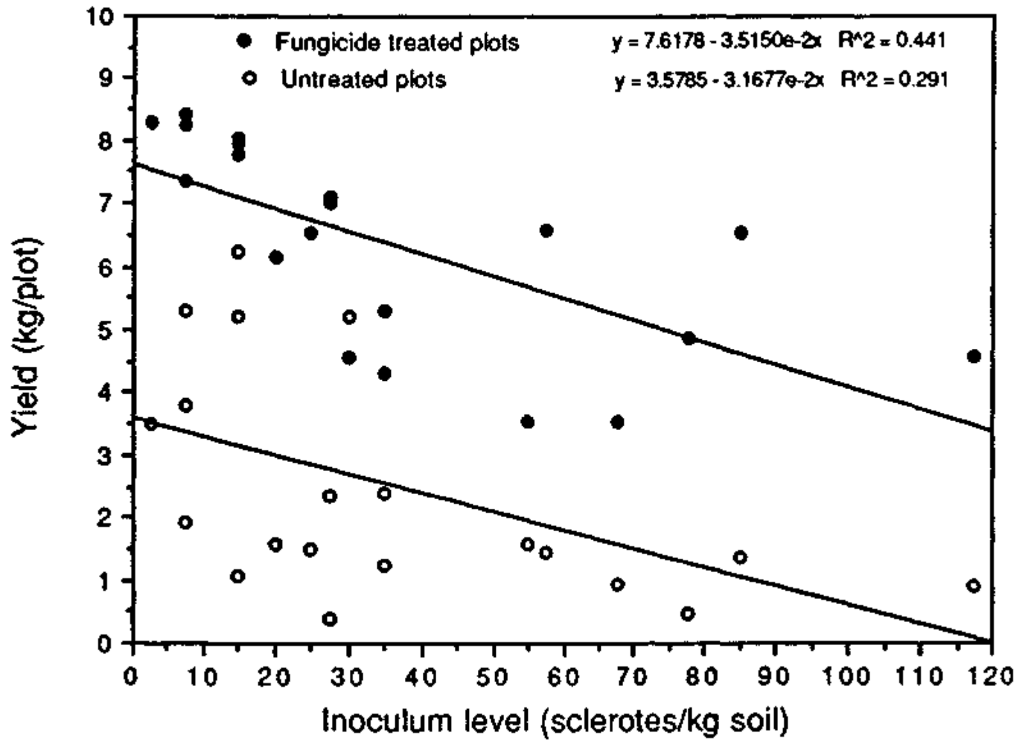

Figure 4. Relationship between inoculum level (sclerotes/kg soil) and yield in fungicide - treated, and untreated plots at Gatton Research Station in 1993.

In addition, there was no statistically significant correlation between sclerote numbers and % yield reduction [(yield treated plots - yield untreated plots) x 100 / yield treated plots], although there was a trend for a bigger yield reduction as the sclerote number increased (Figure 5). At low sclerote numbers there was a wide variation in the % yield reduction; for example when there were less than 50 sclerotes/kg soil the % yield reduction ranged from 13% to 95%. At higher inoculum levels the % yield reduction values were consistently higher.

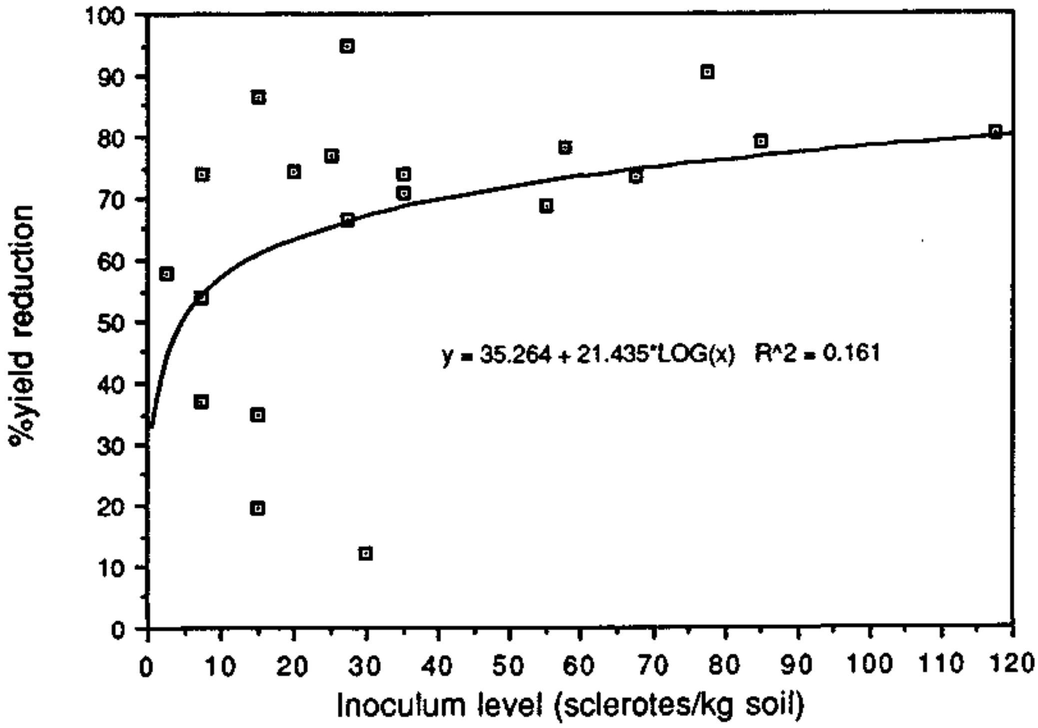

Figure 5. Relationship between inoculum level (sclerotes/kg soil) and yield reduction at Gatton Research Station in 1993.

In the 1994 trial the number of replicates was increased to 90 in an attempt to improve accuracy of the data. The range of sclerote numbers (10 - 560 /kg soil) was greater than in the 1993 trial. As in the previous year's trial there was a significantly positive correlation between % healthy plants and yield over the whole trial. Although there was a trend for a decrease in the % healthy plants and yield as the sclerote number increased, the correlations between these parameters were not statistically significant (Figure 6). In addition, and similar to the previous year's results, there was no statistically significant correlation between sclerote number and % yield reduction (Figure 7). There was a wide variation in % yield reduction, irrespective of the inoculum level.

The data from the 1995 trial were not analysed because few plants were killed by white rot across the trial due to the drought conditions, the infrequent application of poor quality, salty water and an epidemic of downy mildew which occurred in mid-late September. Extraction of sclerotes from the soil at the start of the trial had revealed that the inoculum levels in plots ranged from 13 to 709 sclerotes /kg soil.

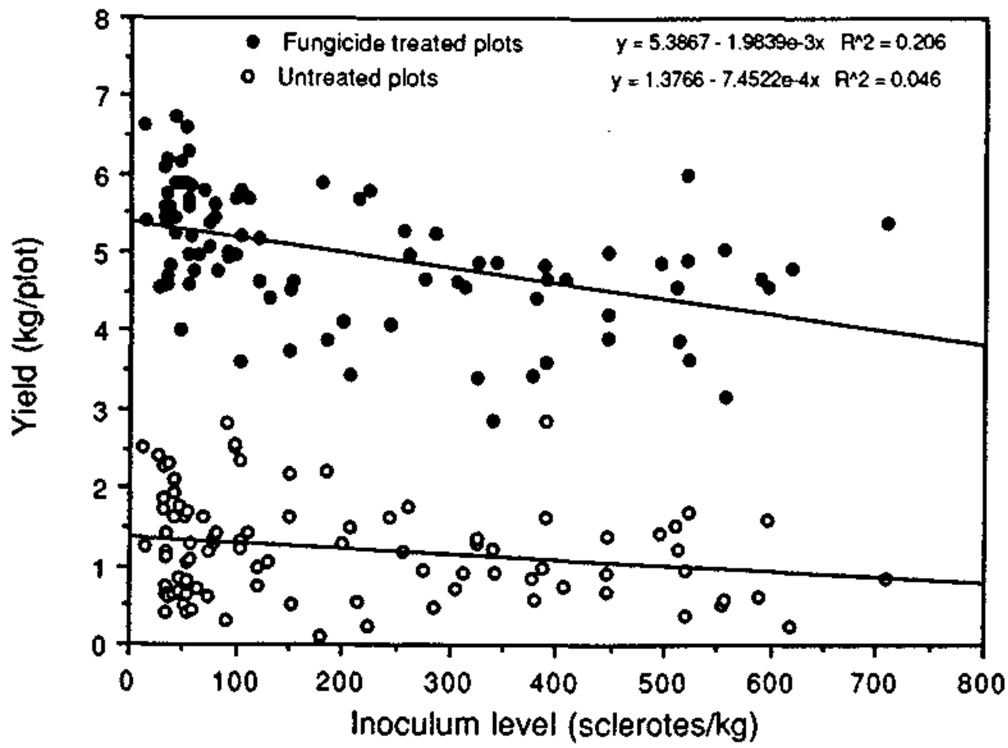

Figure 6. Relationship between inoculum level (sclerotes/kg soil) and yield in fungicide - treated, and untreated plots at Gatton Research Station in 1994.

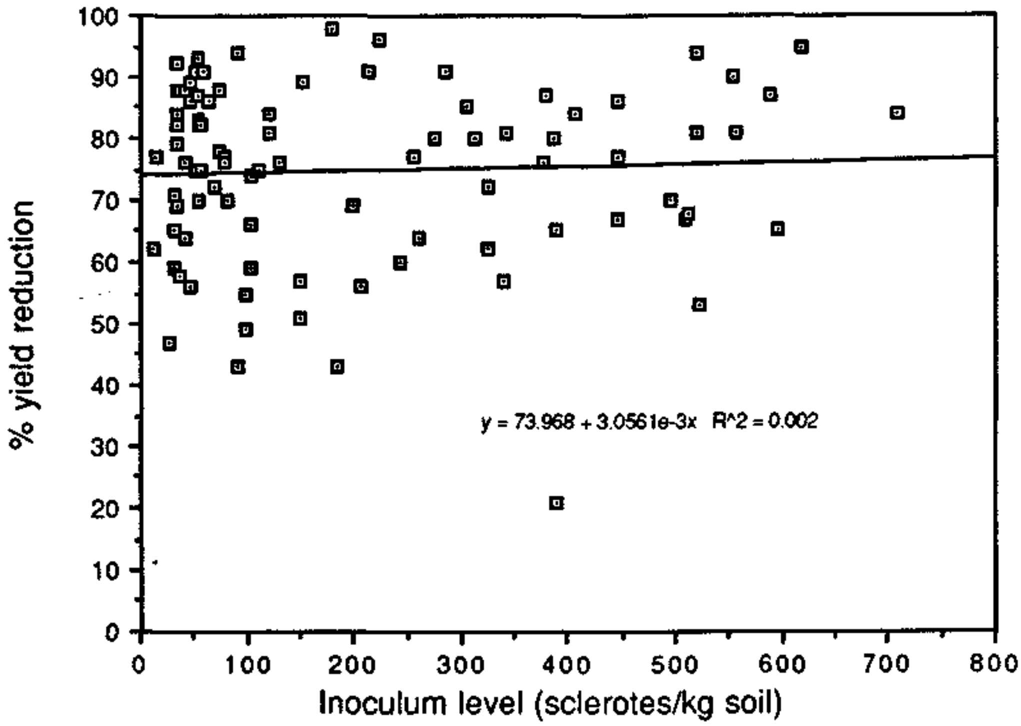

Figure 7. Relationship between inoculum level (sclerotes/kg soil) and yield reduction at Gatton Research Station in 1994.

Farmers trials. At trial site 1 in 1993, the sclerote numbers ranged from 3 to 30 (av. 5) sclerotes/kg soil, while at the other site the range was 3 - 310 (av. 10)/kg soil. The disease did not develop at the first site, despite there having been a history of white rot on the site 3 years previously. At the other site, the whole area was inadvertently sprayed with procymidone during the trial, making an assessment of yield loss impossible. However, there was a very high rate of survival (>95%) in the trial, indicating that the grower's use of the registered fungicide was effective. In the 1994 trials, the sclerote numbers were very low, ranging from 0 to 5/kg soil, considering that both sites had been affected by white rot in previous years. The sites were both treated with Sumisclex 275 Flocol as an in furrow spray at planting at 4L/ha and as a plant basal spray at 2L/ha twice during the season. When the data from both trials were collected, the % plants healthy at maturity ranged from 0% to 3.8% per plot, with an average of 0.36%. At very low inoculum levels, it is clear that fungicides can effectively control white rot.

CONCLUSIONS AND RECOMMENDATIONS

1. The severity of white rot was not increased by high moisture. Under the conditions of the trial, there was no difference in white rot severity between the high moisture regime and the low moisture regime. However it is possible that under prolonged, wet conditions when onions are under more stress white rot could be exacerbated.

2. Fungicides must be applied at planting, as an in-furrow spray or as a soil surface spray, to provide effective control. The data collected in the efficacy trial conducted during the project provide further evidence for the need to apply a fungicide to the soil at planting. Application of procymidone to the basal parts of plants, without a spray prior to or immediately after planting, resulted in a lower yield than the treatments which included a fungicide spray at planting.

Grower recommendation: *That the practice of applying a fungicide at planting as an in-furrow spray or to the soil surface immediately after planting be encouraged. Widespread adoption of this practice will result in more effective control of the pathogen.*

3. The appearance of white rot in a crop changes from year to year. In the three trials white rot appeared at about the same time in a particular year, irrespective of the date of planting. The date of appearance of white rot changed from year to year. Although data on May -planted onions were gathered from only one trial, previous trials have shown that white rot usually appears in these onions when it does in April-planted onions. The results from the trials conducted during this project indicate that soil temperature, and perhaps the duration of temperatures below a particular value, play a large part in the time of appearance of the disease. Similar time of planting trials conducted over more seasons would enable evidence to be gathered over a wider range of conditions. The results also indicate that selecting a later time of planting will reduce the damage caused by white rot in most years.

4. In addition to a fungicide applied at planting, the first follow up plant basal spray should be applied in mid June. Fungicides, to be effective, should be applied before white rot is evident. As outlined above, the appearance of white rot changes from year to year, but some general recommendations can be made regarding the time of application of the first follow up basal spray after emergence. In the trials conducted during the project, white rot never appeared before late June for any planting date. As a consequence, an application of an effective fungicide such as Sumisclex 275 Flocol at the recommended rates, and by appropriate methods before late June should provide effective control, when used in conjunction with a fungicide application at planting and any additional sprays after the first basal spray. Field trials have shown that applications of fungicides after white rot has appeared results in poor control.

Grower recommendation: *That the first plant basal spray be applied in mid June in the Lockyer Valley and that later sprays be applied at 4 weekly intervals, as required. As with many plant pathogens, early control of Sclerotium cepivorum necessitates application of a fungicide before the disease is evident. An application at the appropriate time will ensure that infection levels do not build up during the season to unacceptable and uncontrollable levels.*

Corporate recommendations: *1. That a study of the relationships between environmental factors such as soil temperatures, and the appearance of white rot be conducted, and that the use of the monitoring of such factors in the development of white rot warning system be encouraged.*

2. That further research on the use of frequent plant basal sprays of an effective fungicide at lower than recommended rates is warranted. There is very little information on the minimum fungicide concentration necessary to provide effective control. Many current application strategies involve the use of a fungicide dose which is often much higher than is necessary to control the target pathogen. An alternative approach is to endeavour to maintain the fungicide dosage to a near optimum level through more frequent applications

5. No significant relationship between the numbers of sclerotes of *Sclerotium cepivorum* in the soil and reduction in yield could be established. In two trials there was a highly significant positive correlation between the % of healthy plants in a plot and yield, but no significant correlation was found between inoculum levels and yield or between inoculum levels and % yield reduction. However there was a trend for a decrease in yield as the inoculum level increased. There are a number of possible explanations for the poor correlation between sclerote numbers /kg soil and yield parameters; firstly it is recognised that the numbers of sclerotes vary markedly within a very short distance in the soil, so the sampling methodology used to measure sclerotes may not result in a true indication of the numbers in a particular area. Secondly, as indicated by the results, less than 50 sclerotes per kg of soil resulted in widely varying yield reductions and up to 95%. This finding is in contrast to Porter (1990) who reported that low sclerotes numbers (5-50/kg soil) will result in "some" yield reduction. Thirdly, microorganisms antagonistic to *Sclerotium cepivorum* are common in most onion-growing soils, and their populations vary greatly within the soil, so direct measurements of sclerote numbers do not account for different levels of parasitism throughout the soil. If additional testing was required to ascertain the levels of parasitism in each soil sample, the costs of routine sampling of soil samples for sclerote numbers, and for a prediction in potential yield loss would be prohibitive. Our results do show, however, that even relatively low sclerote numbers can result in serious losses of onions from white rot.
Corporate recommendation: *That further work in this area not be encouraged for the present.*

EXTENSION AND PUBLICATION OF RESULTS

Extension

The significant results in this project (as outlined in recommendations 2 and 4) have been extended to growers in the Lockyer Valley through a field day conducted in September, 1995 at the Gatton Research Station, in *Onions Australia* and in a proposed article for the QFVG 1996 Annual Report. Information will also be made available through the QDPI Information Services.. Although the measurement of sclerotes numbers has proved to be inadequate as a predictive tool for potential yield reduction, the results have also been extended to growers.

Publication schedule

1. Draft of paper on time of planting studies to be submitted to Australian Journal of Experimental Agriculture by June, 1996.

2. Draft of paper on relationship between sclerotes numbers and yield reduction to be submitted to Australian Journal of Experimental Agriculture by June, 1996.

Publications to date

Ryley, Malcolm (1995). White rot in Alliums, p.8 *in* Horticulture Highlights 2, QDPI, Granite Belt Horticultural Research Station.

Ryley, Malcolm and Obst, Neale (1995). Influences on white rot - time of planting and sclerotes levels. *Onions Australia* 12:37.

REFERENCES

Coley-Smith, J.R. (1990). White rot disease of Allium: problems of soil-borne diseases in microcosm. *Plant Pathology* 39:214 -222.

Crowe, F.J., and Hall, D.H. (1980). Soil temperature and moisture effects on sclerotium germination and infection of onion seedlings by *Sclerotium cepivorum*. *Phytopathology* 70 :74-78.

Crowe, F.J., Hall, D.H., Greathead, A.S., and Baghott, K.G. (1980). Inoculum number of *Sclerotium cepivorum* and the incidence of white rot of onion and garlic. *Phytopathology* 70: 64-69.

Entwistle, A.R. (1987). Relationships between soil sclerotes populations of Sclerotium cepivorum and the incidence of Allium white rot. *In* Proceedings of 3rd International Workshop on Allium White Rot (Ed. A.R. Entwistle). T.W. Printing Associates Ltd, Leamington Spa, UK. Section 6, p. 21.

Entwistle, AR. (1990). Root Diseases. *In* Onions and Allied Crops (Eds. HD Rabinowitch and JL Brewster), Boca Raton, Florida : CRC Press.

Fullerton, R.A., Stewart, A., and Slade, E.A. (1995). Use of demethylation inhibiting fungicides (DMIs) for control of onion white rot (*Sclerotium cepivorum* Berk.) in New Zealand. *New Zealand Journal of Crop and Horticultural Science* 23: 121-125.

Hall, D.H. and Somerville, P.A. (1983). Effect of inoculum potential on control of white rot by fungicides. *In* Proceedings of 2nd International Workshop on Allium White Rot (Eds. P.B. Adams and A.R. Entwistle), p. 113.

Porter, I.A. (1988). White rot control : Sumisclex works but correct use is essential. *Australian Onion Grower* 4: 26.

Porter, I.A., Maughan, J.P. and Towers, G.B. (1991). Evaluation of seed, stem and soil applications of procymidone to control white rot (*Sclerotium cepivorum* Berk.) of onions. *Australian Journal of Experimental Agriculture* 31: 401-406.

Resende, M.L.V., Zambolim, L., and Da Cruz, J. (1987). Efficacy of fungicides in the control of garlic white rot, according to the level of *Sclerotium cepivorum* Berk. sclerotes in the soil. *In* Proceedings of 3rd International Workshop on Allium white rot (Ed. AR Entwistle) T.W. Printing Associates Ltd, Leamington Spa, UK. Secton 3, p. 36.

Ryley, M.J., and Obst, N.R. (1994). Control of onion white rot (*Sclerotium cepivorum*) with fungicides in southern Queensland, Australia. *In* Proceedings of Fifth International Workshop on Allium White Rot (Eds AR Entwistle and JM Melero-Vara). Instituto de Agricultura Sostenible and Horticulture Research International. Section 5.2

[redacted]

[redacted]nions Aus[redacted]lia

[redacted]MBER 1995

Published by Scope Publishing, for the
Australian Onion Association Inc.

[redacted]rial

Ian and John Salvestrin

[redacted] to introduce [redacted]an Salvestrin [redacted] an editor of [redacted]he first time. [redacted]ome positive [redacted]end your [redacted]

[redacted] present the [redacted]ble way that [redacted]o develop.

[redacted]unter some [redacted]n the future [redacted] Symposium [redacted]y to be held [redacted]mber, 1997, [redacted]act hundreds [redacted]s, including [redacted] farmers, [redacted]rs. It will be [redacted]ed and it will [redacted]o talk to the [redacted]orldwide.

[redacted] important? [redacted]

[redacted]happening in [redacted]moment and [redacted]story often [redacted] editions of [redacted] serve as a reminder of how things were not as good, not very long ago. It is common knowledge that most in the Industry have continued to experience good times. Inevitably though, it will change; it could be tougher than ever.

All businesses wanting to develop and profit into the 21st century, will face challenges involving quality, price, sound marketing principals, research and product knowledge/industry understanding. Success will depend on our ability to take up these challenges.

That is why the Symposium will be important. You will rub shoulders with the best in the Industry and have access to the best expertise and knowledge. It can only serve to further equip you as you take up these challenges.

This magazine aims to focus on the same aims - to provide answers to your problems and highlight the latest technology and issues facing the industry.

I hope you find it good reading and wish you all the best in the future

Ian Salvestrin

Ian Salvestrin
EDITOR

The Horticultural Research and Development Corporation (HRDC) is acknowledged as a major supporter to Research, Development and Advisory activities in the Australian Onion Industry. The HRDC provides matching Commonwealth funds for approved projects on a dollar for dollar basis. Most articles in this magazine, report on projects which have been co-funded and supported by the HRDC.

[redacted]Corporation

FRONT COVER: Photograph courtesy of VECON PTY LTD.

[redacted]tents

[redacted] TO CONTRIBUTORS

[redacted]d annually in November. Articles are [redacted]elated to onions. Please submit copy [redacted] July. Where possible, please supply [redacted] and photographs as coloured prints. [redacted]ould be submitted at approximately

[redacted]on of products does not imply [redacted] registration. Contact your local [redacted]officer for advice on registration status.

Influences on White Rot

Planting time and Sclerotia levels

Plant Pathologist and Neale Obst, District Experimentalist are with the Queensland Department of Primary
ba, Queensland

aused by the fungus, Sclerotium
or pathogen of onions in the Lockyer
rn Queensland.

resting bodies
urvive in the soil
and which are
ed soil within a
fields. Under
s the sclerotia
to root exudates
and invade the
e. The below
a white fungal
e rotted areas,
s sclerotia. At
offer the only
control, but on
has not been
oor application
timing of sprays
ls in the soil.

als have been
Research Station
perties on two
niology of white
ect of different
appearance and
ease, and the
ers of sclerotia in

article (Onions
page 27) we
of planting trial
which we found
peared in March
ions in late June
nted on the first
as not seen until
nation suggested
of white rot was
environmental
age also was an
case of the June
were conducted
udy the variation in the appearance of white rot from year to year. In the 1991 trial white rot was first evident in the March planting in late June, and in the April and May plantings in late July, while in 1992 the disease appeared in late June in the first two plantings (March and April). In 1994 the first signs of infection were not seen until mid July for all three planting dates. In the four trials, onions planted in May (1991,1992 and 1994) or early June (1990) had a better survival rate than onions planted earlier, and in three of the four years the April - planted onions were more severely affected than the onions planted in March. These results have wider implications than just selecting a time of planting which will reduce the damage caused by white rot, particularly with regard to the timing of fungicide applications. The following conclusions can be drawn from these time of planting trials and from fungicide efficacy trials conducted since 1987:

- Onions planted in March will in most years be more severely affected by white rot than onions planted earlier or later.

- When white rot first appears changes from year to year.

- The first soil spray during the crops growth should be applied before the disease appears, which is mid June in most years.

In 1993 and 1994 two trials were conducted to determine if a relationship between the numbers of sclerotia in the soil and yield loss could be established, with the aim of using sclerotia numbers in a field to predict the likely yield loss, due to white rot, of an onion crop before it is planted. The trials consisted of a number of plots (30 in 1993 and 90 in 1994), each consisting of four 5m rows. Prior to planting soil samples were taken from each plot, sclerotia were extracted, and the numbers of sclerotia in a standard weight of soil were determined. One half of each plot was sprayed every 8 weeks with a fungicide known to be effective against white rot and the other half was left unsprayed. In each split plot the numbers of survivors were counted at regular intervals during the growing season and bulb yiel was measured at maturity. In both trials there was a high positive correlation between % survivors and yield, as would be expected. However, although there was a trend in both years for lower yields and higher yield losses as sclerotia numbers increased, the correlations were not statistically significant. Figure 1 displays the relationship between sclerotia numbers and yield loss in the 1993 trial. Other factors such as small differences in the physical and chemical nature of the soil across the trial site may have had an influence on the results. Although the trial data suggest that sclerotia numbers may not be an accurate predictor of yield loss in a field, it is evident that even low number of sclerotia (< 5 per 400g of soil) can cause yield losses of more than 50%.

Another trial is being conducted this season in which efforts have been made to improve the accuracy of the measurement of sclerotia numbers in the soil, and in which a number of planting times have been incorporated. Even if a direct relationship cannot be established in this trial, testing for the absence or presence of sclerotia in a field will be a useful tool in the management of onion white rot.

HORTICULTURE HIGHLIGHTS

A newsletter for Granite Belt fruit and vegetable growers

No 2 JUNE 1995

IN THIS ISSUE

DPI QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES SOUTH REGION

produced at the Granite Belt Horticultural Research Station

EDITORIAL

by Andy Jordan

Welcome to the second issue of *Horticulture Highlights*. This issue has been posted to subscribers only. If you have friends or neighbours who would like their own copy they can fill in the form on the back cover or call into DPI at Applethorpe. Subscription is $10.00 per year.

We've made a few small changes to the format of *Horticulture Highlights*. We hope they make it more readible. We had a number of comments from the last issue. We will try to take them all on board. Again, your comments and suggestions are most welcome.

I would like to draw to your attention to three items in this issue. The first is an interview with Marcel Veens from Sunstar Fruits. Simon Middleton talks to Marcel about training young trees. We will be holding a workshop on the same topic with Marcel early next month. We will be repeating the workshop a couple of times, but participation at each session will be limited to 16 people. As a subscriber you have advanced warning and the opportunity to 'book in' before we give it general publicity. The full details are on page 13.

Items two and three are not so pleasant. We give you a couple of serious warnings about the use of unregistered pesticides and other chemicals on crops. If you use an unregistered pesticide **for any reason** you leave yourself open to prosecution and the destruction of your produce. Produce is being tested all the time - don't be the next one to be caught!

It is the answers to such questions that will tell you what the aims in pruning *your* orchard should be.

Many of the answers to these questions will best be found by looking at your trees in *summer* when they are in full leaf and the fruit are present. The responses to pruning cuts, and the strength and presence of fruiting buds can be readily observed in *winter*.

Remember also, to look at all your blocks separately, as each will differ from others in one or more critical ways (variety, rootstock, tree age, planting density, soil type, problems occurring, etcetera). Take notes as you go, for it will be impossible to memorise all that you see!

Once you know *your* pruning objectives (general and specific), and how *your* trees have responded to pruning cuts made in the past, it's ***now*** time to gather information on the pruning techniques required to achieve your goals.

There is an enormous range of information available (whether by reading, orchard visits, or talking to others) that encompasses a wide spectrum of opinion, that can, if you're unprepared, leave you highly confused! The bottom line is to be clear in ***your own mind*** of what you want pruning to achieve for ***you***.

Apple tree response to pruning is a complex topic. There are however many important pruning principles that should be known and that may be of direct practical application in your orchard. Several of these are covered in the interview with Marcel Veens in this issue of Horticulture Highlights, and these will be considered further in pruning workshops to be held in early July 1995.

The purpose of this article is to make you ***think*** about your pruning, and why you do it. So every summer and winter, take the time to stand back, observe, and 'Let your trees do the talking'. It will be some of the most productive time you'll spend in your orchard!

WHITE ROT IN ALLIUMS

by Malcolm Ryley

DPI Toowoomba

White rot is a serious disease of onions, garlic, leeks and shallots which is very difficult to control once it becomes established in an area. Every effort should be made to reduce the possibility of introducing the pathogen from affected areas via contaminated planting material and equipment.

White rot is caused by the fungus Sclerotium cepivorum. It is a major disease of Allium species (onions, garlic, leeks and shallots) throughout the world. It is a serious disease in the Lockyer Valley and has been found on a few farms on the Darling Downs. Plants can be infected at any stage of growth with seedlings dying before or soon after emergence and young plants wilting, while in older plants wilting may be confined to older leaves. Affected plants usually die.

The most characteristic symptom of the disease is the development of cottony white fungal strands on the rotting stembases. These are often seen only when the plant is removed from the soil. Small black spherical bodies (sclerotia) about 2 mm in diameter which develop on the strands are the main means by which the fungus survives in the soil and spreads from field to field.

White rot typically occurs in patches which are initially only a few metres wide but which enlarge every year. Infection occurs over a wide range of soil moisture, but over a relatively narrow range of soil temperature with 14oC - 19oC being optimum. Under these conditions the sclerotes germinate in response to the root exudates of its hosts and invade the roots and basal plate, rotting the basal parts the forming the cottony growth and new resting bodies.

Control is difficult once a field is infected with white rot. Every effort should be made to minimise the chances of introducing the fungus into a clean paddock. Vegetative planting material such as garlic cloves must be obtained from a known white rot free field, and soil should be washed from machinery, vehicles and other equipment suspected of having been in a white rot infected area. At present there are no commercial varieties of any of the hosts which are resistant to Sclerotium and rotations are not effective because the sclerotia can survive in the soil for at least 15 years.

Sumisclex 275 Flocol is registered in Queensland for the control of white rot in onions and garlic and should be applied as per label. The application regime for garlic entails a preplant dip followed by a spray of the soil surface above the row directly after planting, while for onions a soil spray after planting and at regular intervals during the season is necessary. The first follow-up spray on onions must be applied to the basal parts of the plants and before the disease is observed; failure will result in poor control.