THIRD INTERNATIONAL WORKSHOP

on

ALLIUM WHITE ROT

INSTITUTE OF HORTICULTURAL RESEARCH
WELLESBOURNE, UK
(formerly NATIONAL VEGETABLE RESEARCH STATION)

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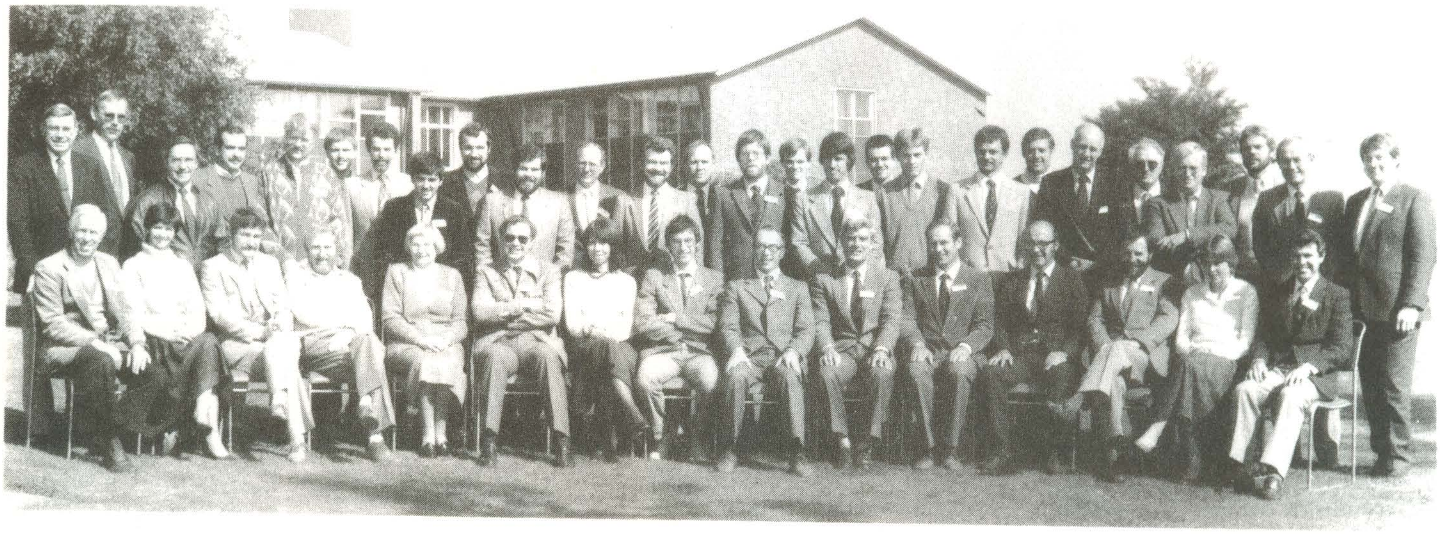

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INDEX

SECTION 1 Geographic Distribution and Economic Importance

SECTION 2 Methods

Page

SECTION 3 Chemical Control

SECTION 4 Biological Control and Integrated Control

/contd.

Page

SECTION 4 Biological Control and Integrated Control (contd)

SECTION 5 Genetic Control

SECTION 6 Epidemiology

SECTION 1

Allium white rot in Holland

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Table 1. World production of onions (1983; 1000 tons)

CHINA	2823
INDIA	2700
USSR	2030
USA	1689
JAPAN	1200
TURKIJE	1040
SPANJE	957
BRAZILIE	730
EGYPTE	660
ZUID-KOREA	542
ITALIE	522
PAKISTAN	475
NEDERLAND	412

Table 2. Export of onions from Holland (tons)

Country receiving exports	1980	1982	1984
AFRIKA	49124	52968	44474
AMERIKA	5692	16391	12134
AZIE	6174	15778	18655

Table 3. Percentage onion imports in Germany, England and France which originated from Holland

	Germany	England	France
1980	47%	31%	43%
1982	50%	35%	43%
1984	42%	33%	54%
1985	37%	31%	45%

Table 4. Onion production in Holland

Area grown (ha)	Type of crop
12 000 [a]	dry bulb onions
1 000 [b]	sets (first year)
2 000 [b]	sets (second year)
800	silver skin onions
150	shallots

[a] Total production of dry bulb onions is 530,000 tons (2% of world production) with a value of 250 million Dutch guilders

[b] Value is 100 million Dutch guilders

Table 5. Effect of Sumisclex on <u>Allium</u> white rot in Sealand, 1985

	Treatment	Number of plants at start of growing period /(m)	% dead plants during growing period	% bulbs with white rot at harvest	total % dead plants and bulbs with white rot
	drilled onions				
A.	Control	28.1	39.6	43.4	83.0
B.	Sumisclex 4 kg/ha soil treatment	27.9	5.5	5.1	10.6
C.	Sumisclex 4 kg/ha soil treatment + 25 gram/kg seed treatment	26.6	4.4	3.1	7.5
D.	Sumisclex 4 kg/ha soil treatment + 50 gram/kg seed treatment	24.5	2.9	4.4	7.3
E.	Sumisclex 25 gram/kg seed treatment	27.2	20.4	36.9	57.3
F.	Sumisclex 50 gram/kg seed treatment	21.3	6.4	42.2	48.6
	sets (first year)[a]				
G.	Control	12		85.3	
H.	Sumisclex 4 kg/ha soil treatment	319		11.3	
J.	Sumisclex 6 kg/ha soil treatment	322		5.2	
	sets (second year)[a]				
K.	Control	9.5	2.6	36.2	38.8
L.	Sumisclex 4 kg/ha soil treatment	9.8	0.8	12.7	13.5
M.	Sumisclex 4 kg/ha soil treatment + 0.15% Sumisclex dipping	9.8	0.9	3.4	4.3
N.	Sumisclex 0.15% dipping	9.7	0	12.9	12.9

[a] sets: first year - from seed to small bulbs; second year - small bulbs to consumable bulb

SUMISCLEX = PROCYMIDON

Table 6. Effect of Sumisclex on *Allium* white rot in North Holland, 1985

	Treatment	Number of plants at start of growing period /(m)	% dead plants during growing period	% bulbs with white rot at harvest	total % dead plants and bulbs with white rot
	drilled onions				
A.	Control	26	19.7	17.9	37.6
B.	Sumisclex 4 kg/ha soil treatment	24.6	6.1	4.2	10.3
C.	Sumisclex 4 kg/ha soil treatment + 25 gram/kg seed treatment	25.7	10.1	0	10.1
D.	Sumisclex 4 kg/ha soil treatment + 50 gram/kg seed treatment	26.5	5.3	1.4	6.7
E.	Sumisclex 25 gram/kg seed treatment	26.2	8.7	8.3	17.0
F.	Sumisclex 50 gram/kg seed treatment	25.7	7.8	10.2	18.0
	sets (first year)[a]				
G.	Control			35.4	
H.	Sumisclex 4 kg/ha soil treatment			3.4	
J.	Sumisclex 6 kg/ha soil treatment			0.2	
	sets (second year)[a]				
K.	Control	11.6	0.7	29.9	30.6
L.	Sumisclex 4 kg/ha soil treatment	11.8	0.4	4.2	4.6
M.	Sumisclex 4 kg/ha soil treatment + 0.15% Sumisclex dipping	11.8	0	2.9	2.9
N.	Sumisclex 0.15% dipping	12	0	12.9	12.9

[a] sets: first year - from seed to small bulbs; second year - small bulbs to consumable bulb

Table 7. Soil sclerotial populations in summer dry bulb onions, 1985

	Numbers of scelrotia per kg soil			
	Before drilling		After harvest	
Treatment	Sealand	North Holland	Sealand	North Holland
Sumisclex 4 kg/ha soil treatment	84	4	34	1
Sumisclex 4 kg/ha soil treatment+ 25 gram/kg seed treatment	82	6	150	4
Sumisclex 4 kg/ha soil treatment+ 50 gram/kg seed treatment	68	10	24	1
Sumisclex 25 gram/kg seed treatment	82	1	152	2
Sumisclex 50 gram/kg seed treatment	76	16	26	1
Control	72	2	52	8

[a] soil sclerotial analysis: 40 samples from each plot (of 6 m^2) were combined

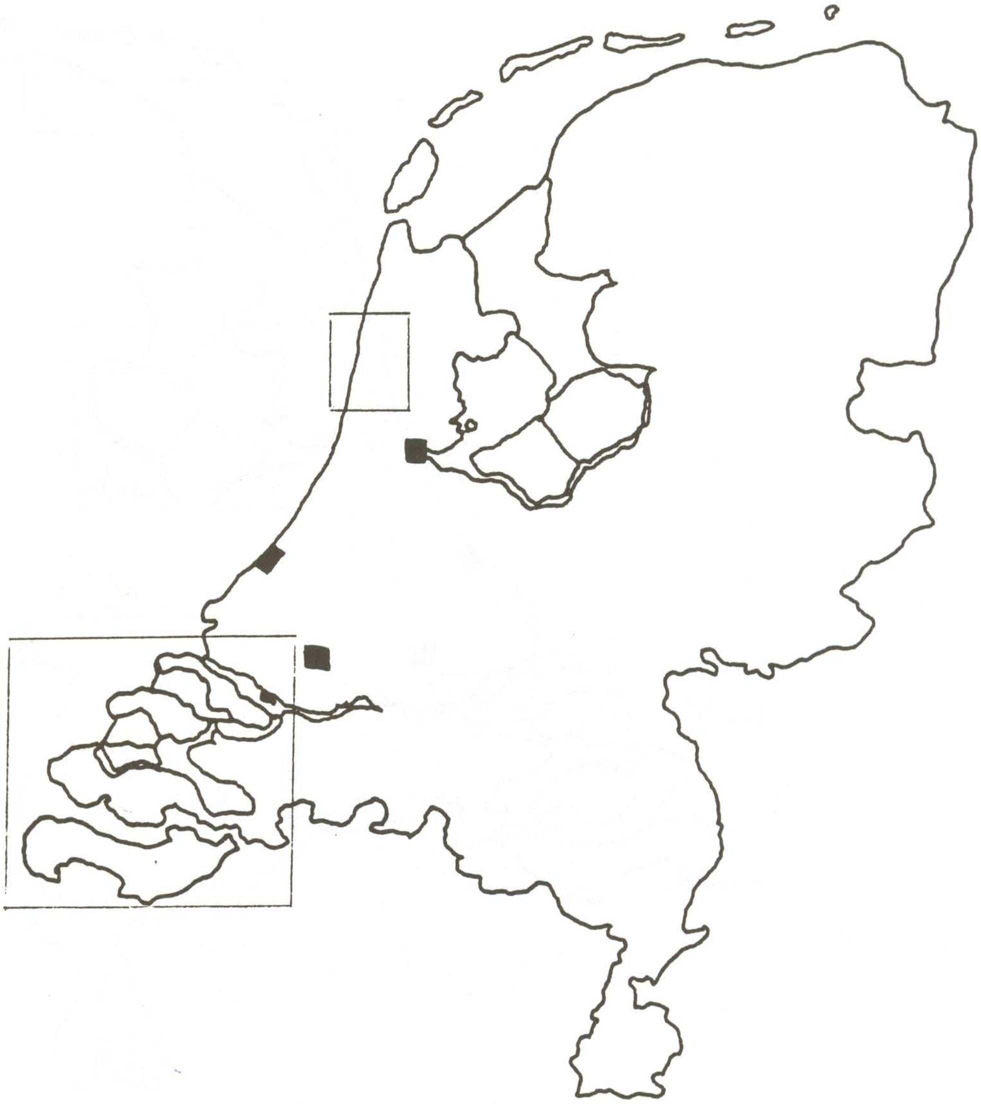
Table 8. Soil sclerotial populations in onion sets, 1985

	Numbers of sclerotia per kg soil			
	Before drilling		After harvest	
Treatment	Sealand	North Holland	Sealand	North Holland
Sumisclex 4 kg/ha soil treatment	126	1	144	4
Sumisclex 6 kg/ha soil treatment	182	1	88	1
Control	120	1	214	522

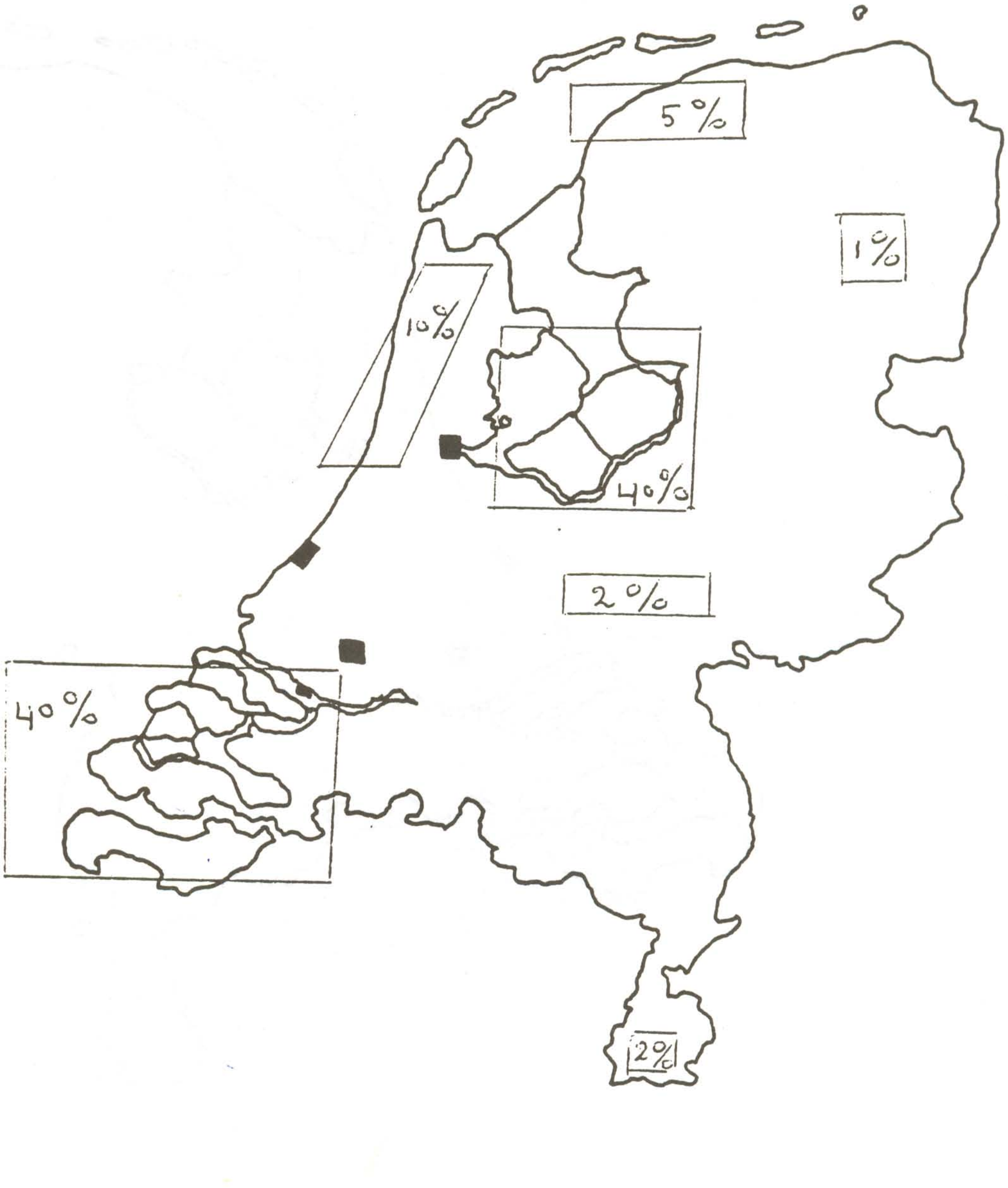
Table 9. Soil sclerotial populations in second year onion sets, 1985

Treatment	Numbers of sclerotia per kg soil			
	Before planting		After harvest	
	Sealand	North Holland	Sealand	North Holland
Sumisclex 4 kg/ha soil treatment	56	2	22	1
Sumisclex 4 kg/ha soil treatment + dipping (0.15%)	88	10	30	1
Sumisclex dipping (0.15%)	36	2	16	8
Control	58	22	92	1

White rot areas in Holland.



Onion areas in Holland.



The Status of White Rot in Onions and Garlic in the States of California, Idaho, Oregon and Washington, U.S.A.

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California is infected with White Rot throughout the entire state. Disease conditions are so severe in the Salinas Valley, one of the principal growing areas, that garlic acreage is being moved to the San Joaquin Valley. The disease is very serious in the Tule Lake and has spread across the boarder to Klamath Falls, Oregon.

In the state of Oregon, the following commercial growing areas are free of disease. Malhuer County in eastern Oregon adjoining Idaho, Hermiston, Gaston, Sherwood, and Medford. Lake Labish, Deaver-Conner, Corvallis, Madras, and Klamath Falls all have infected commercial fields. It is interesting to note that Washington County Commercial field (Gaston and Sherwood) are free of the disease; home gardens in the county have been infected. It was felt that disease was principally introduced from California garlic into Western Oregon. It is speculated that the home garden onions were infected as a result of shipping onion sets from Walla Walla, Washington.

Washington's winter onions raised at Walla Walla have had White rot disease for many years. However, the onions raised in the Columbia basin generally appear to be free of the disease.

It has been interesting to note the progress of the disease in Lake Labish. It started in 1978 in one small field, which was put under quarantine. It has spread inspite of the quarantine, which was lifted in 1985.

Dr Paul Koepsell, Extension Plant Pathologist at Oregon State University, has been the principal researcher in Oregon for White rot. His primary effort has been isolating bacteria, which have biological effect on the disease. To a lesser extent, Dr. Koepsell has accomplished chemical control work with soil fumigants and fungicides.

Methyl bromide + chloropicrin at 200 + 200 lbs. per acre and Vapam (metham) at 75 to 100 gallons per acre have controlled White rot disease in Western Oregon. Rovral (Iprodione) and Ronilan (vinclozolin) fungicides have controlled White rot in onions at 1.5 to 2.0 lbs. ai per acre, in Western Oregon, but with unacceptable phytotoxicity to onions. Reports from Walla Walla area of Washington have stated no phytotoxicity to onions with Rovral at 2.0 lbs. ai per acre.

Distribution of white rot (Sclerotium cepivorum) infestation in the western US

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Well-known infestations. The first identification of Sclerotium cepivorum causing white rot in the United States was from La Grande (Union Co.), Oregon, in 1918, presumably from a non-commercial source. The disease spread through the San Francisco Peninsula southwest through San Mateo Co., Santa Clara Valley and San Benito Co. from 1939 through the 1960's. It appeared in the Walla Walla, Washington, and Milton-Freewater, Oregon, area by 1957 and subsequently intensified in that region. The Tule Lake, California, and Klamath Falls, Oregon, area has become generally infested since white rot was first noted in 1958. The Salinas Valley of California became infested during the 1960's through the 1970's.

Lesser known and new infestations. In California, single field infestations, resulting from disease occurrences in 1975 and 1976, occur in the Sacramento-San Joaquin Valleys in Yolo, Contra Costa, San Joaquin and Fresno Counties. The Yolo Co. infestation at the University of California, Davis, was intentionally developed for research purposes. In Oregon, several fields in Marion, Benton and Linn Counties of the coastal Willamette Valley have been infested for several years resulting from disease in both onions and garlic. One garlic field in central Oregon (Jefferson Co.) was widely infested in 1982. Central Oregon currently grows over 1200 acres of garlic for seed use in California, along with comparable garlic seed acreage in the Willamette Valley. White rot in La Grande in Union County has not been re-reported since 1918; however, there are no commercial Allium crops grown in that county. In Washington, the Yakima Valley area (including Yakima and probably Benton Counties) harbours infested soils, but disease incidence on spring planted onions is slight in this region, thus official reports are generally unavailable. Also, most counties in Washington west of the Cascade mountains have dispersed infestations in non-commercial situations; these also are rarely officially reported. In Nevada, about 1500 acres of garlic for seed (plus 2000-3000 acres of onions) are produced in Lyon Country. Within this area, white rot occurred on garlic near Yearington in 1975-76 and near Smith Valley in 1983. In Idaho, the first confirmed incidences of white rot occurred in 1986 in one commercial onion seed field and two home gardens in the Treasure Valley are around Boise, Idaho, and Ontario, Oregon. This area has one of the largest commercial onion acreages in the US, with annual production on between 15,000-20,000 acreas. There are unconfirmed reports of white rot in this area of Idaho from about 8 and 40 years ago.
In other western states, white rot is not known to occur in Arizona, New Mexico, Colorado, or Utah; but it has occurred in home gardens in Montana.

Allium white rot in the UK, 1984-86

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The areas and values of *Allium* crops in the UK in 1984-86 were as follows:

	1984/85		1985/86	
	ha	£ m	ha	£ m
Salad onions - summer[a] plus overwinter	1514	14.6	1831	17.6
Dry bulbs - summer - overwinter	5293 1139	21.4	6243 1011	21.3
Leeks	2217	16.6	2557	20.8
Garlic[b]	50	0.3	-	-
Shallots[b]	20	0.1	-	-

[a] salad onions - summer and wintered crops no longer distinguished

[b] S Perkins, ADAS cited by Walkey *et al*. (1987)

In 1983-86 there has been increasing concern at the presence of *Allium* white rot (AWR) on dry bulb onion crops in Cambridgeshire and Lincolnshire. Over the past decade there has been an expansion of the onion industry in these areas. The expansion has followed the improvements in the methods of growing and storage resulting from publicly funded research and has been accompanied by private and public investment in equipment and buildings. Onions are being introduced into rotations for the first time and also occurring for the second and third times within the rotation.

In order to evaluate the seriousness of AWR to the onion industry, data is needed on the following:

1. the losses resulting from AWR in the field and in the store
2. the introduction of AWR to 'clean' fields
3. the rate of increase in the incidence and the dissemination of AWR with successive onion rotations

Losses. In autumn 1984, I inspected fifteen fields in Cambridgeshire and Lincolnshire (Entwistle, 1985). AWR was often in patches:-

Pattern of AWR	Number of fields
Severe all over	1
few large patches	8
many scattered patches	4
not surveyed	2

One explanation is that AWR had been introduced to one or two areas in a field. Then, possibly the result of the dispersal of soil by wind or cultivation, the patches became enlarged and were the source of scattered satellite patches.

The patches had a central area in which most of the onions were killed surrounded by an area of less severe infection. Even within patches of severe infection, however, there were areas of healthy onions.

Introduction and dissemination. In about half the fields the occurrence of AWR was attributed to the previous presence of gardens attached to farm cottages or AWR-infected onion debris from packhouses blown there or dumped. The source of AWR in the remaining fields was unknown; one possibility is the movement of soil from infected areas by wind (peat soil), machinery or footwear. Where such dissemination occurred, its presence would be unnoticed until an *Allium* crop was grown.

Effects of rotation on the incidence of AWR. AWR was reported to have increased in one field from 0.5% to 67% in three rotations (13-15 years). In another field, AWR was more severe in the part of a field with a third onion crop compared with the remainder of the field with a second crop only.

There was difficulty obtaining estimates of the rates of AWR increase in other fields due to a lack of previous records. Clearly, there would be an advantage in the routine collection of data of losses due to AWR. Two possibilities are (a) the use of ground survey techniques (Entwistle & Coleman, 1986) and (b) use of remote sensing or aerial photography (Entwistle & Stone, 1986).

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Onion cultivation in Egypt

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Egypt occupied the 5th position in annual average yield of onion in the world the end of 1981 (Table 1). Japan, with an area of 68 000 fedans+ and 16.966 t/fedan, was at that time the world's highest yield producer. In Egypt 8.053 t/fedan of onions were harvested and the total acreage amounted to 34 000 fedans.

Most of the onion growing area is situated in Central and Upper Egypt. The majority of onion is planted during the winter season (Table 2). On the average 11 581 fedans are planted in the summer and 20 790 fedans in the winter (average of 1980 to 1985).

The standard crop rotation consists in the summer of cotton, maize and clover followed by a winter crop of either onions or faba beans (Table 3).

The area, total yield and yield/fedan of onions grown during the winter season is shown in Table 4. The area ranged from 16 383 fedans in 1982 to 26 107 fedans in 1983. The average yield remained constant at 8.4 t/fedan with an exception in 1979, when it was significantly lower.

The main diseases in Egyptian onion cultivation are white rot (Sclerotium cepivorum), neck rot (Botrytis allii), downy mildew (Peronospora destructor) and purple blotch (Alternaria porri). The most important disease is white rot, affecting mainly seed onions during winter cultivation. Adequate crop protection techniques for white rot control are not available, therefore investigations especially in biological control are needed.

+ 1 fedan = 0.42 ha

Table 1: Annual average crop area and yield of onion in the world (1979 - 1981)

Country	Area (1 000 fedans)	Yield (t/fedan)
Japan	68	16.966
USA	112	14.494
Spain	75	12.506
Italy	51	10.214
Egypt	34	8.053
Turkey	167	5.893

Table 2: Summer and winter cultivation of onion in Egypt

Year	Summer (fedans)	Winter (fedans)
1980	12 985	22 192
1981	11 680	18 511
1982	11 395	16 363
1983	10 584	26 107
1984	11 351	19 002
1985	11 491	21 772

Table 3: Crop rotation in Egyptian agriculture

Year	Summer crop	Winter crop
1	maize (Zea mays)	onion/faba bean (Allium cepa/Vicia faba)
2	cotton (Gossypium spp.)	onion/faba bean (Allium cepa/Vicia faba)
3	clover (T. alexandrinum)	clover/onion (T. alexandrinum/A. cepa)

Table 4: Crop area and yield of winter onion in Egypt

Year	Area (fedans)	Yield (t)	Average yield (t/fedan)
1979	23 180	156 957	6.771
1980	22 192	188 306	8.485
1981	18 511	154 235	8.332
1982	16 363	133 001	8.128
1983	26 107	223 910	8.601
1984	19 002	160 315	8.416
1985	21 772	188 785	8.701

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AT J.J. BARKER (SOUTHFLEET) LIMITED
SOUTHFLEET, KENT, UK
(1976 —— 1986)

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ALAN HENSHALL

SECTION 1

INTRODUCTION TO J.J.BARKER

J.J.Barker (Southfleet) Limited farm one thousand acres in the North West region of Kent. This land is split between three separate farms with the largest acreage at Hook Place Farm, Southfleet.

We are growers and pre-packers specialising in vegetable and salad crops which include LETTUCE, RADISH, CABBAGE, GREEN and ONIONS.

SECTION 2

SOIL TYPES

The soil types vary both between and within the three farms. At Southfleet, the soil types include Loamy Clay, Loam and Chalkland. Each soil type influences onion growth and disease development to a different degree leaving us with distinct areas on the farm more prone to white rot than others.

SECTION 3

GROWING ONIONS AT J.J.BARKER

J.J. Barker started farming at Hook Place Farm in 1931, where Harvest Onions were grown along with many other horticultural and agricultural crops. Onion cropping was not intensive at this time and white rot, whilst present, did not cause major problems.

No salad onions were grown on the farm until the late fifties, during which time white rot levels remained constant.

During the late fifties, early sixties, the quantity of onions grown on the farm increased significantly. By the mid sixties J.J.Barker was one of the countries largest producer of salad onions.

The period between 1931 and the latter part of the sixties, saw no chemicals used against white rot in onions. The problem could be tolerated both by the grower and by the consumer, because onions were not grown as intensively as they are today and hence, disease levels were that much lower. However, during the sixties disease levels built up considerably leaving BARKER'S looking for effective methods of control.

SECTION 4

METHODS USED TO LIMIT THE DEVELOPMENT OF WHITE ROT

i. Pre 1976

Prior to 1976 the chemical used to limit white rot development on salad onions was **CALOMEL** (4% $HgCl_2$). This was applied as a seed dressing.

ii. 1976 ——> 1986

During 1976 the development of white rot was limited through the use of **MILDOTHANE** applied as a seed dressing. Formulated as a yellow powder it proved difficult to apply. Initially **MILDOTHANE** was 'stuck' to the seed with wallpaper paste mixed at the farm. This proved an unpleasant practice and so dressing became the responsibility of the seedhouse. However, using **MILDOTHANE DRESSING** produced major problems with the seed flow rate in the drill.

MILDOTHANE was not 100% effective against white rot on J.J.Barker's land. Therefore, **BENLATE** was used as a liquid fungicide against white rot. This had no useful effect against the disease.

By 1978 **IPRODIONE**, marketed as **ROVRAL**, was being used on the farm; initially as a seed dressing. During the first months comparisons were made against the older chemical **CALOMEL**. Whilst both controlled the white rot to a similar extent, **CALOMEL** proved more phyto-toxic and so was discarded in favour of **ROVRAL**. Like **MILDOTHANE**, application of **ROVRAL POWDER** caused a reduction in the seed flow rate especially in wet/humid conditions. However, the chemical gave good control of the disease. The application of **ROVRAL** was greatly improved with the development of the **MICROCOAT SYSTEM**. **ROVRAL** at 50g a.i. per kilo of seed was far more manageable than before, making drilling easier and ensuring a more even coat of chemical to each seed. Before the **MICROCOAT SYSTEM**, ratios of chemical to seed were more variable leading to a greater possibility of white rot attack.

ROVRAL was first presented to the growing crop as a foliar applied spray during 1978. Initially the rate was 18 lb. of formulated **ROVRAL POWDER** per acre applied as an all over spray. However, later on in 1978 the row drenching technique was perfected. This more accurate way of drenching individual onion rows cut the rate down to 3 lb per acre. The rate was further reduced by carrying out two applications of low rate **ROVRAL** drench instead of one high rate.

During the first few years **ROVRAL** controlled white rot effectively when used as a seed coat and a drench. However, by 1981, and especially in 1982, there were positive signs that **ROVRAL** was becoming less and less effective. **RONILAN** then replaced **ROVRAL** as a fungicide drench. At this moment (August 1986) there are no positive signs that *Sclerotium cepivorum* is becoming resistant, or tolerant, to **RONILAN.**

There are two theories as to why **ROVRAL** became less effective as a fungicidal drench. The 'resistance to the chemical' theory is difficult to prove as the exact mode of action of the chemical is unknown. The popular theory at the moment is that of enhanced microbial degradation. Whatever the reason it seems likely that in the future we will see **RONILAN** become less and less effective against the disease.

At J.J.Barker we do not believe that chemicals are the only way to limit the spread of the disease.

It would seem likely that once a field is infected with white rot, the Sclerotia will remain viable for many decades even in the absence of an onion (or related) crop. There is, therefore, a great deal of scope for buying or renting land which has not previously been cropped with onions. The most important factor in this respect is to avoid bringing infected material on to the clean land, either on farm vehicles, implements, or indeed farm workers. If this is allowed to happen, new land quickly becomes infected.

However, by renting land from neighbouring farms and using it for just one crop at a time, the volumes of **DICARBOXIMIDE** chemicals used on the land are relatively small. It might therefore be possible to avoid any microbial degradation.

On paper, this idea of renting land seems to be ideal. However, for Barker's and similar growers, whose onion crops depend entirely on irrigation, the acreage of renting land which is suitable for onion growing but which is also supplied by an irrigation main, is limited.

The most effective method of white rot control, especially on virgin land, must be that of avoiding the introduction of Sclerotia. We should be putting as much thought towards devising practical methods of implement disinfection as we do towards chemical control.

SECTION 5

OUR PERSONAL VIEWS OF ENVIRONMENTAL INFLUENCES ON WHITE ROT

Soil provides the medium in which a crop grows. It, therefore, has a great deal of influence on crop development and hence disease development.

In our opinion, a good loam is the ideal soil medium for onion growth at Barker's. However, the loam must be well structured. This enables good root establishment, optimum salad bulb formation and helps in the lifting of the onions.

Unfortunately not all Barker's land is of this quality, making good onion growing difficult. The flint and stone content is very high and because of the high degree of cultivation needed in an intensive cropping situation, the soil structure is less than optimum. When the soil is wet it lays very heavy. However, in summer when land dries out, the water table drops considerably.

All these factors, both in conjunction and singularly, produce stress, and when the onion is stressed white rot will develop.

Consequently, it is very important to keep a crop growing right from emergence through to lifting. If crop growth is halted at any time white rot will develop. If possible, it is wise to avoid growing onions on those flinty/chalky structureless soils. If a crop is grown in such a situation white rot problems will almost certainly develop.

However, in instances such as these, we have some control over conditions. We can avoid bad fields or at least try and re-structure the soil through correct land management. Greater white rot problems occur as a result of those conditions we find harder to manage.

Water plays a critical role in white rot control. A growing crop of onions must never be allowed to dry out. Even surface drying as a result of wind is conducive to white rot development, hence the need for irrigation. Although it is important that a crop should never come under water stress, we have found that the final 6 weeks of a crop's life are the most important in terms of white rot and water stress.

Whilst white rot is by no means a consistent disease, we have found that it appears to develop each year as the overwintered crop enters spring. We again attribute this to stress. After the winter the soil is compacted, its structure is less than optimum resulting in low porosity. In those conditions it is difficult to keep the crop growing consistently and hence white rot invariably occurs.

One other possibility as to why those crops just entering the spring are more prone to white rot, could be linked to biological control. I have no doubt that there are organisms in the soil that reduce sclerotial number and mycelial density through saprophytic action or other methods. Knowing that the sclerotia of Sclerotium cepivorum are very hardy it is possible that whilst the winter has depleted the sclerotial parasite level, sclerotia are left unharmed and can consequently germinate in large numbers. This is of course pure speculation, however, there is certainly scope for a lot more research into biological control of the disease.

The relationship of white rot development to the temperature changes seen on the farm is not so clear. The high levels of the disease normally seen in March and April could be attributed to temperature changes but we have no definite indication of the optimum temperatures for the disease.

SECTION 6

POSSIBLE METHODS TO LIMIT THE DEVELOPMENT OF WHITE ROT IN THE FUTURE

As previously established, one method of limiting the development of the disease is to keep the onion growing. It would seem sensible then to look at the fertilizer regimes.

If handled sensibly, there is a great deal of scope for slow release fertilizers put down as a base dressing. This should provide the onions with a constant supply of N.P.K. throughout the growing season rather than one large fertilizer dose at the beginning of a crop's life.

The top dressing used should complement the base dressing whilst at the same time not producing the soft foliage that encourages the disease.

These poorly structured soils with which we have difficulty, can be rejuvenated by careful management. We have found it very beneficial to grow cereal break crops in order to incorporate the straw which will build up levels of organic matter in the soil.

It is also possible that we will experiment with FARM YARD MANURE both to improve the organic matter levels and to assess its potential as a direct method of white rot control.

As mentioned before, the need for the development of a practical method of farm vehicular hygiene is of paramount importance.

In terms of chemical control, there now seems to be great interest in **BASAMID**. In conjunction with the local contract chemical company, we have laid down our own **BASAMID** trial. Briefly the comparison was between the standard **RONILAN/ROVRAL** approach and **BASAMID** used both with, and without, polythene sheeting.

An analysis which included assessing each treatment (200 yds x 2 yds) very thoroughly, showed that whilst white rot was kept to a minimum using **RONILAN/ROVRAL**, there was as much white rot in the **BASAMID** treated beds as in the untreated beds. **BASAMID** gave benefits in weed control and onion quality but not in white rot control. We are, however, continuing the trial over winter and will no doubt learn more next spring.

RONILAN is still a viable chemical. We see clearly how effective it is through leaving (albeit by mistake) untreated areas. How long it is before this chemical is brought to the same stage as **ROVRAL** is unclear. However, I am unfortunately pessimistic.

Perhaps in the future, treatment of white rot in onions will lie with biological control. The use of parasitic organisms can only be beneficial both in terms of combatting Sclerotial resistance and avoiding pesticide toxicities.

COEXISTENCE OF GARLIC WHITE ROT WITH COMMERCIAL PRODUCTION IN CENTRAL MEXICO

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Onion, *Allium cepa* and garlic, *A. sativum* are very popular crops in México. They have been incorporated into traditional cuisine for a long time and are widely used throughout the social and economic strata of México. Onions are produced year round whereas garlic is harvested only during the winter and spring, from late December to June.

1. Onion Production in México and White Rot Relevance.

As a consequence of the tropical latitude of México only short day onions are grown. Sweet white Bermuda types are the local favorites with the exception of Sinaloa in the northwest and Yucatán in the southeast where red cultivars are predominant. Most of the limited yellow onion production is exported to the US during winter along with a considerable volume of whites from Morelos, Guanajuato and Tamaulipas, the leading producing states in winter time. Chihuahua is an important producer during the summer.

Most onion production is under irrigation with the exception of a summer crop at Guanajuato, in the Bajío region, which is entirely dependent upon rainfall and where onion sets are used for establishing the crop in the field. Direct seeding at Tamaulipas and Chihuahua, and transplants at Morelos and Guanajuato, are the standard growing techniques. Furrow irrigation is the predominant system with the exception of Tampico in southern Tamaulipas, where sprinklers are used and water is delivered from reservoirs that are filled during the stormy rainy season.

México is a net exporter of onions and because of year-round production, fresh onions for domestic consumption are always available. Long term storage is unknown and unnecesary. Guanajuato, in the Bajío region, produces onions every month, but shares the large national market with the seasonal production of other leading states. Overproduction or loss of the crop in a particular region explains the large fluctuations in prices that traditionally characterise onion marketing in México. Plow-under because of low price alternates with sky-rocketing prices from extreme situations, but on the average onions have been a good cash crop.

Purple Blotch, *Alternaria porri* and Downy Mildew, *Peronospora destructor* are the main commercial diseases. Pink root, *Pyrenochaeta terrestris* is found almost everywhere, but seldom results in economic losses. White rot, *Sclerotium cepivorum* has been found occasionally at the Bajío region but does not represent, at least for this time, a commercial problem. Even though onion is far more important than garlic, this presentation will refer exclusively to White Rot in garlic.

2. Garlic Production.

In contrast with onion which is grown throughout México, garlic production is restricted to the Bajío and portions of the Central Plateau. The Bajío, with parts of Querétaro and Guanajuato states, at the central part of the country has a long harvesting period from December to May, whereas the late harvest of June and July concentrates in Aguascalientes and Zacatecas in the Central Plateau Region. Limited commercial production occurs in some other parts of the country, but is devoted mostly to local markets and has no impact on the overall production.

Within the Bajío region, Guanajuato is the leading producer with an annual acreage that has fluctuated from 6000 to 3000 ha per season. This is usually about 50% of the national acreage but represents well above 60% of the total exports. This area traditionally obtains the highest yields and best export quality. Also some out of state production is processed and exported from Guanajuato packing houses. Pink chileno types are shipped early in the season, from February to May, whereas white types predominate late in the season, from May to July.

Cultural practices are similar to those in California. Standard 40" beds, two rows per bed and furrow irrigation are the standard procedures. Planting is done by hand only in small operations. Large acreages are machine planted with pre-sized cloves previously treated for nematode control. Depending on "seed" size, from 600 to 1300 kg/ha are used. The best yields and emergence are obtained with large cloves. Twenty to 22 plants per meter in the row is the recommended population. About 40 or more plants per square meter represent a very good stand. High yields are obtained only with high plant populations, ample supply of chemical fertilizers and a uniform moisture availability. A common local zinc deficiency is overcome by adding granular zinc at planting time and two or three additional foliar applications. Thrips are the most common insects. Good control of pests and diseases is mandatory.

The two main types of garlic grown are pink and white. To describe the main different cultivars becomes complicated by the fact that every grower is very protective of his own "strain", and although the same type, they may differ considerably in certain aspects, mostly in plant vigour and size and appearence of the bulb. The small, early pink with more than 20 cloves per bulb are "Creole" type, and is used exclusively for local consumption, whereas the typical pink "Chileno" is characterized by large individual cloves, usually from 8 to 14 per bulb, having a beautiful smooth outer appearence. "Creole" may be harvested in about 150 days, whereas "Chileno" requires from 165 to 180. The white cultivars are late maturing and are grown in the cooler climates of Zacatecas and Aguascalientes and the northern part of Guanajuato where the valleys are 2000m above sea level, in contrast with the 1600 to 1700m average altitude of the "Bajío", hence its name (Bajío = low land). Yield averages of "Chileno" types run from 7 to 11 t/ha, whereas whites may reach 18 to 20 t/ha with 14 t/ha being a good average.

At harvest, plants are pulled by hand after a tractor with a special knife has loosened them from the soil. Windrows are formed along the rows taking special care to protect the bulbs from the sun. After 6-8 days roots and foliage are hand clipped and the bulbs moved to the packing house. Cleaning, additional drying and size separation take place before the final selection and mechanical packing into common marketing grades and sizes. The same size is often referred by different names in the international market, so labelling is performed according to the final destination. Bulbs not meeting the high standards of the export market are further reclassified and used for local consumption or industrial purposes.

Diseases and Nematodes. Purple blotch, *Alternaria porri*, is a major problem during rainy winters which may occur every 4 or 5 years. Frequent fungicide treatments have to be applied in order to save the crop. Yield reduction and small size bulbs are common in such years. By contrast there are some years, like the 85-86 season, where many commercial fields did not received a single fungicide application and no damage was recorded. Nematodes, moslty *Ditylenchus dipsaci*, have been the major problem for many years. Succesful growers have been treating "seed" since the 60's with California's method using hot water, and formaldehyde. Commercial nematicides, like Nemacur, have been succesfully utilised by small farmers who do not have seed treatment facilities. Field applications of nematicides are also utilized if plant infestations are localised. Nematodes are such a serious problem that no commercial production is conceived without seed treatment, chemical control or a combination of both. In spite of their importance, nematodes are satisfactorily controlled if recommended practices are followed. Some other minor diseases are occasionally present and although they may produce commercial losses, they are not as serious as nematodes or, in a rainy season, Alternaria. A complete guide for commercial production is available (Heredia, 1985).

3. White Rot.

Contributions of the Bajio Center for Agricultural Research (CIAB).

Altough onion and garlic have been grown at the Bajio for a number of years, White Rot *Sclerotium cepivorum* was unknown before 1975, when a commercial field with substantial loss from White Rot was detected. A brief summary up to 1986 of the combined efforts of research personnel of the Bajio Center of Agricultural Research (Centro de Investigaciones Agrícolas del Bajío, CIAB), deserves special recognition. Thru their efforts we are well acquainted with the problem and able to launch a diversity of cultural practices to try to control the spread of this disease. I feel especially obliged because there are no published reports of their results. Adalberto Heredia, garlic specialist, initiated the research while screening some fungicides and evaluating the commercial damage in the first reported affected field. Later he was joined by Dr. Eliseo Redondo, plant pathologist, who eventually directed the program until his transfer to another position in 1985. He outlined a general project, that to this date remains with no susbstantial change. A critical advance of the program was provided by the contribution of Arturo Hernández Paniagua who devoted full time to this project for more than two years until his premature death. Teresa De Jesús Castillo assumed full responsability of Arturo's experiments and is currently in charge of the project. Marcos Huitzache Gómez, a technician, has been integrated into the project since its inception, and his contributions cannot be minimized. José A. Garzón, after Dr. Redondo departure, has played a substantial role both as a plant pathologist and as an administrator. All references made about CIAB results come from this team of young and enthusiastic investigators.

For the last three years the project has been a joint venture between CIAB personnel and the Garlic Section of the National Union of Vegetable Producers (Unión Nacional de Productores de Hortalizas, UNPH) who are fully financing the project. A key factor for the rapid commercial application of preliminary results has been the monthly meetings with the Garlic Technical Commitee where growers and researchers freely interchange ideas and experiences. The contributions in this regard of both, Gerard Lemaire Sr. and Jr. have been outstanding.

To this date the published results of CIAB are restricted to two brief annual reports addressed to the growers, where no information is provided about the experimental designs, plot size, detailed results or recommendations. The author has been working closely with the group since the begining, and has reviewed the experimental data and a number of their field observations and preliminary results. Unfortunately permission was not granted by CIAB to use or quote from their field notes and laboratory results for this report. For this reason valuable experimental field and laboratory data obtained in the last two years from CIAB, is regrettable omitted here. Hopefully CIAB personnel will publish them in the near future. In addition to the topics included in this report, their research projects cover also Biological Control, Field Flooding and Genetic Resistance. Requests for such information should be addressed to: Coordinador Regional, Campo Agricola Experimental Bajío, CIAB, Apdo. Postal 112, Celaya, Gto. 38000, México.

My account is based on the scarsity of published information by CIAB, the field plots with cooperative growers and mostly on my personal interpretation of the daily advances of CIAB scientists and how their partial results could be integrated and immediately implemented on a commercial scale at "Empacadora

Grupo Agricultores del Bajío, (GAB)", a grower's and exporter's cooperative. This was possible only by the aggressive field production policies of Javier Usabiaga, its General Director who decided also to share openly our experiences, because if doing so, the competitors may control efficiently the disease, and every garlic grower, including ourselves, will benefit.

4. Origin of *Sclerotium cepivorum* at Bajío.

Sclerotium cepivorum is an extremely efficient pathogen (Adams and Papavizas, 1971, Crowe and Hall, 1980) remaing viable in the ground for a long time and capable of violent population explosion under proper conditions. Crowe et al., (1980) reported a 1000 to 10 000 fold increase of sclerotia in the field under the proper growing conditions during a six month period. They found that a population as low as one sclerotia per kilogram of soil before the emergence of garlic could produce 10% diseased plants at harvest time.

Commercial garlic production in the Bajío has been common since the turn of the century. Since the first report of White Rot was in the 70's, it is safe to assume that it has been recently introduced in the region. A parallel situation was present in the USA in the 20's where the first reports were published. This was twenty years after White Rot had been a serious commercial problem in onion and garlic in Europe. Infested garlic importations were suggested by Walker (1924) to be "undobtedly the one by which introduction of the disease into our soils from abroad is most likely". Sixty years later the same dictum could be true in México.

For many years Chileno was the only pink exporting cultivar grown in the Bajío. From time to time growers introduce different cultivars and compare them with their local strains. In the 70's different pink strains from Taiwan were tried by some growers. This early high yielding, but poor quality garlic was planted for two consecutive years in the commercial field where White Rot was first reported. Since the mid 70's there has been a continous increase in the number of affected fields. Complete losses of five to ten hectare fields have been common since 1980. Because this was a new disease in the region, most growers did not pay attention until it was too late and severe losses had occurred. In a very short period of time the disease has contaminated a large area and was observed with most garlic growers. The large number of growers that submitted White Rot garlic samples to CIAB during the 84-85 and 85-86 seasons, is a good index of the novelty and wide spread dissemination of the disease. It will be very difficult to pinpoint how the disease became established, and perhaps more than one source of contamination occurred. The most likely mechanism was a contaminated "seed" lot. It should be remember that small amounts of different strains or garlic types are imported from various sources by the growers. To suggest that the "Taiwan" strain is responsible of the White Rot introduction, falls in a very speculative field based on the fact, that it could be a coincidence, that both appeared and spread about the same time.

Once the disease was positively identified and the magnitude of its economic damage assessed, a systematic research effort was launched by CIAB with a special grant from the Garlic Section of the Unión Nacional de Productores de Hortalizas (UNPH), which has been fully supporting the White Rot Projects. The information found in the "Proceedings of the II International Workshop of White Rot" provided us, at that critical time, the most variable and up-to-date research efforts of the leading White Rot specialists.

5. Integrated Approach to Control White Rot in Commercial Garlic Production.

5.1. Life Cycle.

In the different stages of the life cycle of *S. cepivorum* (Sommerville, 1984), has been suggested that within a single season, mycellium "root to root" infection may be the main dispersal mechanism of the pathogen, and a likely explanation of the exponential increase of its population (Crowe and Hall, 1980). The framework for postulating the following integrated approach, is the life cycle of *S. cepivorum* (Figure 1), where every "link" of the "chain" may be susceptible to some control. On basis of our field results of rouging (see corresponding section), an important dissemination cycle during the same growing season could occur by sclerotia dispersal from diseased plants, followed by an immediate secondary infection to the surronding healthy plants. In the schematic life cycle of Figure 1, this is noted by a dashed line, as "secondary cycle (s) during same season".

It is apparent now that there is not a single cure for White Rot. A sequence of the different approaches has been arranged in the seasonal events of a commercial production. Some of the suggestions are somewhat speculative and may be modified when more sound research data will be obtained. From the

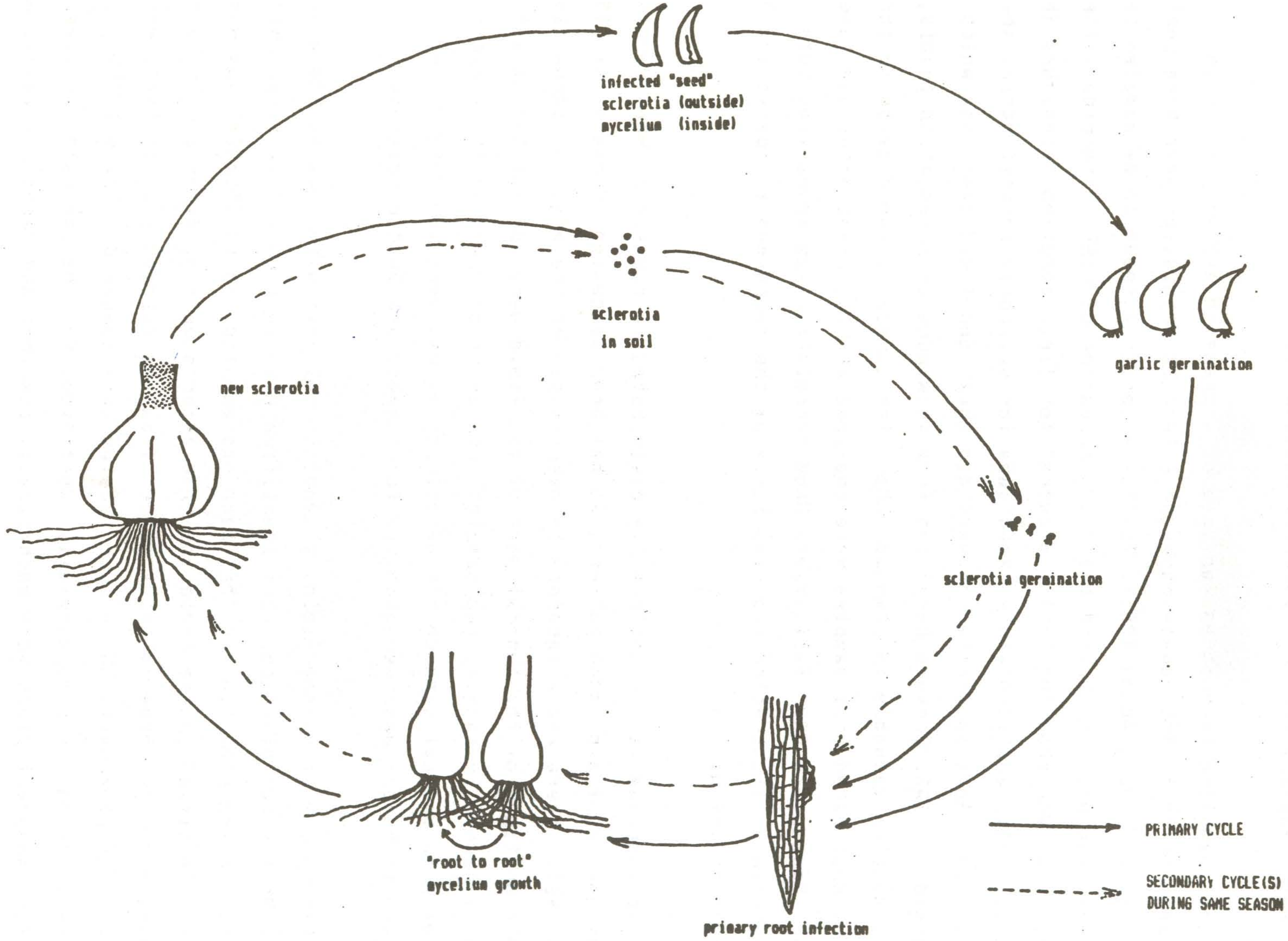

FIGURE 1. LIFE CYCLE OF *Sclerotium cepivorum* IN GARLIC. (Modified from Sommerville, 1984)

commercial production point of view, these are the best choices we have available.

5.2. Field Sampling for Soil Inoculum Assessment.

Soil sampling techniques for sclerotia presence are well known and some estimates of White Rot damage based on sclerotia population have been published (Crowe et al. 1980, Adams 1981). The large garlic acreage to be sampled before planting time was well beyond the human resources of CIAB. Accordingly they organized a "Workshop for Garlic Growers" for field sampling techniques (based on Adams, 1981) and laboratory techniques for sclerotia identification (based on Adams, 1979). Some interested growers did their own field samplings which were processed at CIAB. Growers benefited from knowledge of infestation levels, and CIAB assembled valuable information about the spread of the disease in the region. Replicated soil samples were analized at CIAB plant pathology laboratory and at "Empacadora GAB" facilities. Good correlation was found from both laboratories, illustrating the simplicity of the technique for personnel with no previous training.

The inoculum is not uniformally distributed in the field. When sampling in the diagonals of a diamond pattern, as has been suggested (Crowe et al. 1980, Adams 1981), there was a tendency to over-sample at the edges of large fields, whereas portions of the central part of the field were not sampled at all. In spite of carefully tagging the samples, pin pointing areas in the field from samples with unusual high counts of sclerotia, was very inaccurate. Soil sampling technique was then modified for "Empacadora GAB" conditions.

With a sketch of the field, a hypothetical grid with squares 50m wide was drawn. Horizontal divisions were identified with letters and vertical ones with numbers, so the plot "1A" or "5F" each represented 1/4 ha (50x50m) and was readily identified in the field any time after sampling. After a hole 20 cm deep was dug, a two or three cm thick slice, from the exposed soil profile, was taken with a straight shovel. Three such samples were combined to give a 500 g sample for every 1/4 ha and were carefully identified. For the laboratory analysis 100 g of four adjacent plots were mechanically combined and carefully tagged where a consecutive number and specific field were clearly labeled. The remaining 400 g of the original sample were kept in a dry storage room. When laboratory results showed high sclerotia populations from any combined sample representing one hectare, a duplicated analysis was performed using the four original samples. This was practiced only in those fields showing an uneven population distribution of sclerotia. Precise localization of small infested areas whithin a large field is readilly possible with this method. Particular spots so identified, showed a remarkable correlation of early diseased areas with those with high sclerotia counts (one or more sclerotia / 50g of dry soil).

5.3. Seed Treatment.

Commercial garlic seed has been traditionaly treated with hot water and a one percent formaldehyde concentration for nematode control. One of the conclusive results of Arturo Hernández Paniagua was to find sclerotia (outside) and micelia (inside) the clove. He was able to isolate *S. cepivorum* from bulbs and cloves being prepared for "seed" purposes. *In vitro* results showed a high sensitivity of the fungus to formaldehyde. Seed viability was not affected under laboratory conditions, using up to 10% formaldehyde, whereas the fungus was severely arrested in its development in the range of 3 to 5%. Therefore an increase from 1% to 3% formaldehyde, in the normal nematode seed treatment, is being performed with no apparent harmfull effects to the seeds.

5.4. Use of Clean Seed.

Every effort should be done to prevent the dispersal of the pathogen to clean fields. Seed from infected fields is very likely an efficient dispersal mechanism. Special care is taken to use only seed from fields that were 100% White Rot free.

Theoretically a "disease free" seed lot may be contaminated at the nematode treatment facility. Since in the region there are but a few facilities for the common hot water treatment of the seeds for nematode control, an additional source of contamination could come from treating unknown seed from other growers. Some growers have already restricted the use of their facilities to avoid this potential source of contamination. However this dispersal mechanism has not been conclusively proved.

5.5. Chemical Fungicides at Planting Time.

Contradictory local results have occurred with fungicides applied at planting time. There have been promising results, (Johnston 1980), with various chemicals, particularly Ronilan and Rovral. During the 85-86 season all "Empacadora GAB" fields for seed production were fungicide treated at the recommended commercial rates. In-furrow sprays have been done at the time of seeding. This practice requires a careful evaluation before a general recommendation can be drawn for the commercial fields, due to the high cost of treatment. We must realize that we are in a transitional period, learning how to coexist with an unwanted and new guest. If clean seed is planted in sclerotia-free fields, fungicide application at planting time certainly will not be further needed.

5.6. Field Roguing

Discarding "off type" plants is a common practice in any crop to be used as seed and garlic is not without exception. It has been common since the appearance of White Rot to rogue out any suspicious plant. During the 85-86 season all fields of "Empacadora GAB", including those for commercial production, were constantly screened for diseased plants. Special training was provided in every farm and it is so simple, that in less than three hours experienced farm workers learned to distinguish plants showing the typical early yellowing symptoms. The diseased plants are pulled, placed in bags, taken to a non agricultural portion of the farm and burned.

Crowe and Hall (1980), showed how the mycelium spreads from plant to plant 2-4 cm below the stem plate where roots grow laterally and root density is higher. This is an exact description under our field conditions where first symptoms coincide with clove differentiation and bulb enlargement. When a plant showing the early yellowing symptons is surrounded by healthy looking plants, a vigorous mycelium growth is usually already stretching to the roots of the "healthy" plants. We learned, the hard way, how ineffective it can be to rouge out only the advanced diseased plants.

In a particular field if dead plants occur in an area of 5 m diameter or larger, the crew has been doing a poor rouging job. Our roguing teams were set up to take further advantage of the high sensitivity of the fungus to fungicides and formaldehyde. Two men pulled diseased plants whereas the third sprayed a 10% formaldehyde solution or Ronilan or Rovral on the bare soil from where the plants had been pulled. To evaluate the usefulness of this operation, CIAB personnel collected soil samples from areas from which the plants had been pulled out the ground and treated with Rovral, Ronilan or Formaldehyde but the results are preliminary and inconclusive. The evaluation included the percent sclerotia germination at different soil depths. To our surprise instead of thousands, sclerotia found were hardly sufficient for their germination tests. Subsequent samples gave similar results. It was realized that when pulling plants showing early symptoms, they present a vigorous mycelium and all sclerotia are so embeded in the garlic that almost none are left in the field excluding any further population build-up of the pathogen. Also by pulling the last adjacent "healthy" plant from a diseased area, the main dispersal mechanisms of the fungus, namely sclerotia movement and mycelium root growth, are supressed. If the plant is already dead, a large portion of it remains in the soil including the mature sclerotia ready to be disseminated by cultural operations and irrigation flow.

While lacking statistical data to support this assertion, we are confident that something similar should be happening on the basis of our commercial field experience. Roguing training and instructions were the same in all farms of "Empacadora GAB". Human variation among the foremen of the different farms, produced results that could be equated with a planned experiment where treatments ranged from a "high dose roguing" in which every plant presenting the slightest symptom of the disease was pulled out at a regular three or four day interval, to another "low dose roguing" where only totally dead plants were pulled out every two weeks, immediately before irrigation. Interesting results were obtained. In the field where careful roguing was done, only isolated spots, never larger than 10m², were found up to harvest time. In the fields where poor roguing was performed, several diseased areas of 1/4 to 1/2 ha each, were evident at harvest time. A bamboo stick was placed in every location where a diseased plant was pulled out, so it can be certain that the "high dose roguing" field had plenty of initial diseased loci because the large number of sticks at harvest time. In the remaining farms "intermediate" treatments were practiced and correlated nicely with the two mentioned extremes.

5.7. Solarization.

Soil solarization, or the use of plastics for rising the soil temperature for control of several plant pathogens and pests, has been recently reviewed (Stapleton and DeVay 1986), and some major pathogens of garlic have been succesfully controlled with thin (less than 50mu), clear plastic to soil depths of approximately 1m. Preliminary results of CIAB have been reported (Castillo-Lopez and Huitzache 1986) and are in agreement with the literature. Black plastic increases the temperature, but clear plastic does a better job. To ascertain the temperature effect to *S. cepivorum*, CIAB personnel run germination tests of sclerotia at different depths. Germination was drastically reduced after three months solarization. Check plots had a constant 90 to 100% germination whereas after 4 months of solarization under black plastic, germination was reduced to 60%. In sharp contrast it was found that after two or three months with clear plastic, a range of only 20-30% germination was obtained at either 0-5, 5-10 or 10-20 cm soil sample depth.

The potential use of clear plastic for partial control of *S. cepivorum* is further enhanced when learned that, in the clear plastic treatment, CIAB personnel had trouble finding enough sclerotia for the germination tests. A closer look showed them that a number of sclerotia debris were present. A possibility exists that solarization not only lowers the germination percent of the fungus, but also partially destroys their highly resistant sclerotia. A number of tests are under way by CIAB to collect additional information.

In commercial practice we are combining the roguing and solarization results in such a way that if an affected field presents areas of dead plants larger than 20 m², we isolate the spot from any further irrigation and cover it with clear plastic. Under our conditions this will happen anytime between January to early March, and at the northern part of the state from mid March to early May. To our advantage, this coincides with the highest solar irradiation of the year. The obvious practical and economical implications of this approach demands further supporting data.

5.8. Cleaning Farm Equipment.

For a long time farm machinery movement has been suggested as one of the main dispersal mechanisms of soil pathogens. Movement of specialized equipment from farm to farm is unavoidable, so a standard practice has been to fumigate, with 10% formaldehyde solution, all farm equipment moving from a reported diseased field even whithin the same farm. This is much easier to say than to accomplish, but some progress has been made at least when the equipment is moved to a different farm.

6. Conclusion.

A parallel effort of trial and error from partial results of a research project and the practical implementation by commercial growers, lead us to a multi-faceted approach, aimed to minimize the dispersal of the pathogen in the region and to reduce the commercial damage in the affected fields. A practical commercial procedure is tentatively formulated to control the damage and dispersion of White Rot of garlic in the Bajío area in México. Control measures as related with the life cycle of *S. cepivorum* are presented in Figure 2. and a practical implementation of the integrated approach is summarized in Table 1.

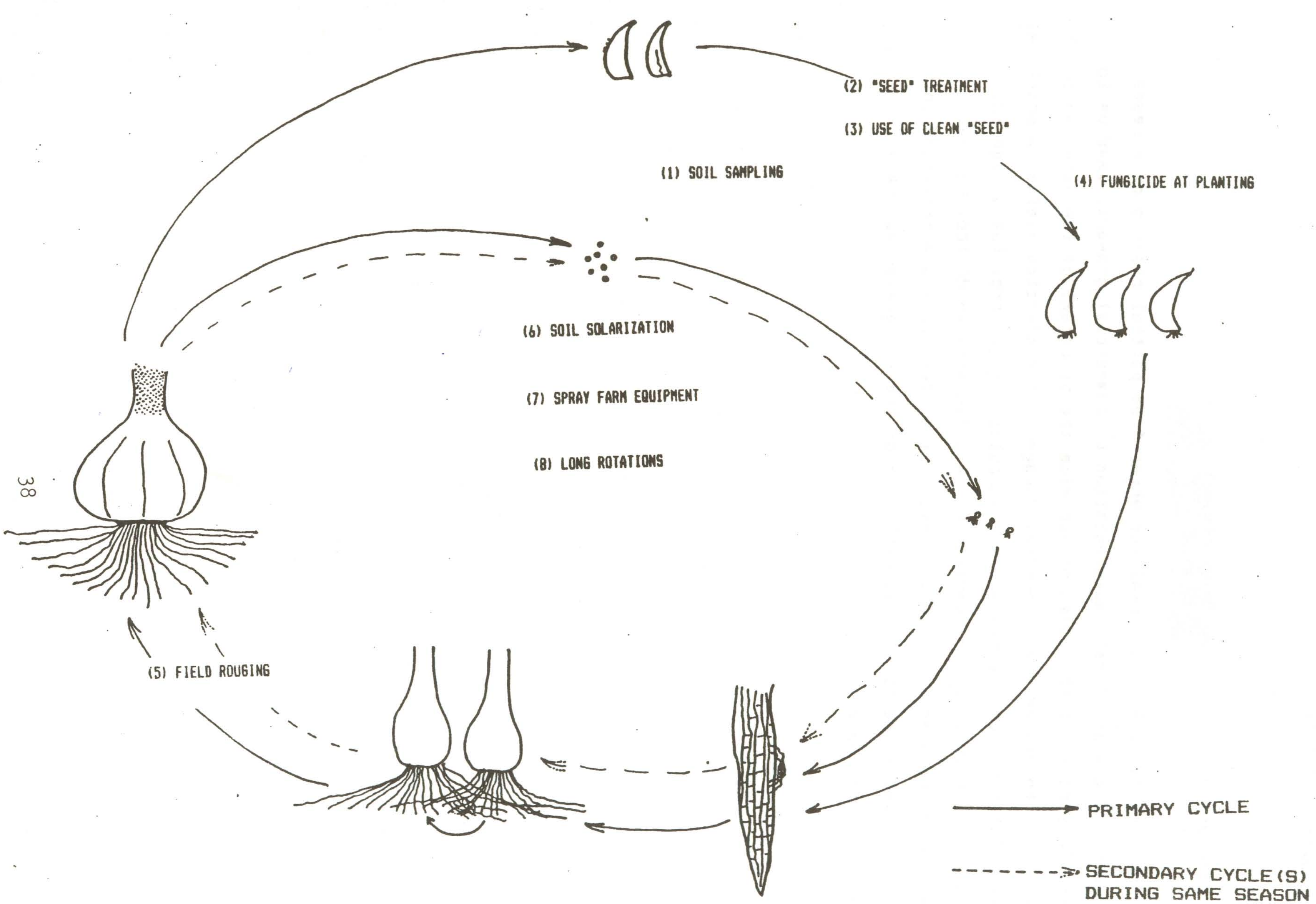

FIGURE 2. INTEGRATED CONTROL OF WHITE ROT IN GARLIC.

Table 1.

Summary of an Integrated Control Program for *S. cepivorum* in Commercial Garlic Production in Central México.

PRELIMINARY OR CONFIRMED RESULTS	IMPLEMENTATION
1. High correlation of soil sampling for sclerotia presence with commercial damage.	1. Soil sampling fields previously planted to garlic or onion from April to July with new technique.
2. "Seed" dispersal by sclerotia (outside) or mycelium (inside). Possible "seed" lot contamination when treating for nematode.	2. Use garlic "seed" only from 100% disease free fields. Suspend contract operations for nematode "seed" treatment of unknown origin.
3. High sensitivity of fungus to 3-10% formaldehyde. Viability of seed not affected by 10%.	3. Nematode treatment. Increase traditional formaldehyde from 1 to 3%.
4. Commercial fungicides give extra protection at planting. (Rovral?, Ronilan?, others?)	4. Fungicide application at planting to all fields for "seed" production. Requires further results for wider implementation.
5. Sclerotia dispersal greately reduced by early and constant roguing. Formaldehyde at bare ground may give extra help. Mycelium grows from root to root.	5. Constant roguing of plants showing early symptoms. Pulling out "healthy" plants adjacent to the diseased spot. Spray bare soil with 10% formaldehyde.
6. Three month solarization with clear plastic reduces population and % sclerotia germination. Results are preliminary but promising. Extra data required.	6. Cover soil with clear plastic for three months to areas of dead plants larger than 5-10 m diameter. Avoid passing irrigation water thru diseased areas.
7. Farm machinery is another dispersal mechanism.	7. Spray 10% formaldehyde on any equipment moving from an infected field. Mandatory if moving to a different farm.
8. Onion and garlic fields may have low sclerotia population and could be potential problem.	8. Rotate onion or garlic fields not less than 4 years. Longer if possible.

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Allium White Rot in New York State, USA:
The Present Situation

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Yellow globe onions are grown annually on approximately 14,000 acres of organic soil in New York. The onions are mostly direct seeded in the spring and harvested in late summer and early fall. Approximately half of the production acreage is in Orange County (Southeastern New York) and the remainder divided between Central and Western New York. The production region in Orange County is mostly one large area of contiguous farms. It is the only region of the state where the white rot disease of onion is known to have occurred to the present time.

White rot has occurred in Orange County for at least the past 26 years. The disease has appeared annually on one 10 acre onion field (Kowal) and except for some slight infestations into adjacent fields (same grower) there has been no significant spread of the pathogen. The disease has never caused anything more than very slight thinning of the plant stand. The only other confirmed outbreak of white rot in Orange County occurred in an onion field approximately 2 miles from the Kowal field. Since 1981, when the disease was last seen there, the field has been planted to lettuce, carrots, and parsley.

At the Kowal field, homegrown early yellow globe seed (18 seeds/ft) is planted in early April and the white rot symptoms generally occur in early June when onions have 3-5 leaves. The symptoms that first appear are very similar to those of onion maggot damage. Without pulling up roots for closer examination, white rot could easily be mistaken for onion maggot damage. The disease affects clumps of newly emerging onions that are spaced very close together. By July, healthy onion plants no longer become affected by the disease.

The organic soil pH in the Kowal field ranges from 5.5-5.9 and 80-1000 lbs of 10-20-20 fertilizer is applied each spring. Cu was applied every year for many years until a soil test return indicated the Cu level was very high. At present, 3 qts of Lorsban/acre are used in the seed furrow for onion maggot control along with 2.5 qts of Dithane FZ for onion smut control. During 1986, 1 lb/acre Topsin-M was used in the seed furrow with no apparent control of white rot.

The field has been kept very clean of weeds with hand labor. Normal herbicide applications include 3 qts Randox and 3 qts IPC usually applied approximately 5/1. One or two sprays of Goal will follow within 2-3 weeks of the Randox application. In past years, 15 lbs of granular Randox was banded over the onions twice. The rows next to the ditchbanks would receive more Randox. Since Randox granular supplies have been dwindling, Randox has not been applied for the last 2 years.

At harvest in late July or early August, infected onions have either already dried up and blown away, or are blown out the back of the harvester. The rest are either removed by the brushes or go down the pickle chute.

As part of the sanitation program, the grower brushes soil from the field from his equipment and storage boxes. He occassionally hoses them with water. Stricter sanitation or quarantine measures have not been imposed on this field.

There is some evidence that the Sclerotium cepivorum in the field may be parasitized by the fungus Trichoderma.

THE PHYTOPATHOLOGICAL SITUATION IN ONIONS IN THE FEDERAL REPUBLIC OF GERMANY

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Based on a questionnaire which I have send out to the plant protection offices in the various onion growing regions I would like to give you a short spotlight on the present situation in our country.

Acreage and yield

At the moment we have an onion acreage of approximately 2400 hectares, 58 % summer onions and 42 % autumn sown winter onions.
Compared with the acreage 50 years ago (5000 hectares) this means a decrease. But the area has been down to 886 hectares in 1978. Keeping this figure in mind we have to state an enormous rise during the last 8 years.
The average onion yield per hectare in 1985 reached 35 tons. This means a degree of self sufficiency of 17 % in relation to the average consumption per man and year of 6 kg.
The main onion regions are concentrated in Rheinland-Pfalz, Hessen and Niedersachsen (see map). Especially in these areas the acreage increased during the last years. The diagram and the table show the detailed figures.

As I did already mention the percentage of the winter onion area is high. This onion type is mainly grown in Rheinland-Pfalz and Hessen under a relative dry climate on light soils where farmers have less problems in harvesting the bulbs.

Phytopathological situation

All plant protection offices have problems with downy mildew (Peronospora destructor) in their area. Officially recommended fungicides aren't available. Ridomil Combi had a recommendation for a short period (1,25 kg/ha, max. three times) but was cancelled because of the toxicology of one of its compounds (Folpet).

Another important disease is Botrytis leaf blight caused mainly by Botrytis squamosa. For the control of this disease farmers are allowed to use the fungicide Dichlofluanid with the commercial name Euparen. The dosage rate is 4 kg/hectare in 2000 litres water, up to four times during the season.

We have a special situation in Sclerotium cepivorum, the white rot causing fungus. Big problems exist in the Palatia area (Rheinland-Pfalz) where we have a long history of onion growing. Summer and winter onions are grown close together and we find onions more or less throughout the whole year in the fields.
15 % of the onion area of Palatia are already infested and we feel that the percentage increases. Our idea is that the transport of the sclerotia of S. cepivorum by wind could be one of the major ways of outspread of the disease especially on these light sandy soils and under a relative dry climate. We have exposed traps to catch wind blown material from infested plots.
In the other regions S. cepivorum doesn't play an important role mainly because these areas do grow onions only since a couple of years and in a wider crop rotation.
Officially recommended chemical control methods aren't available.
The plant protection office at Neustadt/Weinstraße is running

experiments with different fungicides (vinchlozoline-Ronilan, iprodione-Rovral, procymidon-Sumisclex, triadimephon-Bayleton, triadimenol-Bayfidan) in winter onions. Here the situation is very complicated because of the long growing period. The first attack by Sclerotium cepivorum takes place during the autumn and a second one happens in April. Therefore we need two application dates or a compound which acts for 9 months. The latter is more or less impossible.

Some of the upper mentioned compounds control white rot but the next main problem is: how can we get the compound down to that soil layer where the fungus attacks the onion roots.
In the Palatia area most farmers have an irrigation equipment. Therefore the plots will get a 20 litres/m^2 irrigation after the fungicide has been sprayed on the soil surface.
At the moment it isn't sure whether we will get an officially recommended fungicide for the control of Sclerotium cepivorum because of the very expensive registration procedure in our country.

A problem which possibly will destroy all efforts to find a chemical control measurement is resistance of Sclerotium cepivorum to the fungicides. The colleagues in Rheinland-Pfalz found a decrease in the percentage of healthy onions after using some of the test fungicides for 2 or 3 years on the same plot.

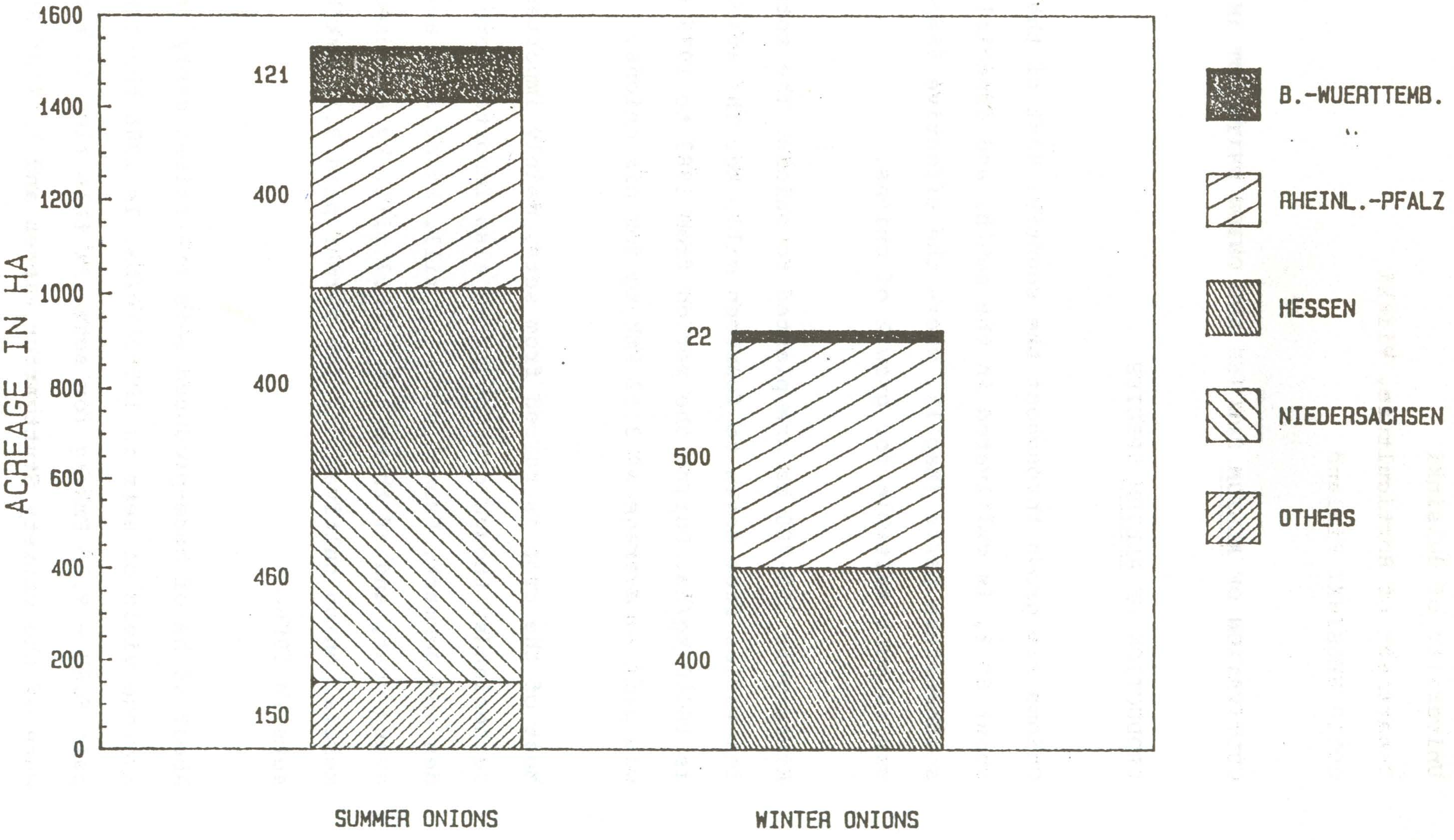
Other diseases of importance weren't mentioned in the questionnaires which I got back from the plant protection service. Nevertheless I have the impression that we will get more problems with soilborne diseases like pink root rot (Phoma terrestris) and Fusarium root rot which possibly will become as important as Sclerotium cepivorum.

BUNDESLÄNDER (countries) OF THE FEDERAL REPUBLIC OF GERMANY

ACREAGE OF ONIONS AND DISEASES IN THE FEDERAL REPUBLIC OF GERMANY

Bundesland (country)	onion acreage in hectares			diseases	farm size	onion acreage per farm	soil type
	spring	summer	winter		ha	ha	
Baden-Württemberg	1.3	111	22	Peronospora Sclerotium cepivorum Fusarium Botrytis sp.	1 -35	0.05-5	sandy loam loam
Rheinland-Pfalz	10	400	500	B. squamosa Peronospora B. allii Scl. cepivorum (15 %) Phoma (1 %) Fusarium (1 %)	20-25	3-5	sand fluvial soils
Hessen	0.5	400	400	Botrytis Peronospora	35-60	6	sandy loam clay
Niedersachsen	15	460	2.5	Botrytis squamosa Peronospora	20-200	1.5-15	loamy sand sandy loam sand

ACREAGE OF ONIONS IN THE FEDERAL REPUBLIC OF GERMANY



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CULTIVATION OF <u>ALLIUM</u> SPECIES AND ONION WHITE ROT IN FINLAND

PRODUCTION OF <u>ALLIUM</u> SPECIES

Onions are grown throughout the country. Most of the crop, about 60 %, is cultivated in the south, and especially the southwestern parts (Map 1), where the effective temperature sum is most suitable for growth of onions.

Every year 550-700 ha are planted to onions. The total production varies from seven to fourteen mill. kg. The average yield is 16000 kg/ha. During the period from 1983 to 1985 the grower was paid an average of 3.12 Fmk/kg for his onions.

Most of the crop is raised from sets, mainly imported from the Netherlands, though previously we also imported some from Sweden and Denmark. From 0.9 to 1.2 mill. kg of sets are imported every year, and of these 0.6 to 0.7 mill. kg are used for commercial onion cultivation. The farmer paid 9.10 Fmk/kg for sets in 1986.

About 40 ha of home-produced sets are raised every year. The average yield of sets is 10000 kg/ha. In 1986 the farmer was paid 6.80 - 9.00 Fmk/kg for sets. At this time 80 % of sets were of the variety Stuttgarter Riesen and 13 % of Sturon.

In the island of Aland and in southwestern Finland, onions can also be grown from seed. The area under seed-raised onions varies from 150 to 200 ha a year.

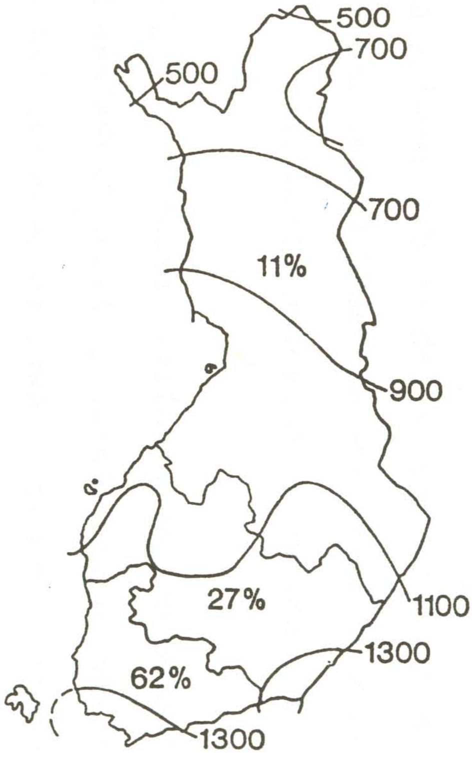
The shallot type of onion is also grown in Finland, mostly in the northern and eastern parts of the country. Previously, shallots were grown throughout the country. They were progressively displaced by the seed-raised non-splitting type of onion during the 1950's and 60's.

Most of the onion harvest is used in a dried form during the storage period. Part is lifted and used fresh, however.

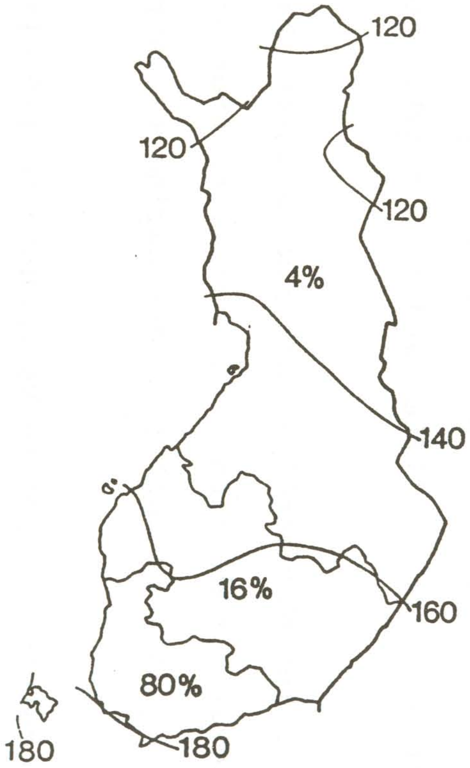
The annual onion harvest does not always cover the home demand. Whenever production falls short, or when storage losses are large, we have to import onions during the spring.

The annual cultivation of leeks amounts to 120 -140 ha. Production varies from 2.1 to 2.8 mill. kg. The average yield is about 17000 kg/ha. Over the period 1983 to 1985 the farmer was paid 8.23 Fmk/kg for leeks. Most of the crop is grown in southwestern Finland, where the length of the growing season is longest, - 80 % of leeks are produced there. Leeks are grown on small areas right up into Lapland (Map 2).

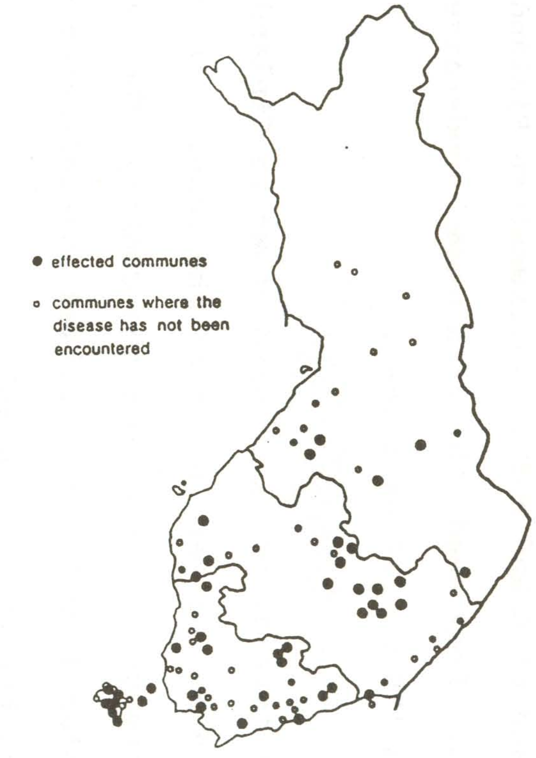
Leeks are planted out as seedlings raised under glass and set out mechanically in the field. In Aland leeks can be left to overwinter where they have grown, to be harvested during the spring of the following year.



Map 1. Areas under onion cultivation in 1985 and effective temperature sum for 1931-1960.



Map 2. Areas under leek cultivation in 1985 and length of growing season for 1931-1960.



Map 3. Distribution of onion white rot for 1968-1985.

There is interest in Finland in garlic cultivation. At present, commercial cultivation is not carried out to any extent. Some growers are also interested in producing seed-raised spring onions.

Chives is mainly grown under glass in Finland. In addition, there is some greenhouse production of early onions and leeks.

WHITE ROT OF ONION

The occurrence of onion white rot was irst confirmed in 1968, when it was found in southern Finland. By 1973 the disease was recorded in the province of Pohjanmaa and by 1974 in the province of Satakunta. When information came in of several infected onion fields in Aland during 1975, we started a study on the distribution and control of the disease in Finland. I shall present a summary of this work in the following.

The distribution of onion white rot and severity of the disease

On the basis of samples sent in we have found that onion white rot has spread throughout the main area of onion cultivation.

By the end of 1985 there were 42 communes with 81 infected farms (Map 3). For the most part the infection was found on onions. On four farms garlic was infected, on one farm leeks.

The wide and rapid spread of the disease was a result of the fact that the inspection of imported sets was not sufficiently stringent at the time when importation began. Especially towards the end of the 1960's, it appears that a considerable volume of infected sets found their way into our country. In 1976, during the importation of sets we made considerably tightened quarantine measures, and the pathogen was found to be present in sets both as sclerotia and mycelia.

In northern Finland, where shallots are grown and the bulbs for planting are taken from the farmer's own harvest, onion white rot does not occur.

The losses caused by onion white rot can be very large indeed; although no precise estimates have been made. On the basis of information received from farmers, yield losses can vary from 1000 to 10000 kg/ha. One reason for the severity of disease outbreaks is that onions are often planted year after year in the same field, without any crop rotation. On some farms yield losses have been so heavy that onion cultivation has been suspended.

Prevention of the spread of onion white rot and control of the disease

Developments in quarantine and advisory work

The Plant Protection Act promulgated in 1981 and the subsequent statute of a year later have given the authorities wider possibilities of taking measures to prevent, or at least restrict the importation and further spread of onion white rot in Finland.

Today, all sets intended for importation, as well as those raised in Finland, are inspected by the Plant Quarantine Service and the State Seed Testing Station of the National Board of Agriculture. The inspection is carried out by local authorities in various parts of the country.

Any consignment of sets found to be infected by the disease is returned to the exporting country. Over the period from 1978 to 1986, the quantity of sets rejected has amounted annually to anything from zero to 5.5 % of sets imported. On the basis of field inspection on domestic fields of sets, from zero to 11.4 % of the inspected acreage was condemned over the same period. Fields on which the disease is found can no longer be used for set production.

The authorities have recourse to control measures on white rot infected farms. What happens in practice is that the official and the farmers sit down together and work out a cropping schedule or plan for the farm. The plan aims to cut down the amount of onion cultivation on the farm, and to ensure that onions are grown on any field no more frequently than every fourth year. At present, 27 farms are included in this programme.

Chemical control

White rot is controlled in onions by means of a vinclozolin preparation. The sets are dipped in a solution containing 0.1 % of the active ingredient for 15 minutes. After drying, usually the day after the treatment, the sets are planted. Vinclozolin can be used only on onions to be harvested in the autumn and stored dry for winter use.

The use of vinclozolin results in a reduction in the degree of infection by the disease. According to farmers, even with such application yield losses may still vary from 200 to 5000 kg/ha. The farmers claim that the efficacy of vinclozolin has not fallen off with time.

Other chemicals and modes of application have been tested, but none has been approved for general use. The Agricultural Research Centre has published the results of these studies in compilations of trial data of the Institute of Plant Pathology for 1976 to 1977, and in information bulletins of the Pesticide Regulation Unit for 1978 to 1980. Most of these publications are in Finnish.

Biological control

We have made some preliminary trials with *Trichoderma* spp. The isolates we have tested, both in petri-dishes and in pot experiments, have shown inhibitory effects upon the growth of the pathogen. At the moment, a study is in progress to test the effect of Streptomyces spp. upon Sclerotium cepivorum. This study is being carried out by Mrs. Marja-Leena Lahdenperä of the Kemira Research Centre, Espoo, near Helsinki. I hope she will have the opportunity of presenting her results during the next meeting of the working group.

SUMMARY

Onion production is of considerable economic significance in Finland. The domestic harvest is sufficient to cater for most of the demand.

About ten years ago, onion white rot appeared to threaten seriously the cultivation of onions and related crops. Present day measures imposed by the authorities concerned now effectively prevent further incursions of the pathogen to Finland, and also halt the spread within our country.

Advisory work has kept farmers informed about the dangerous nature of the disease, and about the control measures possible. The farmers are striving to improve the situation.

Chemical control is restricted to the use of a single fungicide and a single method of application, a situation which does not satisfy the farmers.

The only research carried out on onion white rot is within the field of biological control.

Allium white rot at Woodfield Farm, Birlingham, Worcestershire, UK

G.W. REVILL

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Onions and leeks have been grown on Woodfield Farm since 1940 when the MAFF forced growers to plough ground and grow onions for the 'health of the Nation'. White rot was first noticed during the late 1940s but as the area of onions grown was only 1.6 ha (4 acres) and was confined to harvesting in the spring (hence spring onions) rotation was not a problem and therefore the disease was not serious.

During the late 1950s and early 1960s, onion seed was coated with calomel dust, using alcohol resin as a sticker, and dried on sacking in warm conditions. This treatment gave adequate disease control for the increasing yet still relatively small area grown.

After 1970, the area of salad onions increased dramatically especially the summer-grown crop and salad onions were then produced all the year round; because of limited opportunities for rotation at Woodfield Farm, a large proportion of the area was grown on another farm owned by the same company.

During the 1970s we started using thiophanate-methyl (Mildothane) for white rot control and this proved to give superior results compared with calomel. Then followed the introduction of iprodione (Rovral) seed and stem base treatments based on research by the NVRS. By 1977, all our onion seed was dressed with iprodione and all our onions drenched with the same chemical using spray booms designed specially for the purpose. We found we could reduce the chemical rate to half that suggested by the NVRS and this we proved on our own trial site.

At Woodfield Farm we have started an experimental area. The trial area is 0.4 ha and is surrounded by trees and in the past have had total loss of crop with white rot. In 1978, we decided to grow successive onion crops (continuous cropping) to determine the effect the control measures with iprodione and to determine the the minimum rates of chemicals needed to give a commercially-acceptable standard of disease control.

By 1982, we had changed to vinclozolin (Ronilan) for both seed and stem base treatment and so effective was control of white rot, that we categorically announced that we had complete control of white rot. Thus on our trial site, untreated areas were devastated whereas treated areas were white rot free. By the end of 1984, we contacted Dr Entwistle, NVRS to tell him we had lost control with both the lower and higher rates of vinclozolin. Dr Entwistle supported this with evidence that neither iprodione nor vinclozolin was giving control on the quarantine field at NVRS. The loss of control on the trial site at Woodfield Farm was followed by a similar loss of control on commercial fields.

This loss of control was a shock and a step back, and the long-term implications of no control commercially began to loom as a formidable problem. In hindsight, we feel that this loss of white rot control by vinclozolin was similar to a loss of control by thiophanate-methyl.

Our present area of bulb and salad onions and leeks was now in excess of 80 ha and onions were grown every other year on the better soils. We are now reducing the problem of white rot by giving a wider rotation following the purchase and rental of white rot-free land. The intention is to give white rot affected soils a longer rotation and thus give the present chemicals the opportunity to give satisfactory control. It is too early to say if this strategy will succeed but we have had no problem of white rot this year; I am reminded, however, that white rot can cause devastating losses in September and October when conditions seem to favour the disease.

I believe our trial site gives us invaluable information and I would like to highlight what in my opinion is needed in future research basing my thoughts on this site. This is the eighth year of continuous onion cropping with ten crops at various times of the year and has a high incidence of white rot. Last year, at a meeting at NVRS, I described the results of some trials done with the collaboration of the ADAS (Appendix 1).

In 1986, the trial was repeated with the difference that the other half of the site was irrigated. Farmyard manure was added after ploughing and the N-dressed and non-dressed beds were repeated in approximately the same position (approximately because it is difficult to be precise after ploughing the ground). Very little white rot is showing in any plot. Why is there a marked change since 1985? What can we learn?

A few years ago, brassica clubroot was a serious problem on many of our fields. ADAS were then advising a minimum of 10 years' rotation and dipping the plants in fungicide. Soil treatment with the field application with soil partial sterilants to control clubroot, is uneconomic except in a limited number of situations. The long-term reduction of brassicas on our farms looked necessary until we found out how we could contain the disease very effectively as other growers have done by natural control and now grow continuous brassicas without any problem on these heavily-infested fields.

With white rot, I feel that our future limited resources should not be used to fund research on the use of soil partial sterilants, or even resistance in cultivars but should be into finding out what we may be overlooking because it is obvious and simple. I consider that onions under stress become more vulnerable to white rot; by avoiding plant stress we can limit the incidence of white rot. Our own trial results I believe confirm this. Commercially we are now putting this into practice by giving more attention to detail, so where possible, we are improving our planting conditions, keeping the soil moist and not letting it get excessively dry. Even when a field is devastated by white rot, there are a few onions that remain healthy. Why do they survive? If we can find out the answer to this question, I feel we may well solve the problem of white rot.

I just wonder if perhaps out in the commercial or amateur world, there is someone who is smiling at our problems, and who already has the answer very simply and effectively.

Appendix 1.

SALAD ONION WHITE ROT TRIAL, Woodfield Farm, Birlingham, Worcestershire, UK

On 31/10/85 Plant Pathology staff from ADAS Evesham visited the site to collect samples for assessment back in the laboratory.

Our aim was to sample from certain Irrigated/Non-Irrigated plots and at the same time compare this with the presence/absence of the fungicide programme. With this in mind we collected hundered plant samples, randomly selected, from each of the plots in beds, 2; 5; 6 and 9 (16 plots assessed in total).

Bed 2	Irrigated	Fungicide
Bed 5	Irrigated	No Fungicide
Bed 6	Non-Irrigated	Fungicide
Bed 9	Non-Irrigated	No Fungicide

The results of our individual plot assessments are shown on the enclosed plan. Assessments were based on the presence of obvious white rot with no attempt being made to incubate up any plants that looked "dubious".

From the 16 plots assessed it was possible to gain some idea of the influence of the individual treatments of Lime; FYM; Irrigation and Fungicide on the incidence of white rot (Table 2). In each case 8 plots received the treatment whilst 8 did not, though obviously they were not the same combination of plots each time (see Table 1).

Table 1 - Plot Combinations Used to Complete Table 2

Treatment	+	-
Lime	2, 12, 5, 15 6, 16, 9, 19	22, 32, 25, 35 26, 36, 29, 39
FYM	2, 5, 6, 9 32, 35, 36, 39	12, 15, 16, 19 22, 25, 26, 29
Irrigation	2, 5, 12, 15 22, 25, 32, 35	6, 16, 26, 36 9, 19, 29, 39
Fungicide	2, 12, 22, 32 6, 16, 26, 36	5, 15, 25, 35 9, 19, 29, 39

It was not possible to assess the role of Top Dressing alone because of the initial 16 plots chosen.

Table 2 - Summary of Results

Treatment	Mean % White Rot		% Reduction
	+	-	
Lime	16.6	26.1	36.4
FYM	11.1	36.1	69.3
Irrigation	15.4	27.3	43.6
Fungicide	17.6	25.1	29.9

These results are open to some critism as they reflect the findings from only 16 plots, hopefully they may serve as a useful guide.

SALAD ONION WHITE ROT TRIAL - 1985

G W Revill & Son Ltd, Woodfield Farm, Birlingham, Pershore, Worcestershire

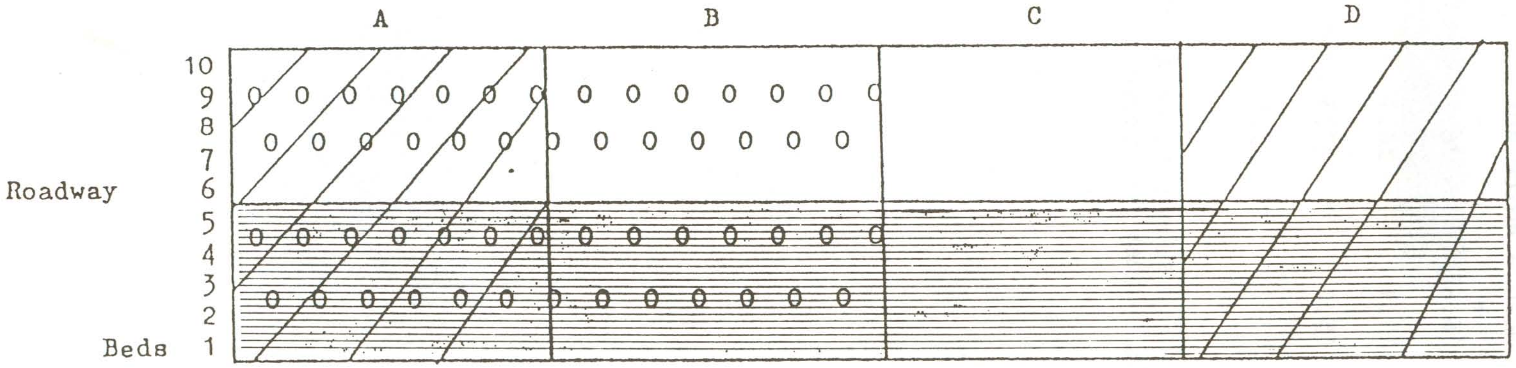
White Lisbon Winter Hardy Field Long Acre

Base UKF No 1 4 cwt acre

Drill No 20 - Alternate Beds Dressed Ronilan + Drenched at Emergence

Drill No 18 - No dressing on rest

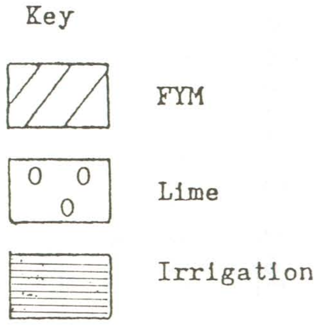
Drill Date - 2 July

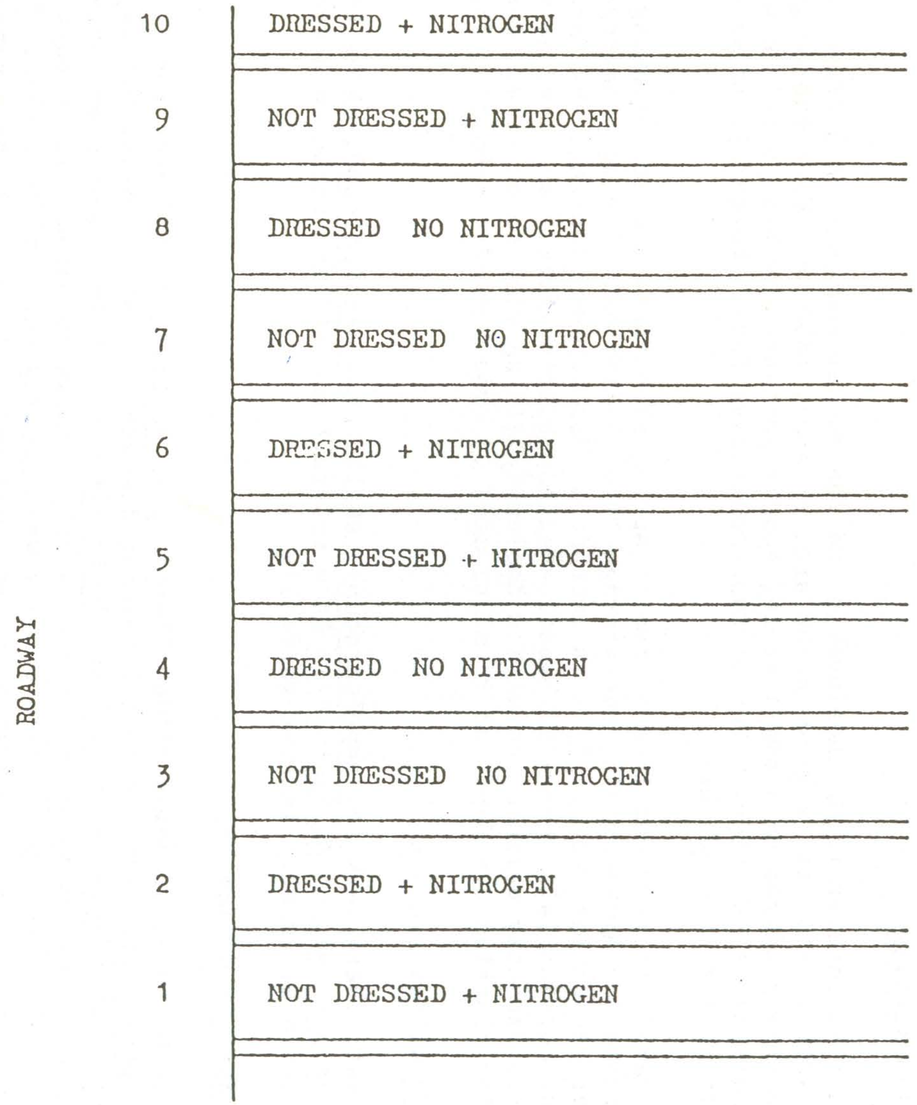


FYM - applied to ploughing and cultivated with soil

Lime - 3 tons approximately cultivated in top 3 inches

Nitrogen Top Dressing Every other dressed and not dressed beds
Rate - Approximately 1 cwt every 2-3 weeks NITRO CHALK




10 DRESSED + NITROGEN
9 NOT DRESSED + NITROGEN
8 DRESSED NO NITROGEN
7 NOT DRESSED NO NITROGEN
6 DRESSED + NITROGEN
5 NOT DRESSED + NITROGEN
4 DRESSED NO NITROGEN
3 NOT DRESSED NO NITROGEN
2 DRESSED + NITROGEN
1 NOT DRESSED + NITROGEN
ROADWAY

Allium crops and Allium white rot in Czechoslovakia

J. ROD

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Allium cepa

Onions are the second most produced vegetable in Czechoslovakia (cabbage is the first) accounting for an area of 9500-10,000 ha per annum. The annual onion per capita onion consumption is 9 kg. About 80% of onion crops are grown from direct-drilled seed and the remainder from onion sets. A major part of the onion production is intended for dry bulb harvest and a limited amount only is grown as salad onions. Bulb crops are mostly grown from spring drillings, a few crops are grown from seed drilled in mid-August.

The cultivar Vsetana released in 1946 is the most widely grown cultivar, being suitable for crops grown by both direct drillings and from sets. In the near future, cv. Vsetana is expected to account for half the area reserved for onion production. Other cultivars are cvs Alice, Zlatava, Hanka and a new hybrid Forta F_1. All these cultivars can be stored long-term. They have a slightly pungent flavour, and their dry scales are noted for several shades of yellow. Cv. Karmen has a sweeter flavour so it is consumed raw; the dry scale colour is dark purple and the inner scales'are pinkish with red skin. Cvs Hiberna and Augusta are used for August sowings and are grown mainly as salad onions.

Allium sativum

Garlic is popular in Czechoslovakia and the annual consumption averages 0.5 kg per inhabitant. It is grown on an area of about 1800 ha. Even though garlic is mostly produced on a small scale, some experience has been obtained with large-scale production. Thus on two cooperative farms the garlic is grown on areas larger than 100 ha.

The garlic is produced from autumn or spring plantings. Autumn planting guarantees a higher yield, but storage life is limited. Spring plantings give lower yields but storage life is extended. For autumn planting, cvs Zahorsky, Alan, Moravan (all so-called broadleaved non-bolting forms) are used as well as cvs Bzenecky palicak, Ropal and Znojemsky giving rise to bulbils. For spring planting cvs Japo and Prim are used (narrow leaved non-bolting forms).

Other Allium species

Amongst others leek (*A. ampeloprasum*), shallot (*A. ascalonicum*), chive (*A. schoenoprasum*) and *A. fistulosum* (a very small amount) are grown on a very limited area (mostly in home-gardens).

Diseases in Allium spp.

In Czechoslovakia, downy mildew (*Peronospora destructor*) and neck rot (*Botrytis allii*) are the most important diseases of onion. Nevertheless, *Fusarium oxysporum*, *F. solani* and *Penicillium* spp. bring about some losses. White rot (*Sclerotium cepivorum*) is nearly unknown in onion. It appears very sporadically with small-scale growers when growing onion after garlic. During its period of growth (and when stored, too) garlic is infested by a number of fungal pathogens. The most frequent pathogens are as follows: *Fusarium solani*, *F. oxysporum*, *Botrytis* spp. (mainly *B. byssoidea*), *Penicillium* spp. (mainly *P. cyclopium*) and *Helminthosporium allii*.

White rot, however, is the most serious disease of garlic causing losses both to small-scale growers and to specialised cooperative farms. Protection against all the garlic pathogens mentioned above is carried out dipping cloves into a suspension containing benomyl, benomyl + thiram or iprodione before planting. The protective treatment (especially with iprodione) is effective against all the pathogens mentioned but when an infestation of soil with white rot sclerotia has occurred this treatment protects plants for a short time only. Garlic is not treated during its period of growth in the field.

ALLIUM WHITE ROT IN IRELAND

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Allium Crops Grown

In Ireland, the area of onions has declined from 600 ha in 1977 to 240 ha in 1985. The 1985 break-down of *Allium* crops was: bulb onions 185 ha worth about IR£900,000, salad onions 55 ha - IR£400,000 and leeks 25 ha IR£230,000. Bulb onions consisted of Autumn-sown 25 ha, spring-sown 60, transplants 65 and sets 35.

The decline, mainly in bulb onions can be attributed to poor prices, a number of bad summers causing poor bulbing and low quality thick-necked bulbs, and the incidence of *Cladosporium* leaf spot from 1978 onwards. White rot is not regarded as a significant factor in the decline.

The adoption of transplanting in the past 2 or 3 years is an attempt to increase yields, to ensure satisfactory bulbing even in a bad summer, and to obtain earliness and better harvesting conditions.

Incidence of White Rot

White rot is not widespread in onion crops in Ireland, though crops in many areas may have patches of disease. It is found commonly in private gardens and is also prevalent in a few traditional growing areas.

An example of such areas is Castlegregory on the Dingle Peninsula in county Kerry. There, onion growing was introduced in 1932 to replace potatoes affected by potato root eelworm. In 1955, a Co-operative Society was formed to organise growers and market the produce. The general pattern has been that up to 200 growers produced 100 to 150 ha of bulb onions of which 30 - 50% were sets. There has been little or no rotation. The onion area has now declined to 30 ha.

We know that white rot was prevalent in the area prior to 1955. From 1955 onwards, seed was pelleted with Calomel at the Co-op for any field in which white rot had been noted. In any year, 10-20% of the seed was treated and usually at the full rate of 1.0 Kg/kg seed. It appears that the degree of infestation did not increase significantly over the years. Perhaps a high water table in winter has had some influence. During the Calomel era, sets were not treated but were planted, where possible, in cleaner fields.

In recent years, seed is treated with iprodione at 125 g a.i. / kg seed. Sets are dipped in a suspension of iprodione at 2.5 g a.i./l water. It appears that satisfactory control continues to be obtained.

Significant white rot also occurs in county Dublin where 60% of salad onion production and 75% of leek production is located. Practically all producers of salad onions now buy iprodione - treated seed. If white rot is noted in a crop of salad onions or leeks, a basal spray of iprodione is applied. In general, the growers consider that they are obtaining satisfactory control of white rot though some feel that the disease has become worse in the past two or three years.

Research

Soil infestation first occurred at Kinsealy Research Centre in the mid sixties, and a naturally infested area supplemented with added inoculation was used for trials in 1971 and 1972. The efficacy of Calomel seed treatment (0.5 or 1.0 kg/kg seed) was confirmed. Benomyl was also found to be effective to some extent but was phytotoxic at rates above 31 g a.i./kg (1). However, benomyl applied as a dust to sets gave good control of white rot with no evidence of phytotoxicity at rates of 1 or 2 g a.i./kg sets (2). In 1972, the distribution of infected plants relative to various placements of inoculum agreed with the laboratory findings of Scott (3) that the mycelium of S. cepivorum grows through the soil only to a very limited or negligible extent (4).

With the arrival of iprodione on the white rot scene (5) a second series of trials were carried out on another infested area at the Research Centre from 1978 to 1982. In 1978, iprodione applied to salad onions at 63 g a.i./kg seed reduced white rot at harvest from 60% to 3%. In bulb onions, a rate of 250 g a.i./ kg was necessary for significant control reducing disease from 57% to 19%. It was found that rates of 125 g a.i./kg or higher applied with methyl cellulose caused difficulties in mechanical sowing. Iprodione applied as a row drench (basal spray) at 10 g a.i./100 m row reduced disease at harvest in salad onions from 49% to 1% and in bulb onions from 78% to 9% (6). Similar results were obtained with seed treatments and basal sprays in 1979.

In 1980, iprodione and vinclozolin were equally effective as basal sprays. Each chemical applied at 15 g a.i./100 in row reduced white rot at harvest from 15 to 2% (7). For control of white rot in transplants, iprodione was incorporated in peat before blocking or applied as a drench to blocks just before transplanting. Drenching was the more effective and at 5 g a.i./ m^2 of blocks before planting in April gave good control until late June. By late July, disease was prevalent and severe in all plots (8).

Similar results were obtained in 1981 and in addition, seed treatments of salad onions with iprodione, vinclozolin and meclozolin each at two rates were compared with standard Calomel treatments. All treatments gave significant control but only meclozolin at 125 g a.i./ kg. seed was significantly better than Calomel at 500 g/kg (9).

In 1982 combinations of treatments were tested to prolong the period of control in transplants. Peat blocks were drenched with iprodione at 5 g a.i. / m^2 before transplanting and this was followed by basal sprays in the field. It was found that a basal spray of iprodione (7.5 g a.i. or greater / 100 row) applied about one month after transplanting was the most effective follow-up treatment and gave good control to the end of August (10).

Conclusions

Although onion production has declined in Ireland in recent years, there is now renewed interest by growers particularly in relation to transplanting. Reliable and economic control of white rot will be an important factor in the future development of onion growing. In relation to white rot, my own interest and activity at present can perhaps be more accurately described as advisory/extension than research. Further developments in white rot control are eagerly awaited.

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CANADIAN ONION PRODUCTION AND THE STATUS OF ALLIUM WHITE ROT INFESTATION.

In Canada, the main type of domestically grown dry onion is the yellow cooking onion, which is grown from seed and is suitable for long term storage. A small percentage of the crop is produced from sets for the early market. Other types grown in Canada, but only in a minor extent include "silverskins" and "Sweet Spanish" onions.

Dry onions are a major vegetable crop in Canada ranking 10th in economic importance, and in 1984 had a farm value of $13.2 million. Annual per capita consumption is increasing and was approximately 6.5 kg in 1984.

Production is concentrated in relatively small areas in 5 provinces. Ontario leads in onion production, followed by Quebec, British Columbia, Manitoba, and Alberta. (Table I). The majority of the 130,000 tonnes produced in Canada is grown on organic soils. These soils vary in depth from 0.3 m to 2 m and have a very high water holding capacity.

Crop rotation is practiced in some areas where onions are alternated with carrots, lettuce, and celery. Monoculture of onion, in organic soils, is possible without serious problems of disease or nematodes, except where white rot is found. Onions are seeded in the spring (April-May) and harvested in August-September.

Table I

'000
Onion Production - Canada (tonnes).

	1982	1983	1984	1985
Quebec	36.3	29.5	36.3	35.8
Ontario	74.4	74.5	85.7	85.1
Manitoba	4.4	3.0	3.2	3.6
Alberta	2.3	2.6	2.0	2.1
B.C.	5.9	5.4	6.2	5.0
Total	123.3	115.0	133.4	131.6

The main insect problems are onion maggot and thrips. The main disease problems are smut, Botrytis leaf spot, and downy mildew. Only in recent years has white rot been a problem in some areas.
Granular insecticides are used to control onion maggot. Smut is controlled with seed treatment. Foliar sprays are applied to control the adult onion maggot fly and to keep disease under control.

As soon as the necks soften and the tops have fallen, the crop is lifted with a mechanical digger, which pulls the onions and deposits them in windrows. After a period of 10-15 days drying in the field, the onions are then picked up by a mechanical harvester which removes the tops from the bulbs and deposits the bulbs into large 500 kg bins or bulk wagons. The bins are usually stacked up two or three high in the field for further drying and curing. Some growers have special in-door drying facilities to dry and cure the onion immediately after harvesting either in bins or in bulk piles.

The majority of the onions are very hard, tough skinned hybrids which are capable of long term storage.

The marketing season starts in July with a small production of sets, followed by the main crops in August and losses up to 30-40% of a crop in a particular field in a particular year, but there has never been an overall crop loss in any one year greater than 1%, since the disease was first recognized in 1970 in that region. According to a report by Mr. Wayne Odermatt, Fresh Vegetable Specialist, Ministry of Agriculture and Food, Cloverdale, British Columbia, growers who have had serious problems in a particular field usually avoid replanting to onions and switch to other crop. According to Mr. D.J. Ormrod, Plant Pathologist in Cloverdale, British Columbia, white rot is more damaging in mineral soils (sandy loams) than in organic soils, as the same level of inoculum appears to cause greater losses in the mineral soils. This is believed to be due to the greater range of natural control processes at work in organic soils.

A survey conducted in the Cloverdale area in 1985 shows only 5 out of 10 surveyed plantings affected by white rot, although all commercial onion farms in that area are known to be infested with the disease. This failure for the infection is thought to be attributed to dry weather during 1985. While infection did extend to 5% of one planting only 0.2% of the total hectarage was infected.

Ontario

There are 5 regions in Ontario where onions are produced. The Bradford and District Marshes, located about 50 km from

Toronto is the major production area. The soil is organic, similar to the British Columbia soil. In this area, white rot was first noticed in 1976. Since that time the disease has spread to several fields, some adjacent to the original infested area, as well as to fields that are 5-10 km away. The disease has caused crop losses as high as 40% in one field, but overall crop losses are estimated at no greater than 1%. Growers deliver their onions in bins to central packing stations. These bins are used by the packers to collect culls and soil, thus contaminating the bins and no doubt white rot sclerotia were spread to many farms in this manner. Some growers have discontinued growing onions in infested fields and switched to growing carrots. If the disease is still confined to small patches in the field, the grower continues for a few years until the cost of grading and the reduction in yield makes onion production uneconomical. Growers are faced with a serious threat to the industry unless a control for the disease can be found.

High priority has been given to white rot research in Ontario. Several projects are under way, partly conducted by the industry (BASF Canada Inc.) and partly by the Department of Environmental Biology, University of Guelph. These projects include biological control by means of flooding and chemical control with iprodione, dichloran and vinclozolin.

Dicloran (Botran) is the only fungicide registered in Canada for the control of white rot. It has not been used by growers due to the method and time of application of this material. The manufacturer recommends that the fungicide be applied one to two weeks before seeding as a coarse spray to the surface of the soil. Growers are reluctant to delay seeding onions in the spring as it will delay harvesting and reduce yields. In experiments, dicloran has not given satisfactory control of the disease. Cultivars resistant to the disease are not available although two hybrids developed in Japan: Eskimo and Norstar may have some tolerance.

Quebec

White rot has not been reported in this province until 1985. The disease is confined to one grower's field located near St. Remi, an organic soil region south of Montreal. There has been no suggestion to-date on how the disease got there and where it could have come from.

Summary

Canadian onion production is largely confined to three provinces, Ontario (65%), Quebec (27%), and British Columbia (4%).

White rot is considered a potentially serious problem in the Cloverdale area of British Columbia and the Bradford area of Ontario. At the present time there are no cultivars resistant to white rot. The only fungicide registered in Canada is dicloran (Botran) but it has_not given satisfactory control throughout the whole growing season.

Biological control by means of flooding is presently being investigated in Ontario. Cultivar resistance is being studied in British Columbia.

Matthew Valk, P.Ag., Senior Muck Crops Specialist
August, 1986.

SECTION 2

Differences in the incidence of *Allium* white rot in direct-drilled and module-grown bulb onions

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INTRODUCTION

During investigations into the factors responsible for the patchy occurrence of white rot (*Sclerotium cepivorum Berk.*) in commercial onions, the incidence of *Allium* white rot (AWR) was apparently high in module-grown plants compared with plants which had been grown from seed sown directly in the field (termed direct-drilled). Therefore, the incidence of AWR was assessed systematically in the two types of crop and samples of soil examined for the presence of sclerotia.

The following year module-grown and direct-drilled onions were planted at Wellesbourne in an attempt to locate a suspected source of AWR.

MATERIALS AND METHODS

Commercial onions. Bulbs had been planted in spring 1985 and occupied c. 4 ha, one third (35 beds) of which had been grown from modules and the remainder were direct-drilled. Beds were *c.* 250 m in length and comprised four rows spaced 0.3 m apart. The five beds either side of the junction between the two types of crop were sampled on 13 August 1985 at eight postions along the direction of planting. The presence of AWR was recorded in samples comprising either five onions (direct-drilled) or three modules (*c.* 15 onions) from each row. Distances between sampling position varied between 15-40 m and included a total of 150 m length of bed.

Samples of soil were collected from one bed each of direct-drilled and module-grown plants. The sampling positions were *c.* 1 m from the onions assessed for AWR. Two additional samples in each bed were included, extending the length of bed sampled to 230 m. The beds that were selected were each once removed from the junction between the two types of plant. This procedure was adopted to reduce the possibility of sampling soil and sclerotia which may have spread between the two areas. The samples comprised three subsamples of soil 10 cm diam. x 10 cm depth, collected midway between the four rows of plants. The whole of each composite sample (*c.* 450 g soil) was wet-sieved and sclerotia tested for viability (Entwistle, 1984). After the soil had been sampled the incidence of AWR was assessed on onions adjacent to the soil samples.

Location of AWR suspected at Wellesbourne. In an experiment with spring-sown bulb onions in 1985, four out of several thousand developed AWR in store. There had been no evidence of AWR during the season or at harvest. Spring-sown bulb onions had also been grown on the same site in 1977 and 1981, also without evidence of AWR. Thus, the source of AWR in the stored onions was not known but there remained the possiblility that it had originated in the experimental field. Module-grown plants, with their apparently higher susceptibility to AWR, were grown as a method for detecting AWR in the experimental field.

Hassy modules (308 modules/tray) were sown with 6 seeds per module on 20 March and transplanted on 1 May 1986. For comparison, seed was also sown directly into the field (*c.* 3.5kg seed/ha) at the same target density as the module-grown plants. Seed and modules were planted on the same date in beds 20 m in length and 1.52 m in width. Each bed contained four rows spaced 0.3 m apart; modules were spaced 0.3 m apart within the row. There was a total of seven beds of onions; module-grown and direct-sown plants occurred in alternate rows.

Plants were inspected at *c.* 2 week intervals for the presence of foliar wilting and yellowing and the presence of mycelium and sclerotia. Modules with infected plants were removed on 6 August together with samples of soil (termed A) 10 x 10 x 3 cm deep around the base of the onions; the trowels were washed free of soil and a second sample of soil,(termed B) 10 x 10 x 10 cm, was collected from below the module. The whole of the B samples (*c.* 1-1.5kg soil) was wet sieved and sclerotia tested for viability. Sclerotia from five of the A samples were cultured to check the identity of the pathogen.

RESULTS

Commercial onions. Mean AWR incidence was 2-10% in beds of drilled onions compared with 55-71% in beds of module-grown plants (Table 1). Three of the samples of direct-drilled onions were healthy whereas module-grown plants in similar areas of the bed immediately adjacent had >75% infection.

A total of sixteen sclerotia were recovered from the 20 samples (*c.* 9 kg) of soil. Fourteen of the sclerotia were viable but none yielded *S. cepivorum*.

Wellesbourne. Foliar symptoms were first observed on 7 July but were present only in the module-grown plants. Mycelium and sclerotia were observed 10 days later. By 6 August, fifteen out of the total of 924 modules were affected by AWR as evident by the presence of sclerotia (Fig. 1). Modules containing AWR-infected plants occurred apparently randomly throughout the experimental area. In the direct-drilled onions, AWR was first recorded on 21 August and was restricted to a single 10-cm length of row.

The identity of *S. cepivorum* was confirmed by culturing sclerotia from the A soil samples, the numbers of sclerotia were too high to count (>1000 sclerotia/kg soil). Sclerotia were recovered from all samples of soil below infected modules (B samples) and populations ranged from 11-41 viable sclerotia per kg soil.

DISCUSSION

In the commercial onion crop, AWR incidence was consistently higher in module-grown plants compared with direct-drilled plants. Factors which may be responsible for the increased infection are a) the early presence of roots as a source of root exudate stimulatory to the pathogen (Coley-Smith, 1960) or a concentrated source of susceptible host tissue, b) increased susceptibility of host tissue resulting from a stress caused by growing plants in modules or from damage at transplanting, c) increased maturity of the module-grown plants, d) increased mycelial spread between plants, e) increased susceptibility early in the season when conditions are more favourable for AWR.

Module-grown plants were used successfully for the detection of AWR at Wellesbourne, whereas direct-drilled onions were not. Conditions were rather unfavourable for AWR in June-July otherwise more infection might possibly have been detected. There is the possibility that a similar technique might prove of value in commerce, eg. if module-grown plants were intercropped the year previous to the onion crop, thus giving advanced warning of the presence of location of AWR.

Conversely, growers should be wary of using modules where AWR is suspected, at least until the causes for the increased infection are known. It is possible also that onion sets might also prove more susceptible to white rot because of a similar rapid growth of roots.

The absence of viable *S. cepivorum* sclerotia in soil from the commercial onions crop was unexpected, particularly because of the high incidence of AWR. In other parts of the same field, AWR occurred in module-grown plants both where soil sclerotial populations were high and where they were low. Possibly, the module-grown plants were susceptible to infection at soil sclerotial populations that were too low to measure and further increases in sclerotial numbers had little additional effect on AWR.

There have been no reports on the numbers of sclerotia present in fields with module-grown plants. In garlic, a crop grown from cloves which, like module-grown onions or onion sets, rapidly produce roots, numbers ranged from 0-1000 sclerotia/kg soil (Crowe *et al*., 1980) to 0-16,500 sclerotia/kg soil (Amein *et al*., 1982). Possibly conditions were more favourable to AWR in California than in Egypt, thus fewer sclerotia were needed for infection.

The expectation at Wellesbourne was that any AWR, thus sclerotia in soil, would have been localised. Possibly a source of infection, had once localised then dispersed by cultivation. One source of the sclerotia might have been the white rot quarantine site. It seems improbable, however, that large numbers of sclerotia could have been transported over a distance of *c*. 1000 m in conditions of strict quarantine. Another possibility is that the sclerotia may have been present for a number of years and that infection has not been noticed because of naturally occurring biological control. Thus Utkhede & Rahe (1978) detected sclerotia in thirteen fields but only one had evidence of infection.

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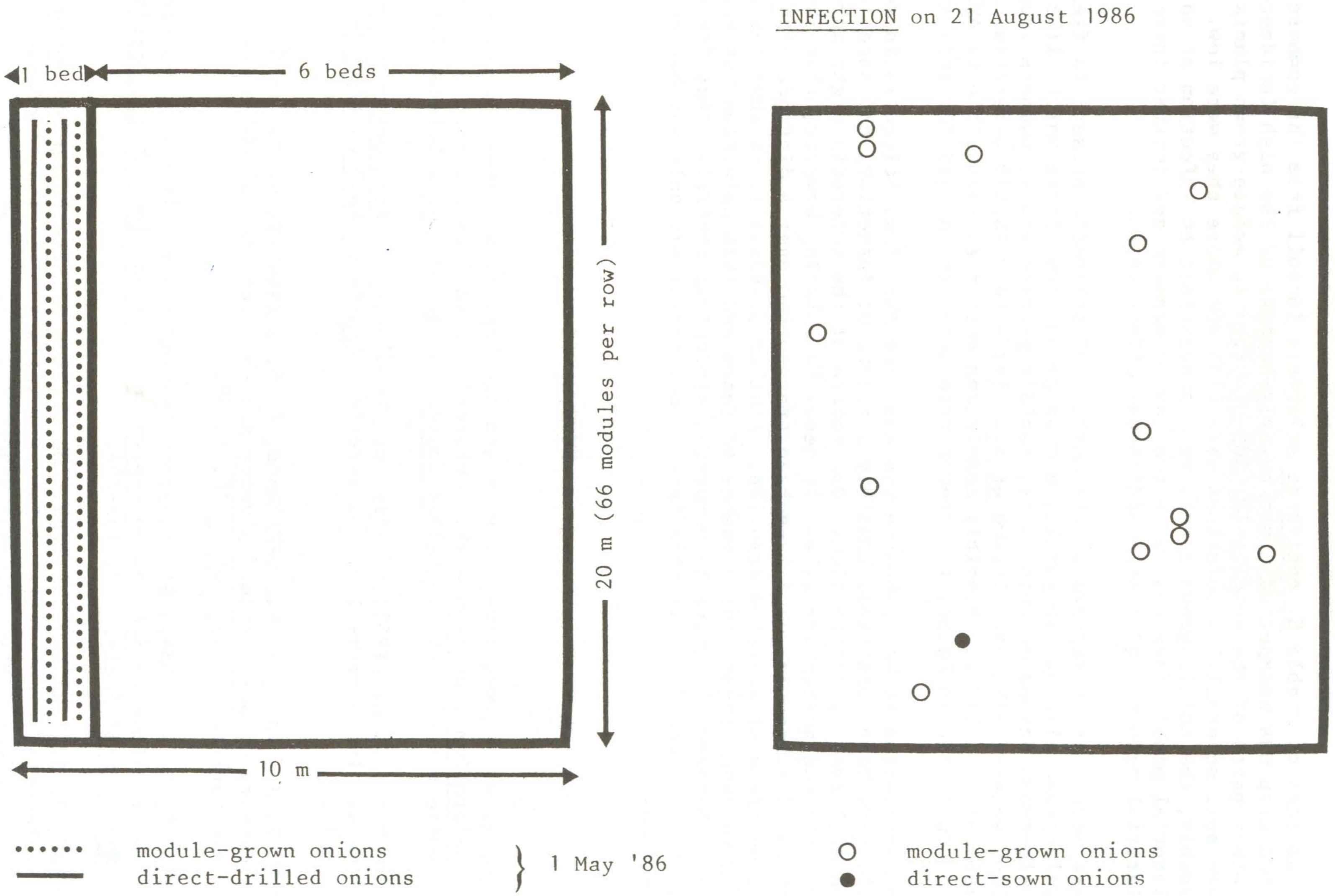
Fig. 1. Use of module-grown onions locating *Allium* white rot



INFECTION on 21 August 1986

Table 1. Comparison of Allium white rot (AWR) in direct drilled and module planted onions, Fenhouses, 1985

Distance from baseline (m)	% white rot									
150	0	0	0	0	10	60	50	0	0	0
102	0	5	0	0	0	75	75	100	100	75
96	0	0	0	0	0	100	100	100	100	50
89	5	0	0	0	0	75	75	90	75	25
42	5	5	0	5	0	0	0	25	65	50
30	55	40	30	20	5	65	50	25	55	100
18	10	0	0	0	5	50	45	100	100	50
6	0	30	0	5	5	60	60	85	75	90
Mean	9	10	4	4	3	61	57	66	71	55
Bed no.	40	39	38	37	36	35	34	33	32	31
	Direct drilled onions					Module planted onions				

Use of aerial photography for the detection of _Allium_ white rot

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INTRODUCTION

Commercial onion crops in Cambridgeshire and Lincolnshire are increasingly affected by _Allium_ white rot (_Sclerotium cepivorum_ Berk.) (Entwistle, 1985). There is a need for accurate data on the location, incidence and spread of the disease as an aid to the understanding of the disease, thus allocation of research priorities, and to farm management.

One method of obtaining such information is to map the presence of the disease by ground survey (Entwistle & Coleman, 1986). The permanent record can then be compared with onion crops in future years. Limitations of available manpower, however, restrict the number of fields that can be surveyed. Aerial photography is another method for surveying plant diseases (Entwistle & Stone, 1986; Toler _et al_., 1981).

The infection of _Allium_ roots by _S. cepivorum_ impairs root function thus restricting water uptake. The resultant stress is seen first by changes in green colour and foliar wilting, later by yellowing and plant death. These changes are not restricted to white rot, however, and poor soil structure, nutrient deficiency and drought also cause yellowing.

Leaf stress and the increased exposure of soil following plant death are accompanied by changes in spectral reflectance, which can be recorded photographically (Jackson, 1964). Therefore aerial photography has the potential for obtaining records rapidly and economically (Wildman _et al_., 1976).

This is an account of investigations in Lincolnshire in 1984-86 in which onion crops were ground-surveyed for the presence of white rot and the record compared with aerial photographs.

METHODS

Ground survey. Three experimental and one commercial crops were investigated (Table 1). Onions were grown in beds, _c_. 1.5 m width and comprising four rows spaced 0.3 m apart. Plants were inspected at regular intervals along the beds and the presence of stem base symptoms recorded on 10-20 onions from each of either two or four rows.

Aerial photography. Seven sites were photographed in 1984 using panchromatic film to record crop tonal and cover characteristics, and colour infrared film to record crop vigour. In 1985, five commercial crops of winter-sown onions were photographed with panchromatic and colour infrared film. Black and white infrared and true colour film were also used. Photographs were taken at a height of _c_. 500 m and an airspeed of _c_. 175 km/hour.

RESULTS

Site 1. White rot was present in autumn 1985 as a foliar wilting confirmed by the presence of sclerotia. Some wilted plants subsequently died, others recovered. No fresh symptoms were seen until the following spring. By July, severe outbreaks of disease were present in patches, mainly at one end of the field.

Aerial photography with panchromatic and colour infrared film failed to detect seedling infection in autumn, probably because of the small size of the plants in comparison with the large area of soil exposed. Differences in growth were readily detected by both types of film and corresponded to the plot boundaries of treatments in which Basamid was tested for its effect on white rot. These differences were not, however, detectable at ground level. Later in summer, differences in the appearance of the onions were again detected photographically, but it was not possible, with accuracy, to relate these differences to symptoms of white rot at ground level. Lack of correlation was attributed to the presence of mayweed (Matricaria), foliar Botrytis and foliar senescence.

Site 2. White rot was present in late July but was evident mainly after digging and not by foliar symptoms. No consistent differences in crop growth were detected at ground level nor were any detected photographically. Lack of foliar symptoms was attributed to the combined effect of large plant size and an abundance of soil moisture reducing stress and the presence of foliar Botrytis.

Site 3, 1985. Part of the field which contained module-grown plants had areas where infected plants had wilted, turned yellow or died surrounded by areas of healthy onions. The presence of white rot varied from few onions to bigger areas comprising several onion beds.

Differences in the appearance of the crop were readily detected photographically by black and white infrared film; detection was also good with panchromatic film. True colour film offered no advantage over panchromatic film; colour infrared offered no advantage over black and white infrared film. It was evident, however, that some areas of poor growth detected photographically were due to pronounced yellowing, stunting and gaps in the row where there was no white rot e.g. in direct-drilled plants. Poor growth was apparently due to poor soil structure and impeded drainage.

Site 3, 1986. On 13 August, bands of healthy plants alternated with similar bands of diseased plants. These bands corresponded to the boundaries where Basamid had been applied. Three days later, the differences were easily seen on panchromatic and black and white infrared film. The differences were in the appearance of crop growth rather than increased exposure of soil when plants died, as in 1985.

The site was ground surveyed again on 9 September. Eighteen areas were located on panchromatic film as indicating poor growth and all corresponded to similar differences detected at ground level (Table 2). The incidence of AWR was 0 to 75%. Most of poor growth, however, was due to stunting and yellowing and not to white rot.

DISCUSSION

Aerial photography was successful at detecting white rot when a) most of the soil in healthy areas of the field was covered by foliage and soil was exposed when plants died from white rot, b) foliar symptoms differed markedly from the surrounding healthy foliage, eg. in the absence of prolonged drought and before senescence, c) white rot was localised rather than dispersed, d) the effects of weeds and foliar pathogens on crop growth were small.

Some of the onion crops were very variable in appearance. Aerial photography effectively detected these differences but did not always distinguish between poor growth resulting from white rot and other causes. There is now a need for further studies to determine whether the identification of white rot by aerial photography can be improved. An essential part of this study will be the continued comparison of ground level symptoms with aerial photographs and the clarification of the factors other than white rot which restrict plant growth.

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Table 1. Details of surveys in Lincs, UK

Site	Area (ha)	Ground survey	Aerial photographs
1. Surfleet 8/84 - 7/85	0.8	6.12.84; 20.6.85	6.12.84; 2.7.85
2. Freiston 3/85 - 9/85	0.8	28.8.85	22.8.85
3. Fenhouses[a] 3/85 - 9/85	4	12.8.85	22.8.85
Fenhouses[b] 3/86- continuing	0.6	13.8.86 9.9.86	16.8.86

[a] part of crop grown from modules, part direct-drilled

[b] same field - direct-drilled crop

Table 2. Relationship between crop appearance on aerial photographs[a] and ground survey, Fenhouses, 1986

No. areas with agreement between photograph and ground survey	No. areas with AWR[b]	Ground survey 9 August				
			Main effects on appearance due to			
		AWR	Poor stand	Weeds	Unidentified	Other
18/18	14	2	2	5	7	2[c]

a Panchromatic film, 13 August
b AWR - *Allium* white rot
c Gaps resulting from samples taken on 13 August 1986

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UTILISATION OF SCHUILING CENTRIFUGE FOR DETECTION OF SCLEROTIA OF *SCLEROTIUM CEPIVORUM* FROM SOIL SAMPLES

The Schuiling centrifuge originates from Holland, and it is used for separating cysts of the potato nematode, *Globodera rostochiensis*, from soil samples.

The device consists of two parts, the centrifuge proper, and a can. In the centrifuge compartment, the swirling motion of water lifts the lighter components to the water surface, from where they are conveyed through the central cylinder onto the sieve.

The debris which has collected on the sieve is rinsed into the can, in which the flowing action of the water once again raises the lighter fraction to the surface, and deposits it onto a filter-paper. The material which has collected on the paper can then be examined with a stereomicroscope.

Methods

We made two sieves for the experiments. The mesh sizes were 0.75 and 0.23 mm. The coarser sieve was placed above the finer one while the instrument was working.

The studies were made both on healthy and on infected coarse sandy soil, which had been air-dried. We put one decilitre at a time into the machine. To the samples of healthy soil we added twenty sclerotia.The material which had collected on the sieve was washed into the can, into a glass beaker or onto a filter-paper using water, sugar solution (density 1.15) or magnesium sulphate solution (density 1.18). In some cases the soil material was dried before the final stage of detection. We also tried to pick up the sclerotia without recourse to centrifuging, by rinsing the sample through both sieves.

The amount of work needed for an analysis of the soil sample was measured by the duration of various operational stages, as well as by the number of filter-papers required to allow the accumulated debris to spread thinly enough for microscopic examination.

Results

When the debris which had accumulated on the sieve after centrifuging was rinsed into the can, we recovered 32 % of the sclerotia, the recovery ranging from 10 to 55 %.

When we did not use the can, and rinsed the residue on the sieve straight onto the filter-paper, we recovered from the paper 74, 79 and 83 % of the sclerotia in three successive runs, with recovery percentages ranging from 65 to 100 %. In the third run, we used less water than in the two previous ones. In this, and in certain other series restricting the amount of water used for rinsing appeared to improve the recovery percentage.

Table 1. The detection of *Sclerotium cepivorum* sclerotia from soil samples with the Schuiling centrifuge.

Method of detection	No. of samples	Sclerotia found %		
Centrifuge				
Water + can	10	32	(10- 55)	
Water	10	74	(65- 80)	
	12	79	(70- 90)	
	4	83	(70-100)	small amount of water
Sugar				
beaker	10	67	(45- 90)	
drying	10	70	(55- 85)	
MgSO4				
beaker	5	72	(50-100)	
		no./dl		
Rinsing on sieve	10	2.1	(0- 10)	
Centrifuge				
Water	10	1.5	(0- 5)	
		(=71 %)		

When we used sugar solution and the beaker, we recovered 67 % of the sclerotia, with a range from 45 to 90 %. When drying of the soil material was included in the treatment, we recovered 70 % of the sclerotia.

With magnesium sulphate solution we detected 72 %, with a range from 50 to 100 %.

When naturelly infected soil was simply rinsed through the sieves, we found 2.1 sclerotia/dl, with values ranging from 0 to 10 sclerotia/dl.

Table 2. Work requirement during the detection of *Sclerotium cepivorum* sclerotia from soil samples with the Schuiling centrifuge.

Method of detection	Detection time min./dl	Microscopic examination time, min.	Total time, min.	No. of filter papers
Centrifuge				
Water + can			30	1.0
Water	8	46	54	5.5
Sugar				
beaker	10	39	49	3.9
drying	15	38	53	4.0
Rinsing on sieve	10	42	52	5.6

When the soil was centrifuged and rinsed off the sieve straight onto the filter paper, we recovered 1.5 sclerotia/dl. By means of the centrifuge we thus detected 71 % of the sclerotia.

A follow-up of the work expenditure revealed that centrifuging with the can was the most rapid technique, and that only one filter-paper was then needed. In the other cases the sequence took 1.6 to 1.8 times as long, and consumed 3.9 to 5.6 filter-papers for each soil sample examined.

Summary

Studies made using the Schuiling sentrifuge showed that sclerotia of Sclerotium cepivorum can be recovered with the instrument, provided that sieves of the appropriate mesh are used.

In order for the centrifuge to be used for predicting the occurrence of onion white rot as well as for the severity of the disease, and for efficient application of the technique in practice, the instrument will have to be further adapted to these purposes.

EFFICACY OF METHODS UTILIZED FOR QUANTIFICATION OF SCLEROTIA POPULATION OF *SCLEROTIUM CEPIVORUM* BERK. IN THE SOIL

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ABSTRACT

RESENDE, M.L.V. & ZAMBOLIM, L. Efficacy of methods utilized for quantification of sclerotia population of *Sclerotium cepivorum* Berk. in the soil

In the laboratory, the efficacy of three techniques used in the extration of *Sclerotium cepivorum* Berk. sclerotia from soil samples was evaluated. With the modified method proposed in this work, consisting of three wet-sievings followed by a dry-sieving, best results in relation to the sclerotia recovery were obtained. The wet-sieving and sucrose floatation method gave intermediate performance and the dilution plate method was least efficient.

The effect of the sclerotia imersion for three minutes in solutions containing seven increasing concentrations of active chlorine, ranging from 0.12 to 2.50 per cent was studied. It was found that the concentration of 1.50% avoided the emergence of contaminant organisms and didn't affect the sclerotia viability, when these were plated on a selective medium.

Three culture media were compared for this viability determination: water-agar, Acidified potato-dextrose-agar and a PCNB-starch-agar selective medium, developed by Papavizas in 1972. It was concluded that this selective medium was the most safe for identification of *S. cepivorum* viable sclerotia.

EFICIÊNCIA DE MÉTODOS UTILIZADOS PARA QUANTIFICAÇÃO DA POPULAÇÃO DE ESCLERÓDIOS DE *SCLEROTIUM CEPIVORUM* BERK. NO SOLO

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RESUMO

RESENDE, M.L.V. & ZAMBOLIM, L. Eficiência de métodos utilizados para quantificação da população de escleródios de *Sclerotium cepivorum* Berk. no solo.

Foi avaliada em laboratório a eficiência de três técnicas empregadas na extração de *Sclerotium cepivorum* Berk. a partir de amostras de solo. O método modificado proposto neste trabalho, o qual consistiu de três peneiramentos a úmido seguidos por um peneiramento a seco, forneceu melhores resultados no que se refere a recuperação dos escleródios. Já o método de peneiramento úmido e flutuação em gradiente de sacarose (Crowe *et al.*,1980), teve desempenho intermediário e o método de diluição em placas (Papavizas, 1972), foi o menos eficiente deles.

Foi estudado o efeito da imersão dos escleródios por três minutos em soluções contendo sete concentrações crescentes de cloro ativo,desde 0,12 até 2,50%, na desinfecção superficial destes. Verificou-se que a concentração de 1,50% evitou o aparecimento de contaminantes e não afetou a viabilidade dos escleródios, quando estes foram plantados em meio seletivo.

Visando a determinação desta viabilidade, foram comparados os meios de cultura ágar-água, BDA acidificado e o meio seletivo a base de amido-PCNB-ágar, proposto por Papavizas em 1972. Concluiu-se que este meio seletivo foi o que ofereceu maior segurança na identificação dos escleródios viáveis de *S. cepivorum*.

INTRODUÇÃO

Dentre os vários fatores que contribuem para a baixa produtividade da cultura do alho no Brasil estão as doenças fúngicas, das quais a podridão branca é a que causa maiores danos, trazendo severos prejuízos aos agricultores (Kimati, 1980).

Sclerotium cepivorum Berk., agente causal da doença, não sobrevive no solo na forma de micélio saprofítico. O inóculo primário do fungo é constituído por escleródios de 0,3 a 0,6 mm de diâmetro, formados a partir de micélio, em bulbos infectados (Scott, 1956; Coley-Smith, 1960).

Apesar dos escleródios serem unidades distintas e de mesmo formato, a quantificação destes no solo não é fácil. Isto porque a população de *S. cepivorum* no solo é relativamente baixa e, ao cultivá-lo em meios de cultura artificiais, seu crescimento é muitas vezes inibido por organismos saprófitas (Papavizas, 1972).

Apesar das dificuldades, muitos autores têm desenvolvido métodos para determinar a população de escleródios do fungo no solo (Mc Cain, 1967; Papavizas, 1972; Adams, 1979; Utkede & Rahe, 1979; Crowe *et al.*, 1980; Vimard *et al.*, 1984). Por meio destes, tem sido possível acompanhar o comportamento desta população no solo durante vários anos consecutivos. Estes métodos têm permitido também determinar a viabilidade dos escleródios submetidos a diferentes tratamentos químicos; correlacionar a densidade de escleródios com a incidência da doença no campo› obter culturas de *S. cepivorum* a partir de amostras do solo; e, em alguns casos, determinar a importância da água de irrigação na disseminação do patógeno (Papavizas, 1972; Adams, 1979; Crowe *et al.*, 1980).

Os processos de extração de escleródios até então descritos geralmente iniciam-se com a pesagem da amostra de solo, a qual é desestruturada em água e passada através de duas (Papavizas, 1972; Utkede e Rahe, 1979; Crowe *et al.*, 1980; Vimard *et al.*, 1984) ou seis (Mc Cain, 1967) peneiras convencionais com malhas decrescentes de 0,841 a 0,250 mm. Já Adams (1979), desenvolveu uma peneira visando especificamente a extração de escleródios de *S. cepivorum*. Em algumas técnicas, o processo de extração tem continuidade utilizando-se a flutuação em gradientes de sacarose (Utkede & Rahe, 1979; Crowe *et al.*, 1980; Vimard *et al.*, 1984). Nas que incluem também a determinação do inóculo viável emprega-se a desinfecção superficial dos escleródios em hipoclorito de sódio a 0,25% (Papavizas, 1972; Utkede e Rahe, 1979), 0,525% (Mc Cain, 1967; Crowe *et al.*, 1980) ou 1% (Vimard *et al.*, 1984), seguida pelo plaqueamento em meio de cultura ágar-água (Crowe *et al.*, 1980), BDA (Mc Cain, 1967; Utkede & Rahe, 1979; Vimard *et al.*, 1984) ou meio seletivo (Papavizas, 1972).

Os métodos relatados demandam muito tempo na execução e nem sempre fornecem resultados satisfatórios. Diante disto, o presente trabalho foi realizado com o objetivo de estabelecer uma metodologia adequada para a quantificação do número de escleródios totais e viáveis de *S. cepivorum*, a partir de amostras de solo.

MATERIAL E MÉTODOS

Extração de Escleródios de *S. cepivorum* a Partir de Amostras de Solo

Foi avaliada em laboratório a eficiência de três métodos de extração de escleródios: o método proposto por Papavizas (1972), o método de Crowe *et al.* (1980) e um método modificado, proposto neste trabalho.

Por meio dos métodos a seguir descritos, procedeu-se a recuperação de escleródios a partir de amostras de 100 gramas de solo com pouca matéria orgânica, previamente infestadas com 100, 50, 25, 12 e 6 escleródios, respectivamente. Para cada método, em cada nível de escleródios incorporados ao solo foram utilizadas seis repetições.

Em todos os métodos o primeiro passo consistiu em quebrar a estrutura do solo, agitando-se a amostra juntamente com 1000 ml de água em um liquidificador à baixa rotação, por 30 segundos. Após, a suspensão aquosa resultante foi passada através de peneiras de 0,841 mm (20 mesh) e coletada em um recipiente com capacidade de cinco litros. O material em suspensão neste recipiente foi vertido em peneira de 0,250 mm (60 mesh), descartando-se o líquido percolado.

A partir daí os procedimentos foram diferentes para cada método. Utilizando-se o método proposto por Papavizas (1972), o material retido na pe neira de 60 mesh foi lavado em água corrente de torneira por três minutos. Após, este foi transferido, com o auxílio de uma solução de cloro ativo a 0,25% preparada a partir de água sanitária Super Globo proveniente de uma piseta, para um béquer, até completar o volume de 20 ml. O béquer foi levado a um agitador magnético e após três minutos de agitação adicionou-se 60 ml de água destilada esterilizada. Com o auxílio de uma pipeta e mantendo a agitação, transferiu-se 1 ml da suspensão de escleródios para uma placa de Petri de fundo quadriculado. Para cada amostra inicial de solo foram utilizadas quatro placas de Petri. Papavizas (1972), utilizou alíquota análoga para posterior plaqueamento em meio da cultura seletivo, visando determinar a viabilidade dos escleródios. Como nessa etapa do trabalho o objetivo foi determinar apenas o número de escleródios recuperados, procedeu-se a contagem destes sob microscópio estereoscópio. Para se obter o número de escleródios em 100 g de solo, o número médio de escleródios por placa a partir da amostra de solo inicial foi multiplicado por 80, porque retirou-se 1 ml dos 80 ml presentes no béquer.

No método de Crowe *et al.* (1980), o material retido na peneira de 60 mesh foi lavado em água de torneira por três minutos e coletado com auxílio de jatos de água provenientes de uma piseta, em um béquer contendo 500 ml de água. Os escleródios e os resíduos orgânicos que ficaram em suspensão no béquer foram vertidos novamente na peneira de 60 mesh e, ao material sedimentado neste, adicionou-se 500 ml de solução de sacarose a 50% (500 g/litro). Procedeu-se a agitação com um bastão de vidro por um minuto e após 20 segundos de repouso os escleródios e os resíduos em suspensão foram também vertidos na mesma peneira de 60 mesh. O material total coletado na peneira foi lavado novamente em água de torneira e transferido, com o auxílio de uma piseta, para uma placa de Petri de fundo quadriculado, até completar um volume de água suficiente para cobrir o fundo da placa. Por meio de uma alça de repicagem, sob microscópio estereoscópio, separou-se os escleródios dos resíduos e procedeu-se a contagem, obtendo-se assim o número de escleródios em 100 g de solo.

No método modificado proposto neste trabalho, após as operações de quebra da estrutura do solo e peneiramento já descritas, adicionaram-se mais 1000 ml de água ao material que havia ficado no fundo do liquidificador.

Este conteúdo foi agitado manualmente e após, repetiram-se as operações de peneiramento. Este procedimento foi realizado por três vezes consecutivas. Posteriormente, todo o material acumulado na peneira de 60 mesh foi lavado sob água de torneira por três minutos, e coletado, com o auxílio de jatos deágua provenientes de uma piseta, num disco de papel de filtro, o qual teve como suporte uma peneira de 20 mesh. Esse papel de filtro foi posto a secar, por aproximadamente 24 horas, à temperatura ambiente. Posteriormente, o material nele presente foi submetido a um peneiramento a seco, em peneira de 60 mesh, e coletado em placas de Petri. Utilizou-se uma alça de repicagem para separar os escleródios recuperados dos resíduos e realizou-se a contagem sob microscópio estereoscópio, obtendo-se o número de escleródios em 100 g de solo.

Em cada método testado, avaliou-se a percentagem de recuperação de escleródios e determinou-se o coeficiente de variação das recuperações obtidas.

Desinfecção Superficial e Meios de Cultura para Determinação da Viabilidade dos Escleródios de *S. cepivorum*

Foi avaliada em laboratório a eficiência de concentrações gradativas de cloro ativo na desinfecção superficial dos escleródios, antes do plaqueamento destes em meio de cultura.

Foram separadas 32 amostras de 50 escleródios cada, sobre discos de papel de filtro. Trinta e duas placas de Petri, cada uma com 50 ml de solução aquosa de cloro ativo nas concentrações de 0,00; 0,12; 0,25; 0,50; 1,00; 1,50; 2,00; e 2,50, foram preparadas a partir de água sanitária Super Globo, contendo 5,2% de cloro ativo. Foram utilizadas quatro placas de Petri para cada concentração, e os escleródios de cada disco de papel de filtro devidamente etiquetado, foram imersos nas soluções de cloro ativo correspondentes. Durante a imersão por três minutos, os escleródios foram movimentados sobre os respectivos discos utilizando-se uma alça de repicagem previamente flambada. Decorrido esse tempo, os discos contendo os escleródios foram transferidos para folhas de papel de filtro esterilizadas, anteriormen te colocadas sobre o balcão de uma câmara de repicagem de fluxo laminar. Após cinco minutos, os 50 escleródios de cada disco foram sendo individualmente transferidos para pontos eqüidistantes da superfície de um meio de cultura seletivo para *S. cepivorum*, contido em uma placa de Petri.

O meio de cultura seletivo utilizado foi proposto por Papavizas (1972) e preparado da seguinte maneira: dissolveram-se 12 g de amido em 100 ml de água quente contidos em um béquer. Em um erlenmyer de 2000 ml foram colocados: 20 g de ágar, 3 g de $NaNO_3$, 1 g de K_2HPO_4 e 0,5 g de $MgSO_4 . 7H_2O$. Verteu-se a solução de amido no erlenmyer e adicionaram-se 5 ml de uma solução contendo 14,9 g de Na_2EDTA e 10,8 g de $FeCl_3 . 6H_2O$ por litro. Completou-se o volume para 900 ml e o pH do meio foi ajustado em 5,2 utilizando-se ácido lático a 5%. A autoclavagem foi realizada a 121 °C, adicionaram-se 40 ml de suspensão aquosa contendo 1 g de PCNB, e 60 ml de solução aquosa contendo 50 mg de clorotetraciclina e 100 mg de sulfato de estreptomicina. O meio de cultura foi então vertido em placas de Petri e armazenanado a 24 °C por 7 dias, antes de ser utilizado.

Procedido o plaqueamento dos escleródios no meio, a incubação foi feita a 16 °C, por quatro semanas. Posteriormente foram avaliados em cada placa de Petri: número de colônias de organismos contaminantes, percentagem de escleródios cobertos com contaminantes e percentagem de viabilidade dos escleródios livres de contaminantes.

Estabelecida a melhor desinfecção superficial, procurou-se avaliar a eficiência de meios de cultura, visando a determinação da viabilidade dos escleródios de *S. cepivorum*. Com este objetivo, procedeu-se prévia desinfecção superficial dos escleródios em solução de cloro ativo a 1,5%, conforme técnica anteriormente descrita. Realizou-se o plaqueamento de 50 escleródios em placas contendo meio ágar-água a 2%, batata-dextrose-ágar (BDA) acidificado (pH 5,2) e meio seletivo proposto por Papavizas, sendo um total de cinco placas para cada meio.

A incubação foi realizada a 16 °C e a avaliação da viabilidade, após duas semanas nos meios ágar-água e BDA e após quatro semanas no meio seletivo, conforme recomendação de Crowe *et al.* (1980), e Papavizas (1972), respectivamente.

Estes meios foram qualitativamente comparados, considerando os seguintes aspectos: simplicidade de preparo, riscos de contaminação, e principalmente, segurança na identificação dos escleródios viáveis.

RESULTADOS E DISCUSSÃO

Extração de Escleródios de *S. cepivorum* a Partir de Amostras de Solo

Em todos os métodos avaliados (Quadro 1), observou-se que as percentagens de recuperação dos escleródios tenderam a diminuir e os coeficientes de variação das recuperações obtidas tenderam a aumentar, à medida que se diminuiu o nível de escleródios no solo. Estes resultados concordaram com os obtidos por Crowe *et al.* (1980), os quais demonstraram que os métodos de extração tornam-se imprecisos quando a população de escleródios no solo for reduzida, sendo esta indetectável quando estiver abaixo de 0,001 escleródio/g de solo.

Analisando o Quadro 1 verifica-se que o método modificado proposto neste trabalho apresentou maiores percentagens de recuperação de escleródios e menores coeficientes de variação, em relação aos outros dois métodos. O método proposto por Crowe *et al.* (1980), apresentou eficiência intermediária e com o de Papavizas (1972), obteve-se as menores percentagens de recuperação de escleródios e os mais altos coeficientes de variação.

A maior eficiência do método modificado deveu-se certamente às repetidas a operações de peneiramente a úmido, além do peneiramento adicional a seco, o qual eliminou a maior parte dos resíduos de matéria orgânica ainda persistentes nesta fase da recuperação.

No método de Crowe *et al.*, a flutuação em gradiente de sacarose a 50% complementar às operações de peneiramento, não demonstrou consistência na recuperação dos escleródios remanescentes. Por último, no método de Papavizas, a utilização para a contagem, de alíquotas de 1 ml da suspensão contendo escleródios, deu margem a grandes variações, fazendo com que esta diluição nem sempre fosse representativa do número de escleródios presente na amostra inicial.

QUADRO 1 - Coeficientes de variação e percentagens médias de escleródios de *Sclerotium cepivorum* recuperados por diferentes métodos de extração a partir de solo infestado com níveis gradativos de escleródios. U.F.V., Viçosa-MG, 1984

Número de escleródios incorporados/ 100 g de solo	Método de Papavizas		Método de Crowe *et al*.		Método modificado proposto	
	Recuperação[1] (%)	CV (%)	Recuperação (%)	CV (%)	Recuperação (%)	CV (%)
100	70,0	29,3	81,0	4,3	92,0	2,8
50	66,7	50,0	83,2	5,0	92,4	3,6
25	53,3	74,5	76,0	7,0	88,8	4,9
12	53,3	154,8	71,7	13,3	83,3	10,0
6	53,3	246,2	63,3	22,0	86,7	8,6

[1] Média de seis repetições.

Desinfecção Superficial e Meios de Cultura para Determinação da Viabilidade dos Escleródios de *S. cepivorum*

Papavizas (1972), relatou que a imersão do material coletado na peneira de 60 mesh durante a extração, numa solução de hipoclorito de sódio a 0,25% por 2,5 minutos, era suficiente para eliminar a grande maioria dos contaminantes provenientes do solo, que se desenvolviam no meio seletivo. Quando se utilizou procedimento semelhante, ainda se desenvolveram muitos contaminantes neste meio de cultura. Então, somente procedeu-se o plaqueamento dos escleródios, após estes terem sido separados dos resíduos de matéria orgânica do solo e desinfectados superficialmente por três minutos em concentrações crescentes de cloro ativo.

As colônias de organismos contaminantes desenvolvidas no meio seletivo dificultaram muito a avaliação da viabilidade dos escleródios, uma vez que vários destes foram cobertos por cada colônia. Então a percentagem de viabilidade dos escleródios foi avaliada, considerando-se somente os escleródios não cobertos por contaminantes.

O número de colônias de contaminantes no meio seletivo de Papavizas tendeu a diminuir com o aumento da concentração de cloro ativo. Também a viabilidade dos escleródios não foi sensivelmente prejudicada pelas concentrações mais altas de cloro ativo. Em face destes resultados (Quadro 2), estabeleceu-se como ótima a desinfecção superficial dos escleródios por três minutos em cloro ativo a 1,5%. Com isto, tornou-se desnecessária a passagem dos escleródios após a desinfecção superficial, em água destilada esterelizada, conforme recomendado por Crowe *et al.* e Papavizas.

Com relação aos meios de cultura, verificou-se que o ágar-água não ofereceu segurança na determinação da viabilidade dos escleródios. Isto porque, em ágar-água, *S. cepivorum* formou somente micélio, e a identificação deste foi difícil, uma vez que neste meio determinados fungos colonizadores de escleródios formaram micélio bastante parecido com o de *S. cepivorum.*

No meio BDA acidificado, ocorreu o desenvolvimento de vários fungos contaminantes, apesar da prévia desinfecção superficial dos escleródios em cloro ativo a 1,5%. Após duas semanas de incubação, a avaliação da viabilidade dos escleródios tornou-se impraticável, uma vez que vários destes foram

QUADRO 2 - Efeito de diferentes concentrações de cloro ativo sobre organismos contaminantes e viabilidade dos escleródios de *Sclerotium cepivorum* em meio seletivo[1]. U.F.V., Viçosa-MG, 1984

Parâmetros avaliados[2]	Concentração de cloro ativo (%)							
	0,00	0,12	0,25	0,50	1,00	1,50	2,00	2,50
Número de colônias de contaminantes[3]	9,50	6,25	4,50	0,75	0,50	0,00	0,00	0,00
Escleródios cobertos por contaminantes (%)	59,00	46,00	35,50	13,00	4,00	0,00	0,00	0,00
Viabilidade dos escleródios livres de contaminantes (%)	90,50	92,50	88,00	94,00	86,50	91,00	89,00	84,50

[1] Meio seletivo proposto por Papavizas (1972)

[2] Média de quatro repetições

[3] Organismos contaminantes mais freqüentes: *Fusarium* spp., *Penicillium* spp. e *Trichoderma* spp.

cobertos pelas colônias de contaminantes ou pelas colônias de *S. cepivorum* provenientes dos escleródios vizinhos.

O meio seletivo proposto por Papavizas demandou mais trabalho e tempo para o preparo que os meios ágar-água e BDA, porém foi o que propiciou o desenvolvimento de menor número de contaminantes. Nesse meio, a partir da terceira semana de incubação, formou-se uma colônia de escleródios ao redor de cada escleródio viável, inicialmente plaqueado. Ao contrário do BDA, no meio seletivo estas colônias tiveram crescimento reduzido e não coalesceram, possivelmente devido ao PCNB adicionado. Assim, os dados de viabilidade obtidos neste meio foram certamente mais precisos que os obtidos em ágar-água ou em BDA acidificado.

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DETECTION OF ALLIUM WHITE ROT INFECTION USING A HAND-HELD RADIOMETER.
A FIELD EXPERIMENT.

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INTRODUCTION

VISUAL DETECTION AND ASSESSMENT OF ALLIUM WHITE ROT (AWR) INFECTION IN A DEVELOPING CROP IS DIFFICULT WITHOUT DESTROYING THE CROP, BECAUSE THE BULB MUST BE EXAMINED AND BECAUSE INCIDENCE OF THE CONDITION VARIES WIDELY WITHIN A SINGLE FIELD.

IT IS HOPED THAT, BY UTILISING A PORTABLE RADIOMETER, THE OCCURENCE OF THE DISEASE WITHIN A FIELD CAN BE MAPPED RAPIDLY WITHOUT DAMAGING THE CROP. PREVENTATIVE MEASURES COULD THEN BE APPLIED ONLY WHERE THEY ARE REQUIRED.

IN ORDER TO TEST THIS IDEA, CONTROLLED FIELD EXPERIMENTS ARE BEING CONDUCTED AT NVRS.

1985 EXPERIMENT

MODULES OF ONION CV RIJNSBURGER ROCKY WERE PLANTED IN BEDS WITHIN A FIELD UNIFORMLY INFECTED WITH ALLIUM WHITE ROT SCLEROTIA.

DIFFERENT LEVELS OF THE DISEASE WERE SIMULATED BY APPLYING MYCLOZOLIN FUNGICIDE:

TREATMENT	MYCLOZOLIN g ai/m row	THEORETICAL PROTECTION
1	0.05	FULL
2	0.025	HALF
3	UNTREATED	UNPROTECTED

THESE TREATMENTS WERE RANDOMLY APPLIED TO PLOTS WITHIN EACH OF SIX HARVEST BLOCKS. FOUR REPLICATIONS WERE MADE OF EACH HARVEST BLOCK.

WHITE ROT ASSESSMENT

ONE WHOLE PLOT IN EACH REPLICATE WAS HARVESTED FORTNIGHTLY SO THAT A VISUAL ASSESSMENT OF WHITE ROT COULD BE MADE. THE NUMBER OF PLANTS INFECTED WAS EXPRESSED AS A PROPORTION OF THE TOTAL NUMBER IN THAT PLOT.

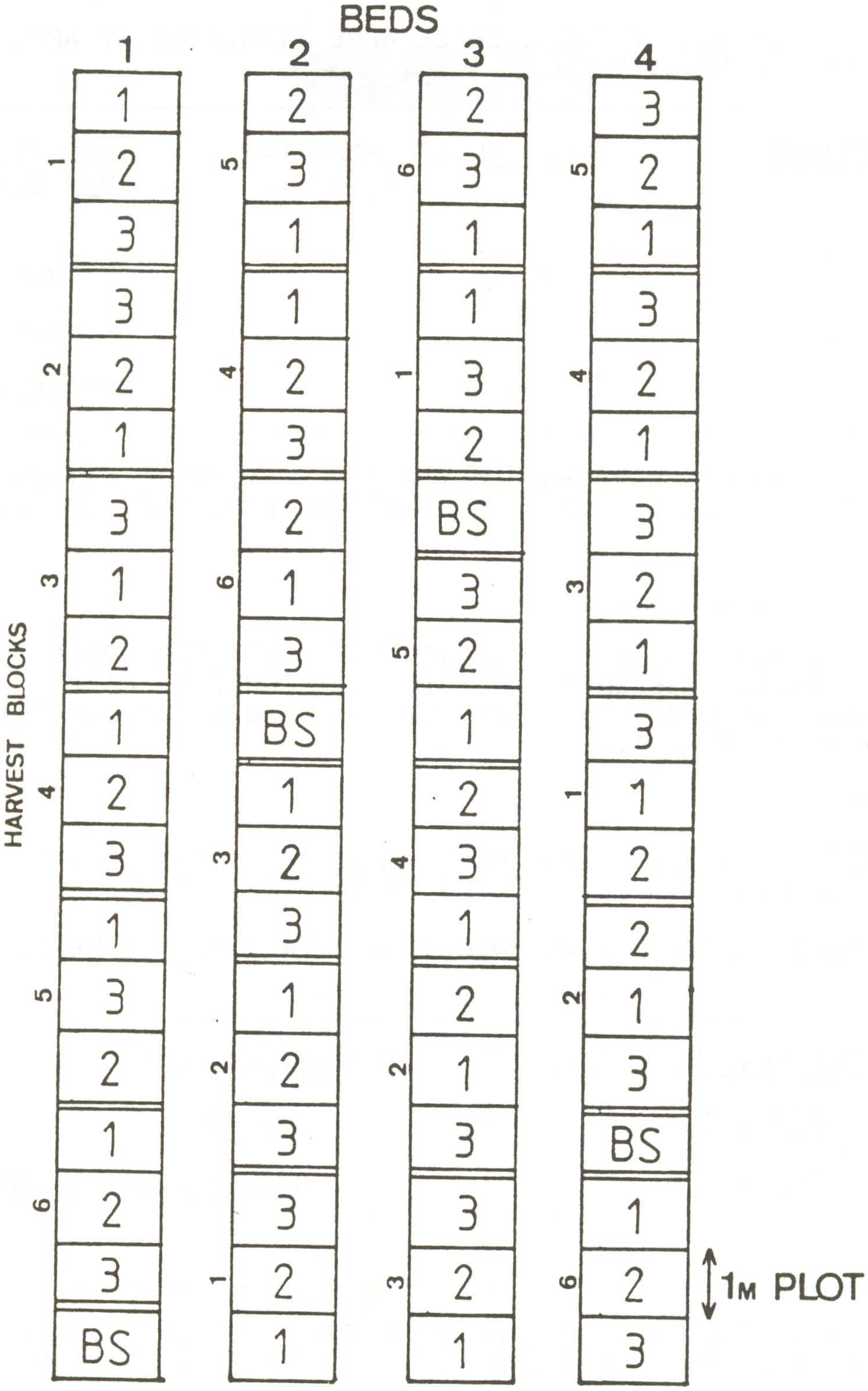
RADIOMETRY

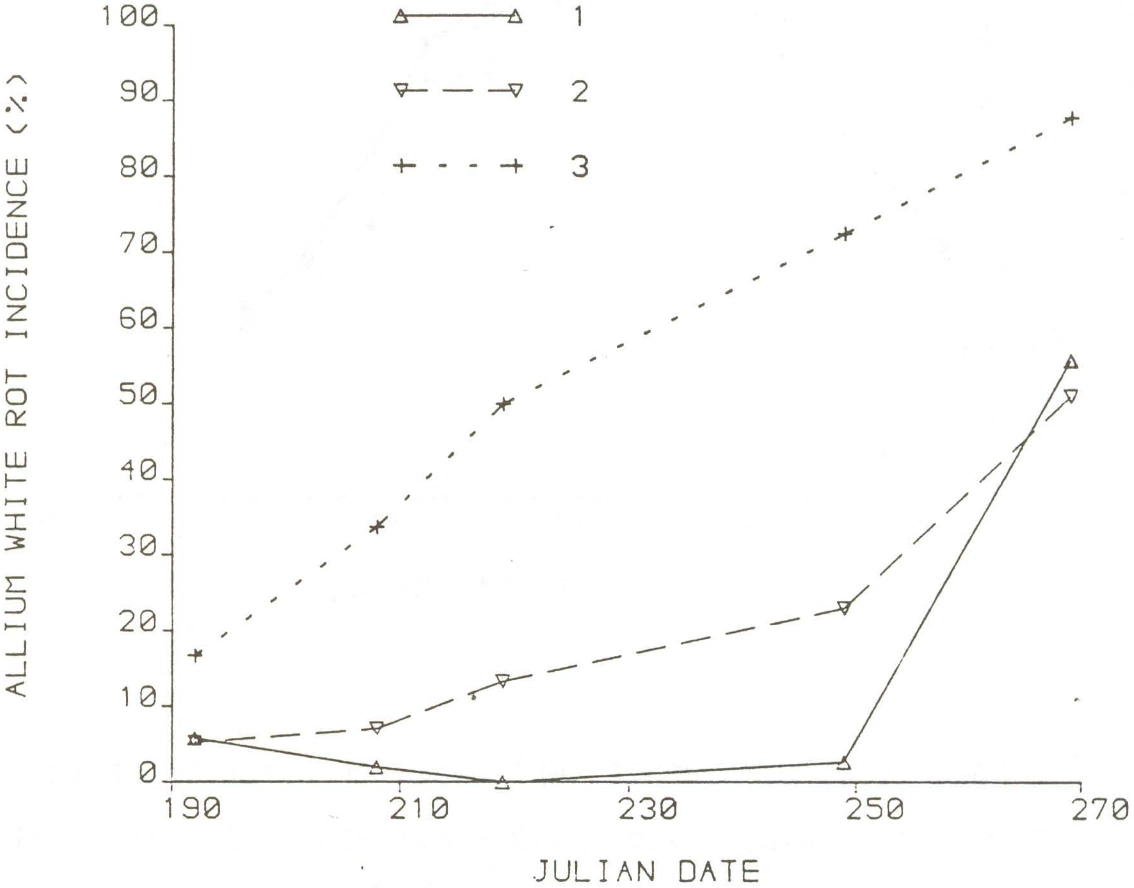
THE MSP1000 MULTISPECTRAL HAND-HELD RADIOMETER, DEVELOPED AT SILSOE COLLEGE AND CONSTRUCTED BY SPECTRASCAN WAS USED.

THE SENSED SPECTRAL BANDS USED FOR DATA ANALYSIS WERE:

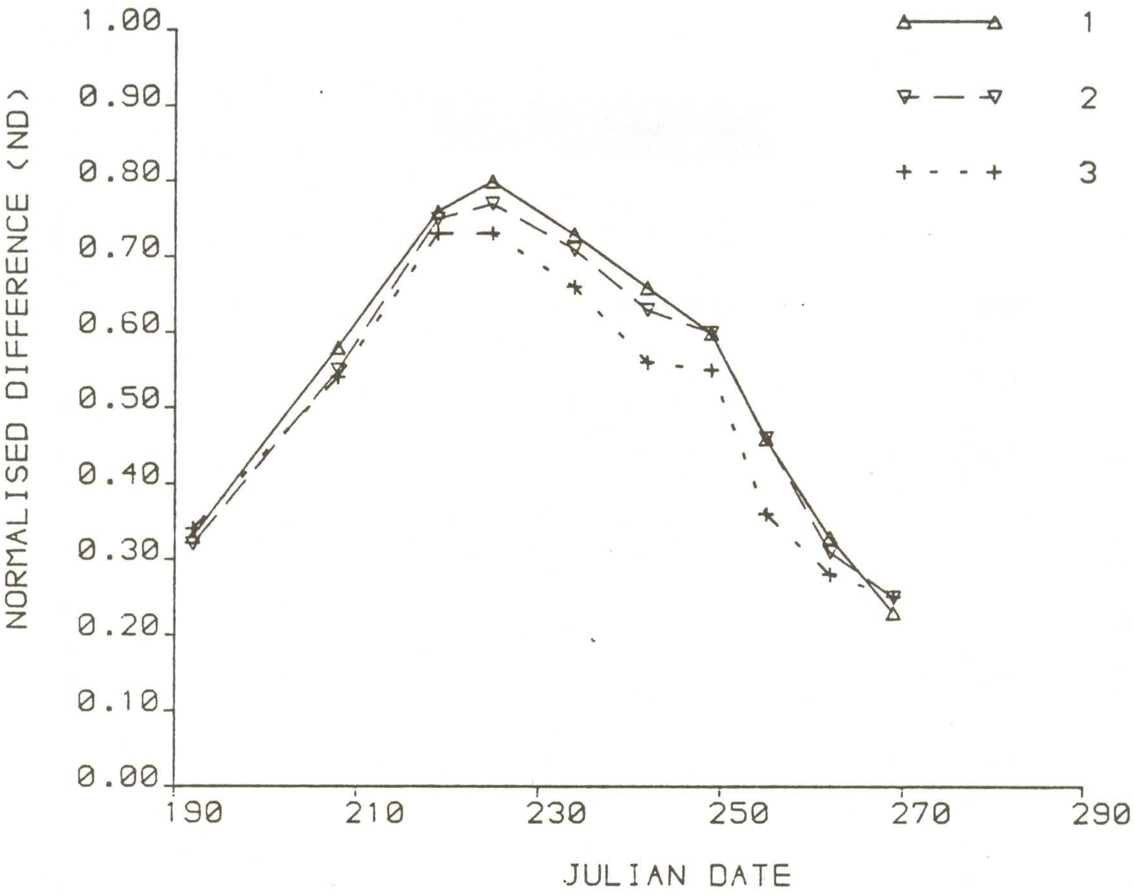
SPECTRAL BAND (nm)	EQUIVALENCE
650 ± 30	RED (R)
750 ± 30	NEAR INFRA-RED (NIR)

READINGS OF THE REFLECTED/INCIDENT RADIATION WITHIN EACH WAVEBAND WERE OBTAINED FOR THE AWR INFECTED PLOTS AT 14 DAY INTERVALS.


BEDS
1
2
3
4
HARVEST BLOCKS
1M PLOT
1 2 3 3 2 1 3 1 2 1 2 3 1 3 2 1 2 3 BS
1 2 3 4 5 6
2 3 1 1 2 3 2 1 3 BS 1 2 3 1 2 3 3 2 1
5 4 6 3 2 1
2 3 1 1 3 2 BS 3 2 1 2 3 1 2 1 3 3 2 1
6 1 5 4 2 3
3 2 1 3 2 1 3 2 1 3 1 2 2 1 3 BS 1 2 3
5 4 3 1 2 6



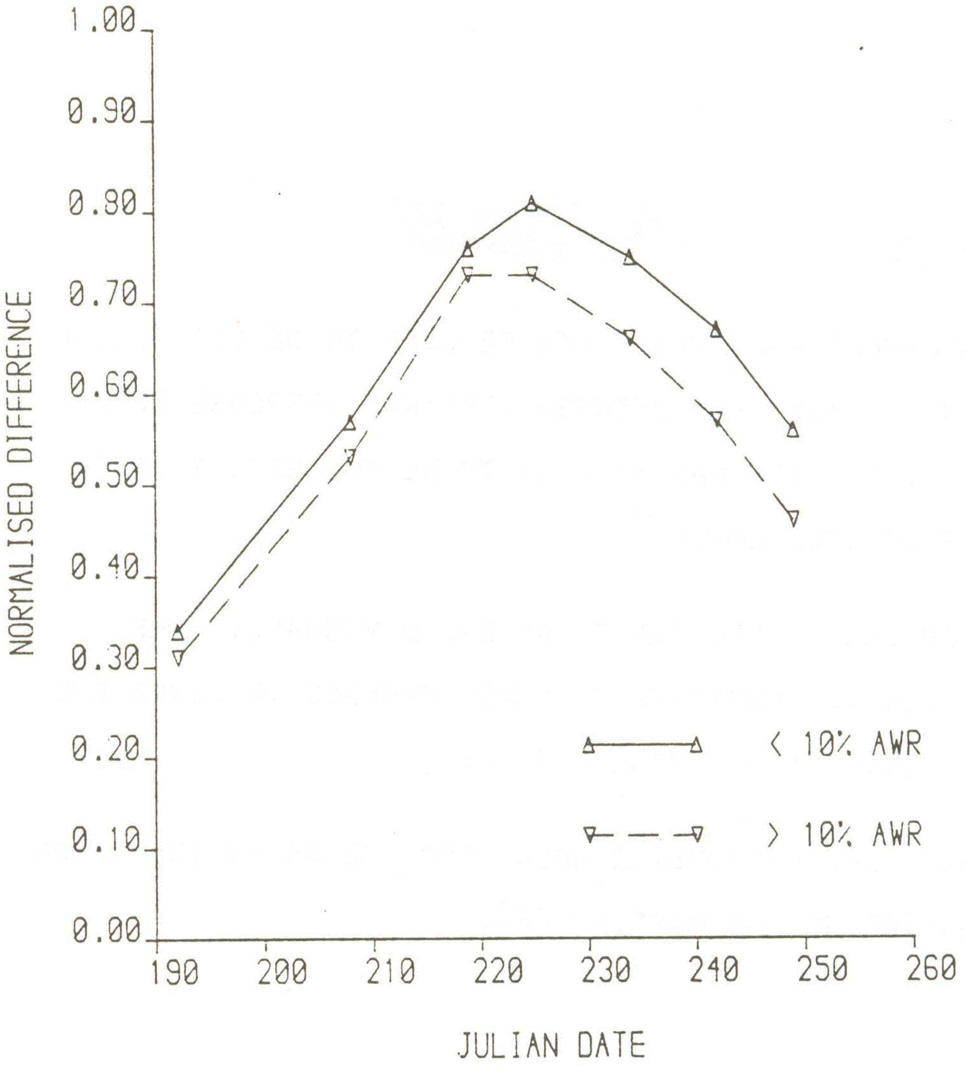
THE THREE TREATMENTS WERE SUCCESSFUL IN PRODUCING DIFFERENT LEVELS OF WHITE ROT INFECTION.



THE NORMALISED DIFFERENCE (ND) INDEX OF REFLECTANCE IS OBTAINED AS A BAND RATIO: (NIR - R)/(NIR + R). THIS RATIO IS SENSITIVE TO VEGETATION AND REDUCES EFFECTS DUE TO SOIL BACKGROUND REFLECTANCE AND SOLAR ANGLE.

ND INCREASES UP TO JULIAN DATE 225 DUE TO CROP GROWTH, AND DECLINES THEREAFTER DUE TO SENESCENCE.

THE SPECTRAL RESPONSES FOR THE TREATMENTS ARE SIGNIFICANTLY DIFFERENT AFTER JULIAN DATE 225 (P = 1%).



AFTER JULIAN DATE 225, ONION PLOTS WITH LESS THAN 10% INCIDENCE OF AWR CAN BE DISTINGUISHED FROM PLOTS WITH MORE THAN 10% OF PLANTS INFECTED. (P = 1%).

CONCLUSIONS

THE HAND-HELD RADIOMETER CAN BE USED TO DETECT ALLIUM WHITE ROT. THE LINK BETWEEN SPECTRAL RESPONSE OF ONIONS AND AWR INFECTION WAS THOUGHT TO BE THE EFFECT OF THE DISEASE ON CROP COVER.

ALTHOUGH CROP COVER CAN BE ASSESSED VISUALLY, THE RADIOMETER IS SENSITIVE TO SMALL CHANGES IN COVER AND MEASUREMENTS CAN BE MADE RAPIDLY.

THE HAND-HELD RADIOMETER HOLDS PROMISE AS AN INSTRUMENT FOR MONITORING AND MAPPING AWR.

SECTION 3

White rot control in the western US, with reference to the influence of inoculum density of *Sclerotium cepivorum*

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Data is presented from work by various scientists in California, Oregon and Washington. In white rot trials in California between 1976-82 in situations conducive to season-long activity of *Sclerotium cepivorum*, in-furrow planting time applications of numerous fungicides, both alone and in combination, proved unsatisfactory at inoculum densities greater than 0.01 sclerotia/gm of soil. Infested soils in areas of the western US with severe white rot commonly range from 0.001 to 0.5 sclerotia/gm of soil for many years. Results from onion and garlic trials in 1982 and 1983 in several different soils infested near 0.2 sclerotia/gm of soil confirmed that Rovral (iprodione) and Ronilan (vinclozolin) were better than other fungicides. Efficacy was improved when in-furrow treatments were combined with seed treatments, but the primary benefit was from in-furrow application. On garlic, Ronilan proved as good or better than Rovral at equivalent rates. On onions, Ronilan proved phytotoxic at the most effective rates of application for white rot control. Nevertheless, neither Rovral nor Ronilan gave commercially acceptable control on either onions or garlic at levels of soil infestation near 0.2 sclerotia/gm of soil, irrespective of application methodology.

Rovral 50W has a national label for in-furrow use for garlic white rot, at 4 lb of product per acre (concentrated into a narrow band around the planting furrow). Commercial growers' experience is limited with this treatment because the California processing garlic industry recently relocated from the generally infested coastal valleys to the generally uninfested interior San Joaquin Valley. Based upon data from Oregon, Washington and California, Rovral 50W was granted state registrations in Oregon and Washington for application to onions similar to that for garlic. From experience in the Willamette Valley (OR) and Walla Walla (WA)/Milton-Freewater (OR) area, this treatment is helpful but frequently insufficient. This may relate to the inoculum density-dependent control experienced in California. Control of white rot with an in-furrow Rovral spray may be enhanced by in-season basal sprays with Rovral (for *Botrytis* control), but such basal sprays by themselves are ineffective. Based upon some preliminary data for *Sclerotinia* control on vegetables in the Salinas Valley (CA), there may be developing on enhanced microbial breakdown of soil-applied Rovral associated with previous Rovral usage in the same soil.

Methyl bromide soil fumigation reduced inoculum density by 98-99%, with the level of resultant disease control still dependent on the magnitude of the 1-2% residual population of sclerotia. Chloropicrin and Vapam were not effective.

Chemical control of white rot in module raised spring bulb onions - comparison of soil sterilants

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The object of this work was to evaluate the control of white rot and the effect on yield of various soil sterilants and fungicides in Hassy module raised spring bulb onions. In addition the effect of the various sterilants on the viability of artificially buried *Sclerotium* sclerotia was assessed.

Site 1 - Kirton ADAS Experimental Horticulture Station

At the 'quarantine site' plots 10 m x 2 m were treated with metham sodium (Metham Sodium) 300 l cp/ha and dichloropropene (Telone II) 220 l cp/ha on 28 October 1985 and with dazomet (Basamid) 380 kg cp/ha on 5 November 1985. The former two chemicals were applied using a Rumpstadt machine and the same machine was driven through the control plots without using any chemical. Dazomet was applied using a spade digger (M Farthing Limited).

The effect of the various treatments on the viability of artificially buried sclerotia was assessed. Sclerotia were placed 25 per bag in Nylon bags together with a small amount of sand. The bags were then enclosed in Netlon mesh and buried in the plots immediately after treatment. The bags of sclerotia were arranged in the Netlon mesh so that they were buried at 2.5, 10 and 20 cm. These were removed prior to planting and their viability assessed (Coley-Smith 1985). Two 'strings' of Netlon mesh containing sclerotia were buried in each plot. Each plot including controls was covered with 500 gauge polythene sheeting on the same day of treatment. The polythene sheet was removed just prior to planting which was 10 April 1986. Half the number of modules were treated with iprodione (Rovral WP 50%) drench 4.42 g ai in 400 ml/Hassy 308 tray (0.25 m²) prior to planting. The trial design was a randomised block, each plot split with or without iprodione drench treatment with 4 replicates.

Site 2 - Moulton

Plots of similar size were treated with the same rates of metham sodium and dichloropropene applied by Rumpstadt on 28 October. In addition, "onion juice", a commercial juice preparation, was diluted ten times and applied through the same machine at the rate of 500 l/ha. Control plots were similarly treated but without any chemical. Dazomet was applied at 380 kg cp/ha and

570 kg cp/ha using the spade digger applicator on 5 November.

'Strings' of sclerotia were buried in each plot as previously described. Each plot was covered with 500 gauge polythene sheet the following day after treatment. The polythene sheets were removed just prior to planting which was on 8 May. Half the number of modules in each plot were treated with vinclozolin (Ronilan 50% WP) drench 3.08 g ai in 400 ml/Hassy 308 tray (0.25 m²) prior to planting. The trial design was a randomised block, each plot split with or without vinclozolin drench treatment with five replicates.

The plants in both sites were grown as local practice and received standard nematicide, herbicide and fertiliser treatments.

Application of the dazomet treatment was considered to have been partially effective (60% effective) at the Kirton EHS and 90% effective at Moulton. This was due to chemical drift in the wind, as the equipment lacked side panels, despite the use of hand-held polythene screens.

The results of viability of the artificially buried sclerotia are given in Tables 1 and 2. At Kirton survival scores of the buried sclerotia in the untreated plots were low. Some of the sclerotia may have been lost by germination and some were recovered in a germinating condition on inspection. This may have been due to the effect of onion debris in the soil, as previous onion crops on this site were ploughed into the soil. These figures indicated that none of the treatments would give a high degree of control. Table 3 gives the white rot assessments carried out on 9 September. Each module was inspected for plants showing below ground symptoms of white rot. No treatment gave a high enough degree of control although above ground visual crop assessments indicated that dazomet and metham sodium treated plots appeared to be the best ones. In addition, iprodione treated sub-plots appeared to be more healthy but not consistently so, however disease scores in these plots were generally higher than ones not treated with iprodione. Possibly iprodione may have an enhancing growth effect of keeping the plots greener longer. It would appear that there was no beneficial effects on the performance of iprodione following the various soil treatments.

The yields of marketable (healthy) onions for the Kirton EHS trial are given in Table 5. An increase in yield was observed in plots treated with metham sodium and dazomet from plants not treated with iprodione. It would appear that there was no beneficial effects on the yield following iprodione treatment.

Table 1

% Viable sclerotia recovered - Kirton EHS

Treatment	Depth of burial		
	2.5 cm	10 cm	20 cm
Untreated	77.0	81.0	90.5
Metham Sodium	37.0	21.0	18.0
Dichloropropene	22.0	46.5	51.0
Basamid	12.0	20.5	30.0

Table 2

% Viable sclerotia recovered - Moulton

Treatment	Depth of burial		
	2.5 cm	10 cm	20 cm
Control	23.2	56.0	37.6
Metham Sodium	29.6	44.0	20.0
Dichloropropene	44.0	46.4	27.2
Onion juice	19.2	44.8	24.0
Dazomet 380 K ha^{-1}	2.0	3.4	3.4
Dazomet 570 K ha^{-1}	0.0	0.0	0.0

Table 3

White rot assessments 9.9.86 - Kirton EHS

Treatment	% Modules affected	
	- iprodione	+ iprodione
Untreated	68.9	78.7
Metham Sodium	51.5	64.0
Dichloropropene	72.2	74.5
Dazomet	27.1	37.8

Table 4

White rot assessments 16.7.86 - Moulton

Treatment	% Modules affected	
	- vinclozolin	+ vinclozolin
Untreated	19.6	3.4
Metham Sodium	14.3	3.8
Dichloropropene	7.5	2.2
Onion juice	12.5	4.4
Dazomet 380 kg/ha	1.8	0.6
Dazomet 570 kg/ha	0	0

Table 5

Yield of marketable (healthy) onions 12.9.86 - Kirton EHS

Treatment	Yield kg/plot	
	- iprodione	+ iprodione
Untreated	9.6	9.1
Metham Sodium	15.9	12.8
Dichloropropene	7.5	8.2
Dazomet	19.5	15.5

At Moulton the survival scores of the buried sclerotia in the untreated plots were extremely low (Table 2). This cannot be explained. The performance of dazomet, especially at the higher rate looked very promising in terms of its effect on artificially buried sclerotia and the disease assessment (above ground symptoms) in mid July. The addition of the vinclozolin treatment reduced disease scores in every treatment. Final disease scores and yield data for Moulton were not available as this trial was not harvested to date (12/9/86).

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We would like to thank BASF UK Ltd for supplying dazomet and for its application, Bush, Boke and Allen Ltd for supplying onion juice, Oldershaw's of Moulton Ltd for allowing us to use their site and to the staff of Kirton EHS for considerable assistance with these trials.

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Chemical control of white rot in module-raised spring bulb onions

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1. COMPARISON OF FUNGICIDES

A range of fungicides was applied to module-raised bulb onion plants in 1984 and 1985 on the 'quarantine site' at the Kirton ADAS Experimental Horticulture Station (EHS) for the control of white rot. The chemicals were applied as pre-planting drenches and basal sprays.

Plants cv Copra (1984) and cv Hyton (1985) were raised in 2.7 cm^3 peat blocks and planted 18 April and 9 April respectively. Pre-planting drenches were applied in 1 litre water per tray (240 blocks) and basal sprays were applied, 5 and 10 weeks after planting, in 100 ml water/m (100 mm wide band) row. The rate of fungicides used are given in Table 1. The trial designs were as randomised blocks with 6 replicates, each plot was 4 m x 5 rows (70 modules/plot). The plants were raised and grown according to local practice and received standard nematicide, fertiliser and herbicide treatments. Weekly disease assessments were made after the first symptoms were recorded (10 June 1984, 22 May 1985) and at harvest the yield of healthy and affected onions were recorded. The results of the final disease assessment, total yield and yield of healthy onions are given in Tables 2 and 3.

Over the two years myclozolin and procymidone gave excellent disease control and yield increase over the untreated. Neither of these fungicides is commercially available nor has recommendations for use in the UK. Other fungicides tested performed poorly in terms of yield of healthy onions. The performance of iprodione appears to have decreased (see J D Wafford's paper on effect of water volume on the efficacy of iprodione presented at this workshop). Iprodione used in 1981 on this site appeared to have given better control. Soil samples from this site are under investigation at the NVRS to test for enhanced dicarboximide degradation. The recommendation for the control of white rot in bulb onions with iprodione was withdrawn by the marketing company in 1986.

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Table 1

Comparison of fungicides - fungicide and rates applied

Chemical	Product	Rate ai/ tray	Rate ai/ m row
iprodione	Rovral 50% WP	4.42 g	0.15 g
vinclozolin	Ronilan 50% WP	3.08 g	0.15 g
myclozolin	Experimental 50% WP	3.08 g	0.15 g
procymidone	Sumisclex 50% WP	3.08 g	0.15 g
thiabendazole	Storite Flowable 45% W/V	4.59 ml	0.135 ml
tolclofos-methyl	Basilex 50% WP	3.08 g	0.15 g
quintozene	Brassicol 20% WP	1.77 g	0.7 g

Table 2

Comparison of fungicides - disease scores and yield 1984

Treatment	Mean number of modules affected/70 30.7.84	Harvest weight kg/plot	
		Yield of healthy onions	Total yield
1. Untreated	63.0^{c}	2.37^{a}	4.00^{a}
2. iprodione	58.17^{c}	4.45^{a}	7.52^{a}
3. vinclozolin	42.17^{b}	10.37^{b}	16.35^{b}
4. myclozolin	3.67^{a}	25.02^{c}	27.02^{c}
5. procymidone	2.33^{a}	28.7^{c}	30.68^{c}
6. thiabendazole	37.83^{b}	8.85^{b}	12.4^{b}
7. tolclofos-methyl	58.67^{c}	3.65^{a}	6.22^{a}
8. quintozene	42.67^{b}	9.05^{b}	12.9^{b}
SED	5.38	1.86	1.95

Table 3

Comparison of fungicides - disease scores and yield 1985

Treatment	Mean number of modules affected/70 22.8.85	Harvest weight kg/plot	
		Yield of healthy onions	Total yield
1. Control	56^{d}	1.3^{a}	7.9^{a}
2. iprodione	37.2^{bc}	4.4^{ab}	10.1^{abc}
3. vinclozolin	47.2^{c}	2.6^{ab}	11.2^{ab}
4 myclozolin	0^{a}	28.1^{c}	37.5^{d}
5. procymidone	0^{a}	30.2^{c}	37.42^{d}
6. thiabendazole	29.2^{b}	6.3^{ab}	17.5^{bc}
7. tolclofos-methyl	30^{b}	7.6^{ab}	22.8^{c}
8. quintozene	8.8^{a}	8.7^{b}	23.8^{c}
SED	5.32	2.92	3.71

Any figures with the same letter in any vertical column are not significantly different at the 5% level.

2. TIMING OF FUNGICIDE APPLICATION

The object of this work was to investigate the timing and methods of fungicide application for the control of white rot of bulb onions grown in modules.

In 1985 procymidone (Sumisclex 50% WP) was applied singly as a pre-planting drench, a basal spray 5 weeks after planting, a basal spray 10 weeks after planting and in all combinations. These treatments were superimposed on Hassy modules and 2.7 cm^3 block raised plants cv Hyton on the 'quarantine site' at the Kirton ADAS EHS. Pre-planting drenches of procymidone were applied at the rate of 13.75 g ai/m^2 in 4 litres water for blocks and 1.6 litres water for Hassy 308 trays. Basal sprays were applied 5 and 10 weeks after planting at the rate of 0.15 g ai procymidone in 100 ml water/m (100 mm band) row. The trial design was a full factorial with 6 replicates, each plot was 4 m x 5 rows (70 modules/plot). The plants were raised and grown according to local practice and received standard nematicide, fertiliser and herbicide treatments. The trial was planted on 9 April; white rot was first recorded on 22 May and weekly disease assessments were made after, and at harvest the yield of healthy and affected onions was assessed.

The results of the individual treatment combinations on disease levels and yield are given in Table 4 and the main effects following factorial analyses are given in Tables 5a, b and c. The factorial analyses of the main effects clearly show that the pre-planting drench and the five week basal spray treatments gave a highly significant (P = 0.001) reduction in white rot levels together with an increase in total yield and yield of healthy onions. The pre-planting drench treatment gave significantly (P = 0.05) better disease control than the 5 week basal spray treatment (Table 4). The 10 week basal spray treatment gave no overall disease reduction but gave an increase in total yield and yield of healthy onions and this may reflect the limitation of the spread of the disease within the module as the disease was recorded 4 weeks before this treatment was applied. There were no signficicant differences in disease levels between the block and Hassy raised plants. However, a significant (P = 0.05) yield increase was recorded where block raised plants performed better than Hassy raised ones. A possible explanation for this could have been that the late planting of this trial affected the Hassy plants adversely.

These trials showed that of the fungicides tested in module-raised spring bulb onions in 2 years, procymidone and myclozolin gave the best disease control and yield increases. Neither chemical is available for commercial use at present in the UK. Work with procymidone in one trial indicated that the best disease control and yield increases were obtained following a pre-planting drench treatment.

Table 4

Timing of fungicide application - disease scores and yield

No.	Hassy + Block -	Pre-planting drench	Basal spray 5 week	Basal spray 10 week	Mean number of modules affected/70 22.8.85	Harvest weight kg/plot	
						Healthy onions	Total yield
1	+	-	-	-	46.2^{d}	4.42^{a}	13.72^{a}
2	+	+	-	-	0.3^{a}	18.97^{defg}	32.45^{fgh}
3	+	-	+	-	15.5^{b}	14.43^{bcd}	27.85^{cdef}
4	+	-	-	+	28.0^{c}	11.03^{abc}	23.8^{bcde}
5	+	+	+	-	0.7^{a}	26.35^{ghi}	35.17^{fghi}
6	+	+	-	+	1.8^{a}	22.05^{efgh}	34.65^{fghi}
7	+	-	+	+	18.2^{bc}	10.03^{abc}	20.75^{abc}
8	+	+	+	+	0.0^{a}	24.33^{fgh}	35.27^{fghi}
9	-	-	-	-	39.2^{d}	7.58^{ab}	17.33^{ab}
10	-	+	-	-	2.7^{a}	21.3^{defgh}	30.73^{efg}
11	-	-	+	-	15.5^{b}	14.75^{bcde}	27.67^{cdef}
12	-	-	-	+	27.3^{c}	9.17^{ab}	22.88^{bcd}
13	-	+	+	-	0.3^{a}	25.49^{ghi}	37.18^{ahi}
14	-	+	-	+	0.0^{a}	32.62^{i}	41.78^{1}
15	-	-	+	+	20.8^{bc}	17.2^{cdef}	29.48^{defg}
16	-	+	+	+	0.0^{a}	27.15^{hi}	39.28^{hi}
SED					5.0	3.34	3.39

Any figures with the same letter in any vertical column are not significantly different at the 5% level.

Table 5

Timing of fungicide application - main effects factorial analysis

a) Disease assessments

Disease assessment mean number of modules affected/70 22.8.85			
Treatment	+	-	Sig-nific-ance
Hassy - Block +	13.23	13.83	NS
Pre-plant drench	0.73	26.33	***
5 week spray	8.88	18.19	***
10 week spray	12.02	15.04	NS

b) Yield of healthy onions

Yield of healthy onions kg/plot			
Treatment	+	-	Sig-nific-ance
Hassy - Block +	19.41	10.45	*
Pre-plant drench	24.78	11.08	***
5 week spray	19.97	15.89	***
10 week spray	19.20	16.66	*

c) Total yield

Total plot yield kg/plot			
Treatment	+	-	Sig-nific-ance
Hassy - Block +	30.79	27.96	*
Pre-plant drench	25.81	22.94	***
5 week spray	21.58	27.17	***
10 week spray	30.99	27.76	**

*	Significant to 5% level
**	Significant to 1% level
***	Significant to 0.1% level
NS	Not significant

Acknowledgements

I would like to thank Mr Simon Groves and other colleagues of the ADAS Plant Pathology Departments at Kirton and Shardlow Hall and the staff of Kirton ADAS EHS for considerable assistance with these trials.

The chemical control of *Allium* white rot at the NVRS, 1983-86

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Loss of control of Allium white rot (AWR) by iprodione and vinclozolin

At the Second International Workshop on *Allium* White Rot, 1983, I reported the failure of iprodione to control AWR in the NVRS quarantine field where previously the treatment had been effective (Entwistle, 1983).

In 1983-86, field experiments were set up to examine the effects of AWR of a) increased doses of iprodione, b) other dicarboximide and benzimidazole fungicides and c) soil sterilisation. The effects of repeated doses of iprodione and vinclozolin to soil on the rates of chemical degradation in soil have also been studied (Walker, Entwistle & Dearnaley, 1984; Walker, Brown & Entwistle, 1986).

Field experiments. A series of stem base treatments of iprodione at 12 d intervals failed to control AWR whereas a single treatment with mycolozolin (meclozolin) was effective (Table 1). Vinclozolin had a considerable effect on AWR although it was not as effective as has been previously reported (Entwistle, 1983); subsequently, vinclozolin has failed to control AWR at the NVRS (Entwistle, 1986a). Carbendazim and thiophanate-methyl also failed to control AWR whereas previously they were effective (Entwistle & Munasinghe, 1980). Plots in the quarantine field, IHR(W), were treated with methyl bromide (MeBr) in summer 1983 then inoculated with *S. cepivorum*. The effects of iprodione and vinclozolin on AWR were compared with myclozolin. When plots had been treated with MeBr, iprodione and vinclozolin were effective at controlling AWR in the autumn period of an overwintered crop of salad onions. By the following April, however, neither fungicide had any effect on AWR whereas myclozolin-treated plants remained free of AWR. When plots had not been treated with MeBr, myclozolin controlled AWR but iprodione and vinclozolin did not (Entwistle, 1986a).

Laboratory studies. Loss of iprodione, measured by loss from soil from the IHR(W) quarantine field, of radiolabelled iprodione or gas liquid chromatography of soil extracts, was highest when soil had been previously treated with iprodione. There were, however, small but consistent differences in soil pH between soils previously treated with iprodione and those not previously treated. The degradation of iprodione in soil is influenced by pH, therefore the results were considered somewhat inconclusive. Accordingly, soils with a similar pH were treated 1-3 times with either iprodione or vinclozolin and the loss of chemical measured by gas liquid chromatography (Walker, Brown & Entwistle, 1986). There was a progressive increase in the rates of degradation of iprodione and vinclozolin with successive applications of chemical. Thus, the time for 50% loss of iprodione was 23 d with the first application of iprodione and 5 d with a second application; less than 10% of the initial dose remained 2 d after soil had been treated a third time.

Implications. Few examples of a similar loss of control of AWR by iprodione or vinclozolin have been reported from commercial farms in 1983-86. There is now, however, increasing evidence of loss of control of AWR by iprodione and vinclozolin in the UK and abroad (see Proceedings of this Workshop).

The effects of soil sterilisation on the capacity of iprodione and vinclozolin to control AWR were temporary therefore soil sterilisation is unlikely to provide a practical solution to the problem of enhanced degradation. In Israel, Yarden et al. (1985) reported that the addition of thiram to benomyl restored the capacity of benomyl to control Sclerotinia in lettuce in soil where there was enhanced degradation of benomyl. Accordingly, thiram was tested for its effect on the capacity of iprodione to control AWR (Fig. 1). Ten weeks after treatment with iprodione, the incidence of AWR was considerably less in plots receiving the combined treatment compared with plots receiving iprodione alone (Entwistle & Coleman, Report of the National Vegetable Research Station for 1986/87 (1987)); however, the effect of thiram was temporary. Fentin acetate or dichlorphen applied with iprodione had similar effects on AWR as the combined thiram-iprodione treatments.

So far, there is no evidence which directly links the loss of control of AWR by iprodione and vinclozolin to the enhanced degradation of these chemicals in soil. Research is now in progress at the IHR(W) to measure host infections in soils with differing degrading properties.

Effects of other chemicals on AWR

Myclozolin (BASF) and procymidone (ICI) have provided effective control of AWR at the IHR(W) (Table 2) (Entwistle, 1983; 1986). Myclozolin is unlikely to be marketed, however and procymidone is not available for commercial use in the UK. PP969 (ICI), SC9906 (Stauffer), propiconazole (Ciba Geigy) and penconazole (Ciba Geigy) all reduced the incidence of AWR in spring-sown salad onions (Entwistle, 1986b,c; 1987a,b (in preparation)). However, PP969 and SC9906 are also unlikely to be marketed in the UK. UBl 1502 (Uniroyal); NC 28410 (FBC) and flowable sulphur (Growers Requisites Northern) were ineffective at reducing the incidence of AWR (Table 2).

Soil partial sterilants. The effects of dazomet (Basamid, BASF) on AWR are currently under investigation on commercial farms. There is evidence that optimum effects of dazomet against white rot are achieved by the use of a 'spading' machine followed by the use of polythene sheeting to seal the soil surface.

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Table 1. Comparison of the effects of iprodione and other fungicides on white rot in salad onions, NVRS 1984 (Entwistle, 1986a)

	Fungicide applied to:-			
	seed	stem base		% white rot at harvest (24 wk)
Active ingredient	rate[a]	rate[b]	no. applications	
Experiment 1				
Calomel	500	-	-	77
Myclozolin	-	0.05	1[c]	0
Iprodione	62.5	0.15	1[c]	78
	62.5	0.05	11[d]	83
Untreated	-	-	-	94
Experiment 2				
Calomel	500	-	-	51
Iprodione	62.5	0.15	1[c]	52
Myclozolin	-	0.05	1[c]	0
Procymidone	-	0.05	1[c]	1
Vinclozolin	-	0.05	1[c]	25
Carbendazim	-	0.15	2[e]	86
Thiophanate-methyl	-	0.15	2[e]	70
Untreated	-	-	-	89

Rate: [a] seed treatment - g a.i./kg seed;
[b] stem base treatment - g a.i. in 100 ml water/m row/application

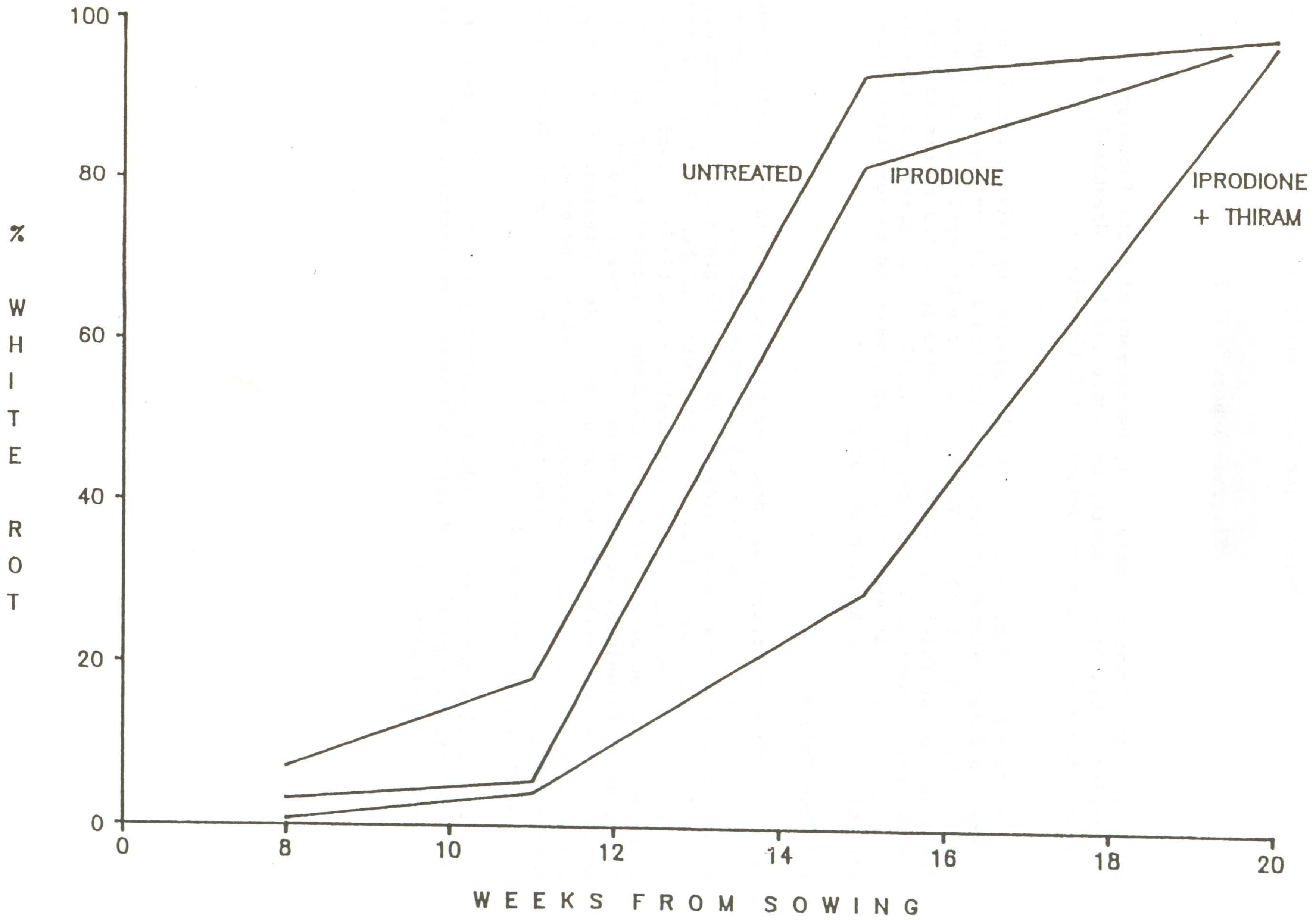
Stem base treatments applied: [c] 37 d, [d] 24, 36, 48 etc d, [e] 37, 69 d after drilling.

Table 2. Effect of various fungicides on white rot in salad onions 1983-86, NVRS

	Fungicide applied to:						
	seed	Stem base (S) or furrow (f)		% white rot			
Active ingredient	rate^a	rate^b	no. applications	1983 (17 wk)	1984 (20 wk)	1985 (20 wk)	1986 (15 wk)
Standard treatments							
Calomel	500	-	-	7	6	89, 97	6
Myclozolin		0.05(S)	1	-	0	1, 5	2
Untreated				96	69	100	78
Candidate fungicides							
Procymidone		0.05(S)	1	-	0		
UBI 1502		0.05(f)	1				
		+0.2(S)	2	58			
NC 28410		0.05(f)	1				
		+0.2(S)	2	81			
Sulphur		87 ml/m^2(f)	1				
		+87 ml/m^2(S)	2	87			
PP969		0.05(S)	7			2	-
		0.05(S)	3			-	1
		0.05(S)	2			-	28
SC9906		0.1(S)	2			0	
		0.05(S)	2			35	
Propiconazole			0.05(S)	1			
		0.01(S)	1				50
Penconazole		0.05(S)	1				25
		0.01(S)	1				50

Rate: [a] seed treatment - g a.i./kg seed;
[b] stem base treatemnt - g a.i. in 100 ml water/m row/application;
furrow treatment - g a.i./m row

Fig. 1. EFFECT OF THIRAM ON CONTROL OF *ALLIUM* WHITE ROT BY IPRODIONE



Onion White Rot Investigations

Progress Report - 1983

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White rot studies conducted in 1983 placed emphasis on control of the disease in direct-seeded onions. Experimental trials were established in a grower's field in the Salinas Valley and at the University of California Field Station at Tulelake. These trials were set up to re-examine some of the treatments made in 1982 on the potential for enhancement of control with pelleted seed at high-soil inoculum levels and to investigate the possibility of using Ronilan on onions.

Tulelake Trials:

Trial 1. This experiment was designed to examine in-furrow applications of Rovral at rates 1, 2 and 4 lbs/A and the potential for enhancement of control by pelleting the chemical on seed at 150 and 300 grams of Rovral per kilogram of seed. The cultivar used was Southport White Globe. Plots were 2 row beds, 2 meters long with treatments replicated 4 times. Stand counts were taken and total bulbs and white rot incidence recorded at harvest. The fungicide as formulated was applied to open furrows with a CO_2 backpack sprayer. Seed was pelleted courtesy of Moran Seed Company. Seed was planted and covered by hand. Inoculum density was determined by wet sieving soil samples taken from the trial area just prior to planting and found to be 0.205 sclerotia per gram of dry soil.

The results are given in Table 1. Only the white rot data is presented as there were no significant differences among the treatments with respect to stand or bulbs harvested.

Table 1. Effect of Rovral as in-furrow applications and pelleting on seed on control of white rot in onions.

Treatments			
In-furrow	Rate lbs/A	Seed pelleted grams (ai) Rovral kilogram	Percent white rot
None		0	64.2 a
None		150	56.7 ab
Rovral	1	0	54.7 ab
None		300	45.5 abc
Rovral	1	300	36.2 bcd
Rovral	1	150	32.5 cd
Rovral	2	300	29.7 cd
Rovral	2	0	29.0 cd
Rovral	4	0	25.5 d
Rovral	4	150	19.5 d
Rovral	2	150	18.2 d
Rovral	4	300	15.7 d

Number with same letters not significantly different at 5% level.

Rovral pelleted on seed without an in-furrow treatment had no significant effect on incidence of white rot. There was no significant difference between Rovral treatments of 2 and 4 lb rates applied in-furrow with and without Rovral pelleted on seed and none of these treatments were significantly better than the low rate of Rovral combined with Rovral pelleted seed. The data does show a trend toward reducing disease incidence with increasing rates of in-furrow treatments and amount pelleted on seed. There was also a trend indicating seed pelleted with Rovral enhanced control when combined with in-furrow treatments.

Trial 2

In previous trials with garlic, Ronilan and Rovral compared favorably with each other in control of white rot at relatively low inoculum levels (0.001-0.006 sclerotia/gram of soil). At high soil inoculum levels (0.2 sclerotia/gram) Ronilan gave significantly better control of white rot than Rovral. Ronilan when used on direct-seeded onions, was found phytotoxic to onion seedlings. When used, applied in the furrow, it caused reduced stand and markedly retarded growth early in the season.

The objectives of this trial was to confirm phytotoxity of Ronilan and to investigate possible means of using the compound for control. In the trial, consisting of 12 treatments, there were 4 replications with each plot, two rows/bed 2 meters in length. Ronilan was applied at 1 and 2 lbs/A and Rovral at 2 lbs/A. Seed was pelleted with Ronilan at 150 and 300 grams/kilogram of seed. The control was pelleted seed without Ronilan.

The results, given in Table 2, show a striking reduction in the number of plants that emerged in Ronilan treatments as in-furrow applications regardless of rate used. There is an unexplained anomaly between the reduction in stand recorded in the plot pelleted with 150 grams of Ronilan and that pelleted with 300 grams. There was was little change in total plants harvested compared to initial stand counts indicating most of the white rot recorded occurred late in the season. Ronilan in-furrow treatments showed significantly better white rot control but these differences must be interpreted on the basis of the reduced stand resulting from the phytotoxic effect of the chemical. Widely spaced plants tend to have a lower disease incidence than closer spaced plants grown under the same conditions. Thus the reduction in disease incidence may not be solely due to the chemical treatment. There is no evidence to suggest seed pelleted with Ronilan improved control when used with an in-furrow application of Rovral. As the amount of Ronilan was increased when applied as in-furrow sprays, plant emergence declined.

Table 2. Effect on emergence of onions and control of white rot by fungicides applied in the planting furrow and Ronilan pelleted seed.

Treatment					
Applied in planting furrow	Rate lbs/A	Seed pelleted Ronilan grams ai/ kilogram	Plant stand	Number plants at harvest	Percent white rot
			Average of four replications		
0	-	300	118 a	103 a	42 ab
Rovral	2	300	112 ab	102 a	26 abcd
Rovral	2	150	106 ab	97 ab	18 cde
Rovral	2	0	100 ab	93 ab	37 abc
0	-	0	98 ab	77 bc	45 a
Ronilan	1	0	86 bc	78 bc	22 bcde
0		150	70 cd	64 cd	15 de
Ronilan	2	0	68 cd	64 cd	7 de
Ronilan	1	150	63 cd	60 cde	14 de
Ronilan	1	300	55 de	52 def	7 de
Ronilan	2	150	46 de	40 ef	3 e
Ronilan	2	300	35 e	35 f	2 e

The data from this and previous trials indicate that Ronilian cannot be safely used with direct-seeded onions at rates sufficient to control white rot.

Salinas Trial

In the trial conducted in the Salinas Valley, the incidence of white rot in the trial area was too low and sporadic in occurrence to provide any meaningful data.

Biological Control

Efforts to reduce white rot using root-inhabiting antagonistic bacteria has proved ineffective. Delay in symptom expression has been noted but the inability of the selected bacteria to maintain high populations in the rhizosphere throughout the growing season is the most likely explanation for failure of this techni to give full-season control. Combining the bacteria with in-furrow applications of Rovral did not enhance control by the fungicide. A detailed write-up of biological control investigations will be made available later this year.

Results from trials conducted for several years show at soil inoculum densities of 0.01 sclerotia per gram of soil or above that control of white rot with soil fungicides drastically declines. At high inoculum levels found in some fields the superiority of Ronilan over other fungicides used became apparent.

The detrimental effect of this compound on onion seedlings, however, makes it unlikely it can ever be safely used on this crop.

Unless fungicides, highly active against the white rot pathogen can be identified, it seems unlikley at this time that chemical control will be feasible in fields where inoculum levels of <u>Sclerotium cepivorum</u> are 0.01 sclerotia per gram of soil or higher. There are a number of new-untested compounds now available that will be screened for activity in the field at Tulelake in 1984, and work beyond 1984 on chemical control will depend on results obtained from these trials.

THE ASSESSMENT OF SOIL PARTIAL STERILANTS FOR THE CONTROL OF ALLIUM WHITE ROT IN LINCOLNSHIRE, U.K.

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INTRODUCTION

I represent a Company of agrochemical distributors trading in south Lincolnshire and Cambridgeshire. Many of our customers have a considerable investment in bulb onion growing and are acutely aware of the major risk to the industry posed by *Allium* white rot. The 1984 season was very dry and we noticed a significant increase in white rot enquiries and instances of crop infestation. Previously, advice was based on stem base drenches of iprodione or vinclozolin. However, our representatives reported reduced levels of control from stem base treatments. These reports coincided with N.V.R.S. information of similar loss of control and the link with enhanced degradation. Most local mineral soils are in excess of pH 7.5 and if brassicas are included in the rotation, soils are usually limed to pH 8.0. High pH may also be implicated in reduced dicarboximide persistence in soil.

In the face of increasing *Allium* white rot incidence and the loss of our only means of chemical control we decided to investigate the possibilities of soil partial sterilisation. This paper shows the effects of a range of sterilants, applied at different rates, on the sclerotial viability of *Allium* white rot and disease incidence in the following onion crop.

MATERIALS AND METHODS

Trial Site

The trial site was situated near Boston, Lincolnshire, U.K., on a fine sandy silt loam soil. The treatments were located on an area of severe Allium white rot infection. The infected onion crop was lifted in September 1984 and the land prepared for application of soil sterilants. Pre-application cultivations consisted of mouldboard ploughing, followed by two passes of a Roterra cultivator. Soil partial sterilants were applied early October 1984.

Treatments and Method of Application

1,3-dichloropropene (Telone II; Dow Agriculture) was applied at 225l/ha and 450l/ha using a Rumpstadt Combiject 225 soil injector. The sterilant was applied at 20cm depth and the soil surface "sealed" by the powered roller on the Combiject 225. Polythene sheeting (38µm) was manually dug in over half the treated area to give three unsheeted replicate plots (2.25m x 10m). and three sheeted replicate plots (2.25m x 10m).

Metham sodium was similarly applied, with and without polythene sheeting at 300l/ha, 600l/ha, 1200l/ha and 2400l/ha.

Methyl bromide was applied manually to similar sized plots at rates of $75g/m^2$, $100g/m^2$ and $150g/m^2$. The methyl bromide was applied to the soil surface of plots previously covered with polythene sheeting (38µm). Methyl bromide treatments were applied in duplicate.

Three strips of untreated soil 2.25m x 70m were left as control plots.

Soil Conditions during Application

Treatments were applied under ideal soil conditions. Soil temperature at application was 14°C at 20cm depth and 10°C four weeks later when the polythene was removed from all sheeted treatments. The soil moisture content was 10% (w/w) which is equivalent to 60% of the available water capacity.

Crop Management

The site was dragged during December 1984 to assist gas release and ensure optimal seed bed conditions. After shallow ploughing (15cm) and rotovation, onions (Hyper, Unicoat) were drilled 3rd April 1985 in combination with aldicarb (Temik). Fertiliser (20:5:15) was applied at the rate of 625kg/ha. Weeds were controlled by pre-emergence use of propachlor/chlorthal-dimethyl (Ramrod/Dacthal) followed by repeat low dose use of chlorbufam/chloridazon (Alicep) post-emergence of the crop. Clopyralid (Shield) was applied for late thistle and mayweed control. Foliar diseases were controlled using metalaxyl/iprodione (Fubol/Rovral) mixtures and benomyl (Benlate) with adjuvant oil.

Monitoring of Field Trial

At the time of polythene sheet removal (November 1984), soil samples (0-20cm depth) were taken with a screw auger from all treatments. These samples were assessed for sclerotial viability in the laboratory.

Levels of Allium white rot infection in the following onion crop were assessed in September by hand lifting 200 - 250 plants from the centre of each treatment. The root system and base of each bulb was inspected for white rot infection.

RESULTS

Viability of Sclerotia

Allium white rot sclerotia were extracted from soil samples by wet sieving and assessed for viability by incubating cut halves of sclerotia on drops of 2% malt agar (Entwistle, 1984). Growth of sclerotia was assessed after five and ten days. Some samples were extracted quantitatively and numbers of sclerotia ranged from 32 - 56kg^{-1} field moist soil. The effect of soil partial sterilant on sclerotial viability can be seen from Table I.

Table I - The effect of soil partial sterilants on *Allium* white rot sclerotial viability.

Soil Partial Sterilant	Viable sclerotia* (% of total extracted)	% Reduction of viable sclerotia[+]
Control	65 - 76	0
Methyl bromide 75g/m^2	0 - 4	94 - 100
Methyl bromide 100g/m^2	0 - 5	93 - 100
Methyl bromide 150g/m^2	0 - 1	99 - 100
Metham sodium 300l/ha	17 - 20	71 - 76
Metham sodium 300l/ha + polythene sheeting	18 - 20	74 - 76
Metham sodium 1200l/ha	29 - 47	33 - 59
Metham sodium 1200l/ha + polythene sheeting	8 - 21	70 - 89
1,3-dichloropropene 225l/ha	30 - 36	49 - 57
1,3-dichloropropene 225l/ha	14 - 44	37 - 80

* Values shown represent the range of four replicate viability tests.

[+] % reduction is based on numbers of viable sclerotia in control samples.

All three rates of methyl bromide greatly reduced the viability of Allium white rot sclerotia. Metham sodium (300l/ha) also reduced the percentage of viable sclerotia present in the soil, although the effect was not as marked as with methyl bromide.

Increasing the rate of metham sodium fourfold did not further reduce the proportion of viable sclerotia.

1,3-dichloropropene (225l/ha) reduced the percentage of viable sclerotia although there was considerable variation between replicate tests.

The effect of polythene sheeting on the performance of both metham sodium and 1,3-dichloropropene was variable. Polythene sheeting only caused a decrease in sclerotial viability where metham sodium was used at 1200l/ha and 1,3-dichloropropene was used at 225l/ha.

Disease assessment in the onion crop

The effect of soil partial sterilants, applied with and without polythene sheeting, was monitored in the following onion crop (Table II).

Table II - The effect of soil partial sterilants on Allium white rot infection in the following onion crop.

Soil partial sterilant	% control of infection[+]
Methyl bromide ($75g/m^2$)	69
Methyl bromide ($100g/m^2$) *[a]	80
Methyl bromide ($150g/m^2$) *	80
Metham sodium (3001/ha) + polythene	0
Metham sodium (3001/ha)	0
Metham sodium (6001/ha) + polythene	9
Metham sodium (6001/ha)	14
Metham sodium (12001/ha) + polythene	9
Metham sodium (12001/ha)	0
Metham sodium (24001/ha) + polythene	18
Metham sodium (24001/ha)	18
1,3-dichloropropene (2251/ha) + polythene ***	83
1,3-dichloropropene (2251/ha) **	78
1,3-dichloropropene (4501/ha) + polythene ***	83
1,3-dichloropropene (4501/ha) ***	83

[a] Significant differences between proportion of infected plants in treatment and nearest control. *, **, *** differences significant at P = 0.05, 0.01 and 0.001 respectively.

[+] Percentage control was calculated by comparing the percentage of plants showing no disease symptons in treated plots and the nearest control plots.

Table II shows that the two higher rates of methyl bromide and both rates of 1,3-dichloropropene significantly reduced the proportion of infected onion plants. However, infection levels in metham sodium treated plots did not differ significantly from the control plots, even when applying the sterilant at 8X the rate recommended for potato cyst nematode control. The effect of polythene sheeting was not significant when used in conjunction with either metham sodium or 1,3-dichloropropene.

DISCUSSION

Results from sclerotia viability tests do not correlate well with disease levels in the field. For example, sclerotial viability tests indicated that 1,3-dichloropropene would not control *Allium* white rot particularly well, although levels of control in the crop were better than with metham sodium. An explanation is that the method of sterilant application does not reduce sclerotia viability evenly down the soil profile. In fact, the sclerotia in closest proximity to the onion plants, which were probably responsible for initial infection of the host plant (Entwistle, 1985), came from a depth of 10 - 15 cm (due to soil inversion by post-treatment shallow ploughing) where the sterilant would have greatest effect on sclerotial viability. However, the soil was evenly sampled for sclerotial viability tests from a depth of 0 - 20 cm. Therefore it is possible that better control of *Allium* white rot is achieved than would be predicted by sclerotia viability assessment.

Although the trial was carefully sited on an area of even and severe *Allium* white rot infestation, there was considerable variation in infection levels between the different control plots and between similarly treated plots. Statistically significant differences between treated and untreated plots were obtained in several cases (Table II) but only when the treated plot was compared to an adjacent control plot. Although the total trial area was kept to a minimum (70m x 25m), *Allium* white rot was not evenly distributed through the trial plots. This trial was designed to screen a wide range of sterilants at various rates with the aim of re-assessing treatments showing efficacy, using larger scale field experiments. We considered that 1,3-dichloropropene and methyl bromide warranted such studies and a trial is presently in progress.

We have also undertaken limited soil partial sterilisation using methyl bromide on a commercial basis to eradicate foci of *Allium* white rot infection during 1986. This technique is of value where *Allium* white rot is discovered in a field for the first time and the area of infection is discrete and allows access for our application equipment.

Until a more specific chemical control of *Allium* white rot is found, we will continue with a very limited programme of development work on soil partial sterilants.

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Evaluation of Procymidone applied as either a Seed Treatment or banded with Fertilizer, on White Rot of Dry Bulb Onions in Victoria.

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White rot of onions caused by Sclerotium cepivorum has decimated onion production in Colac, once Australia's major onion producing area. Recent efforts to control the disease using artificial stimulants and fungicides, eg. onion oil and iprodione, have been partially effective but usually not warranted. More recently trials in Victoria and Tasmania have shown that procymidone may provide the breakthrough that growers are looking for.

On 10th September, 1985, a trial was established at Colac in Victoria, in a soil where the number of viable sclerotia recovered, varied from 100 to 320 per kg soil. The objective of the trial was to evaluate the effect of procymidone used either as a seed dressing or incorporated with the fertilizer in 7.5 cm bands, 5 cm below the seed. Procymidone (Sumisclex^R 50WP, ICI Aust.), was either applied to seed using a 2% solution of methyl cellulose, at a rate of 50 g a.i./kg seed or incorporated with fertilizer at a rate of 0.06 and 0.12 g a.i./m of row (ie. 2 or 4 kg a.i./ha). The fertilizer (Pivot Top Lines Blue, 9:15:13) was applied at a rate of 300 kg/ha. Immediately after banding the fertilizer mix, five rows of onion seed cv. Pukekohe, were sown per plot (7m X 1.62m) An even distribution of seed and fertilizer was applied to each plot using a cone seeder. The trial design was a randomized block with each treatment replicated six times.

Plant emergence was recorded 8 weeks after sowing, and the number of dead or dying plants recorded monthly. Dying and dead plants were checked at each assessment for symptoms of white rot. At maturity the incidence of white rot, and the individual and total weight of healthy bulbs was determined. All assessments were made on 5 metres of the inner 3 rows of each plot, and the experimental site was not irrigated.

Results showed that procymidone had no effect on the number or quality of plants which emerged and therefore was not phytotoxic (Table 1). Soil applications of procymidone reduced disease and increased yields, although the higher rate was more effective (Tables 1 and 2). The seed dressing delayed the development of disease (Fig 3), but there was no difference in either yield or the number of diseased plants at harvest, in comparison to untreated soils. Combining the seed dressing with soil applications of procymidone, did not improve yields in comparison to soil applications of procymidone applied alone. Combining the seed treatment with the lower rate of procymidone however, reduced the number of diseased plants at harvest and maintained a more uniform bulb size. This treatment is preferable to the other

treatments using procymidone at higher rates, as it is more economic and involves less chemical residue.
These results, together with chemical residue data indicate that procymidone is systemically translocated in onion crops, and this appears to be the major advantage this chemical has over the other dicarboximide fungicides.

The seed dressing was very effective in trials conducted by Dr. J. Wong in Tasmania but is thought to be less effective at Colac because of the heavy volcanic soils and the high disease pressure.

Table 1. Effect of procymidone, (Sumisclex^R 50WP), applied as either a seed dressing and/or banded with the fertilizer, on plant emergence and white rot of onions at Colac in Victoria.

Treatment+	No. of plants which emerged per plot	% No. of plants affected by white rot.
<u>Soil applications</u> (S.A.)		
Nil	111	73
S.A.- 2 kg a.i./ha	108	54
S.A.- 4 kg a.i./ha	134	32
<u>Seed treatments</u> (S.T.)		
S.T.	139	68
S.T. and S.A.- 2 kg a.i./ha	120	38
S.T. and S.A.- 4 kg a.i./ha	138	43
LSD ($Pr \leqslant 0.05$)	36.1	12.9

\+ Procymidone was incorporated with fertilizer (Pivot Top Lines Blue 9:15:13) at a rate of 300 kg/ha, and then banded 5 cm below the seed rows.

* Sumisclex^R 50WP was applied at 50 kg a.i./kg seed

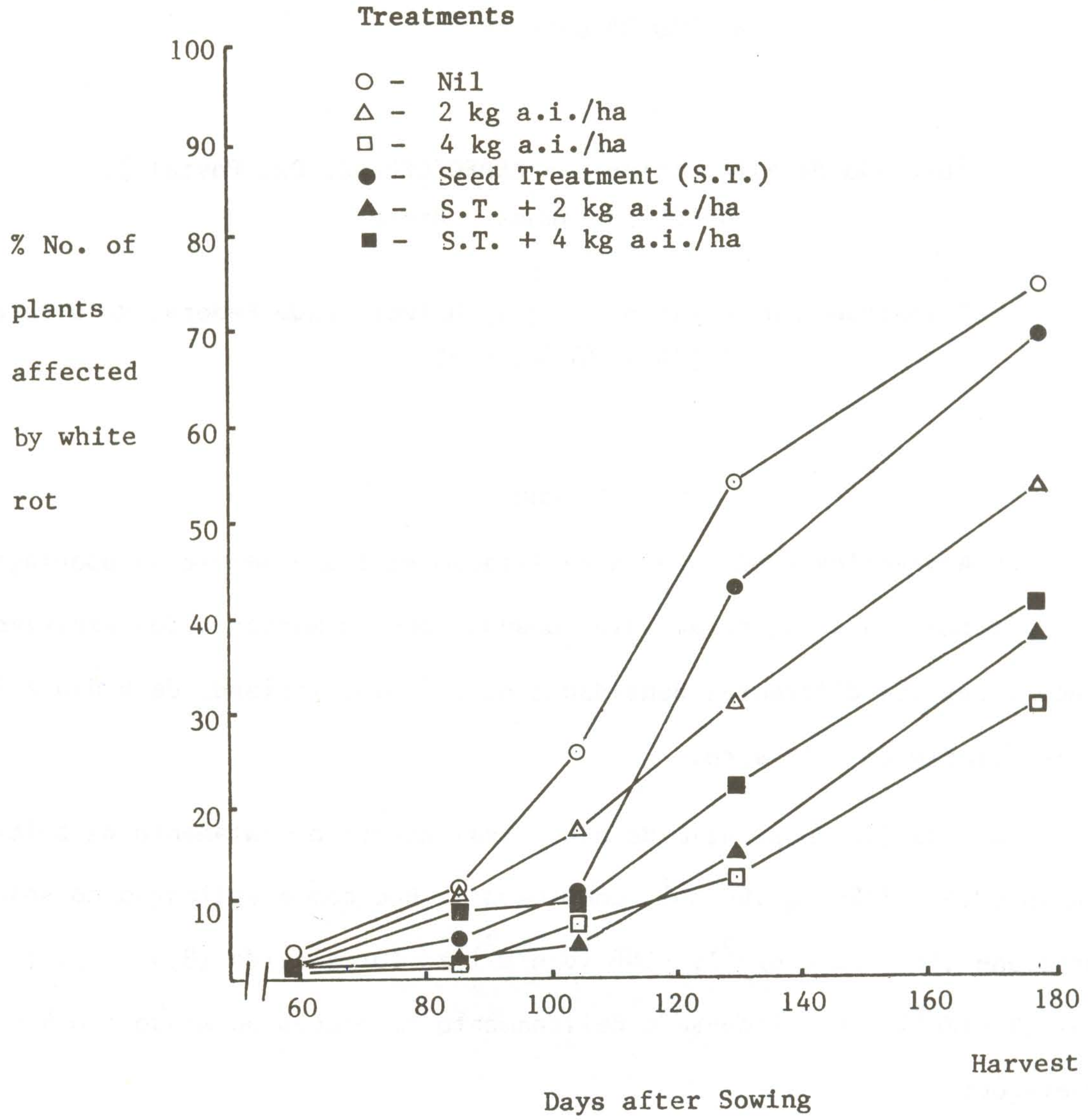
Table 2. Effect of procymidone, (Sumisclex^{R} 50 WP), applied as either a seed dressing and/or banded with the fertilizer, on the number, weight/bulb and yield of onions harvested at Colac in Victoria.

Treatment[+]	% No. of bulbs harvested/plot	wt/bulb (gms)	Yield (kg / ha)
<u>Soil applications</u> (S.A.)			
Nil	27	64	1.5
S.A.- 2 kg a.i./ha	46	94	4.0
S.A.- 4 kg a.i./ha	68	60	4.8
<u>Seed treatments</u> (S.T.)			
S.T.	33	60	2.0
S.T. and S.A.- 2 kg a.i./ha	62	65	4.3
S.T. and S.A.- 4 kg a.i./ha	75	68	5.0
LSD ($Pr \leqslant 0.05$)	14.2	17.5	1.48

+ Procymidone was incorporated with fertilizer (Pivot Top Lines Blue, 9:15:13) at a rate of 300 kg/ha, and then banded 5cm below the seed rows.

* Sumisclex^{R} 50WP was applied at 50 kg a.i./kg seed

Fig. 1. Effect of procymidone, (Sumisclex^{R} 50WP), applied either as a seed dressing and/or banded with fertilizer, on the rate at which plants were affected by white rot at Colac in Victoria.



EFICIÊNCIA DE FUNGICIDAS NO CONTROLE DA PODRIDÃO BRANCA DO ALHO (*Allium sativum* L.), DE ACORDO COM O NÍVEL DE ESCLERÓDIOS DE *Sclerotium cepivorum* BERK. NO SOLO*

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RESUMO

Em Amarantina - MG, após a realização de levantamento da população de *S. cepivorum* no solo, foram selecionadas, para a montagem dos experimentos, cinco áreas com diferentes densidades de inóculo, variando de 0,010 a 3,199 escleródios/g do solo seco.

Por ocasião do plantio do alho, realizou-se o tratamento de bulbilhos com iprodione (1000 g/100 kg), combinado ou não com a aplicação no solo de iprodione (1; 2 ou 4 g/m^2); PCNB (6 g/m^2) ou formaldeído (9,5; 19,0; 38,0 ou 76,0 ml/m^2). Utilizou-se o delineamento de blocos ao acaso com 4 ou 6 repetições.

Avaliou-se, periodicamente, o número de plantas mortas pela podridão branca e, por ocasião da colheita, determinou-se o número, peso total e peso médio dos bulbos sadios, além da proporção de área abaixo da curva de progresso da doença (PACPD).

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* Parte da Tese de Mestrado do 1º autor

Foi demonstrado que a eficiência dos fungicidas dependeu do nível de escleródios no solo. Nas áreas com densidades de inóculo maiores que 0,199 escleródios/g de solo seco, para se obter o melhor controle da podridão branca com o fungicida iprodione, foi necessário tratar os bulbilhos (1000 g/100 kg) e o solo (1 a 2 g/m^2), enquanto nas áreas com menos que 0,199 escleródios/g de solo, o referido tratamento dos bulbilhos foi suficiente para o controle. Os tratamentos com formaldeído no solo(9,5 a 76,0 ml/m^2) não controlaram a doença, mas a combinação destes ou do PCNB (6 g/m^2) com iprodione nos bulbilhos (1000 g/100 kg) mostrou-se promissora, principalmente em áreas mais infestadas, visando reduzir os altos custos do tratamento de solo com iprodione.

ABSTRACT

Efficacy of fungicides in the control of garlic white rot, according to the level of *Sclerotium cepivorum* Berk. sclerotia in the soil.

In Amarantina, state of Minas Gerais, it was carried out a survey of the population of *Sclerotium cepivorum* in the soil. Afterwards, five areas with different inoculum densities varying from 0.010 to 3.199 sclerotia per g of dried soil, were selected for installation of experiments.

At the planting time, garlic bulbs were treated with iprodione (1000 g/100 kg), combined or not with soil treatment with iprodione (1; 2 or 4 g/m^2); PCNB (6 g/m^2) or formaldehyde (9.5; 19.0; 38.0 or 76.0 ml/m^2). A randomized block design was used with four or six replications.

The number of dead plants due to white rot was evaluated periodically. By the harvesting time, the number of healthy bulbs, their total weight and average weight and the proportion of the area below the disease progress curve were determined.

It was shown that the efficiency of fungicides was related to the level of sclerotia in the soil. To achieve the best control of white rot with iprodione, in areas with inoculum densities higher than 0.199 sclerotia/g of dried soil, it was necessary to treat the bulbs (1000 g/100 kg) and the soil (1-2 g/m^2), while in areas with less than 0.199 sclerotia/g of dried soil, this treatment of the bulbs only, was sufficient to achieve control. The soil treatments with formaldehyde (9.5 to 76.0 ml/m^2) did not control the disease. The combination of formaldehyde at these dosages or PCNB at 6 g/m^2 with iprodione at 1000 g/100 kg of bulbs, showed to be promising, mainly the most infested areas, to reduce the high cost of soil treatment with iprodione.

INTRODUÇÃO

Sclerotium cepivorum BERK., agente causal da podridão branca do alho, ocorre no solo principalmente sob a forma de minúsculos escleródios, que são as suas estruturas de resistência.

A densidade de escleródios necessária para provocar elevada incidência de podridão branca é geralmente baixa. Adams (1979), trabalhando com amostras de solo provenientes de quatro Estados Americanos, encontrou densidades de inóculo de até 12,88 escleródios/g de solo em áreas onde havia ocorrido 100% de podridão branca no ano anterior de cultivo. Mas, na maioria destas amostras, esta densidade foi inferior a 0,50 escleródios/g de solo. Na California, Crowe et alii (1980) constataram que populações antes do plantio de 0,001; 0,001 a 0,01; 0,01 a 0,1 e 0,1 escleródios/g de solo resultaram em 10%; 10-85%; 85-100% e 100% de incidência da podridão branca em alho na época da colheita, respectivamente.

Pesquisas realizadas por Hall e Somerville (1983) demonstraram que a eficiência do controle da podridão branca é grandemente dependente da densidade de inóculo presente no solo na época do plantio, sendo que em solos muito infestados o controle não é tão efetivo quanto em solos com menor nível de infestação.

Segundo Kurtz (1983), com o advento de novas técnicas de recuperação de escleródios do solo, a amostragem em campos antes do plantio tornou-se uma prática rotineira na Califórnia. Com isto, sérias perdas em virtude da doença ou gastos desnecessários com fungicidas têm sido evitados, pois os dados obtidos nestes levantamentos têm sido utilizados para prever a melhor opção de plantio e/ou tratamento químico. Kurtz (1983), propõe que o tratamento químico seja dispensado quando não se detectar escleródios no solo, realizando-o, entretanto, quando a densidade de inóculo no solo variar de 1 a 5 escleródios/kg de solo. Quando esta estiver acima de 5 escleródios/kg de solo, não se recomenda plantar alho ou cebola na área amostrada.

Cruz Filho et alii, em experimentos conduzidos em 1982, constataram que iprodione e procimidone proporcionaram melhor controle da podridão branca que o PCNB em solo altamente infestado. Em solo com baixa infestação, nenhum tratamento diferiu da testemunha. Recentemente, Cruz Fº et alii (1984), avaliaram a eficiência dos fungicidas iprodione e vinclozolin nas dosagens de 1, 2, 3 e 4 g/m^2 de solo, combinadas com a dosagem de 1 kg/100 kg para o tratamento de bulbilhos. Na área de alta infestação, o tratamento de solo mais eficiente foi iprodione na dosagem de 4 g/m^2. Na área de infestação média, iprodione (2 g/m^2 de solo), também ofereceu controle eficiente da podridão branca do alho. Entretanto, os autores não definiram o que seria um solo com alto, médio ou baixo nível de infestação.

Além do uso de fungicidas protetores nos bulbilhos e no solo por ocasião do plantio, também têm sido experimentados alguns fumigantes de solo, visando o controle da doença. Anon (1943) e Ali et alii (1971), sugeriram que a podridão branca poderia ser prontamente controlada em pequenas áreas, esterilizando-se o solo com formalina a 2%. Em 1984, Resende et alii testaram o efeito de fungicidas aplicados em solos artificialmente infestados e encontraram que formaldeído em concentrações de 0,1 a 0,8% foi letal aos escleródios de *S. cepivorum*.

No Brasil não há informações a respeito das densidades de escleródios de *S. cepivorum*, nem sua relação com a incidência da podridão branca em campos de alho submetidos a diferentes tratamentos químicos. Também ainda não se obteve um método para controlar economicamente a doença, visando o aproveitamento de áreas infestadas que possuam características favoráveis à produção de alho. Diante do exposto, os objetivos do presente trabalho foram:

- desenvolver um modelo para o controle da podridão branca do alho, em função da densidade de escleródios presentes no solo e da dosagem de iprodione aplicado no plantio do alho;

- avaliar o efeito de outros fungicidas e das combinações destes com iprodione, no controle da podridão branca do alho, em condições de campo.

MATERIAL E MÉTODOS

No mês de fevereiro de 1984, foram realizadas amostragens em nove propriedades tradicionais de cultivo de alho, em Amarantina, município de Ouro Preto - MG. Em cada propriedade foram amostradas áreas de 200 m^2, sendo obtida uma amostra composta de cinco amostras simples retiradas ao longo da diagonal de um quadrado imaginário de 20 m^2 de área. A partir das amostras compostas, procedeu-se a extração dos escleródios, utilizando um método modificado proposto por Resende e Zambolim (Fitopatologia Brasileira, no prelo).

Baseando-se nos resultados deste levantamento, desenvolveu-se uma escala para avaliação dos níveis de escleródios de *S. cepivorum* no solo (Quadro 1) e selecionou-se, para montagem dos experimentos, aquelas áreas que ofereceram melhor uniformidade de distribuição de inóculo no solo.

Em todas as cinco áreas selecionadas, os experimentos foram instalados no delineamento de blocos ao acaso. Cada parcela foi constituída de 1 m^2 de canteiro, no qual foram abertos cinco sulcos de plantio. Os tratamentos e o número de blocos presentes em cada experimento estão esquematizados no Quadro 2.

Nos dias 9 e 10 de março de 1984, por ocasião do plantio do alho, cv. Amarante, e antes de tratamento químico, foram retiradas nas parcelas cerca de 250 g de solo a 10 cm de profundidade, em cada um dos sulcos de plantio. Cada amostra composta obtida por parcela foi acondicionada em sacos plásticos, levada ao laboratório, homogeneizada e dividida em duas sub-amostras de 500 g. A primeira foi seca em estufa a 40 ^{o}C, até atingir peso constante, visando determinar seu peso seco. A segunda foi utilizada na extração dos escleródios, conforme o método modificado anteriormente citado. Foi então calculado o número de escleródios/grama de solo seco/parcela.

Nas áreas experimentais com níveis VIII e IV de escleródios no plantio, foram testados outros produtos químicos e combinações com iprodione. Na área com nível IV, foi testada a cobertura do solo com capim seco disponível no local ou polietileno escuro, realizada após a aplicação de formaldeído (Quadro 2). O tempo de cobertura foi de 60 horas, até os materiais de cobertura serem retirados no ato do plantio.

Antes de serem plantados, os bulbilhos que receberiam tratamento, foram pesados e colocados em um tambor giratório de eixo inclinado, juntamente com o fungicida iprodione, na dosagem especificada no Quadro 2. Girou-se o tambor por dois minutos, adicionou-se água suficiente para umedecer os bulbilhos e girou-se novamente por três minutos, à baixa rotação. Para o tratamento do solo, os fungicidas iprodione e PCNB foram veiculados em 2,5 ℓ de água/m^2 e o formaldeído em 10 ℓ/m^2, sendo ambos aplicados por meio de um regador.

O espaçamento utilizado foi de 20 cm entre sulcos e 5 cm entre bulbilhos, totalizando 100 bulbilhos por parcela. A adubação em cada área experimental foi efetuada conforme sugerido por Souza (1978).

A partir de 82 dias após o plantio, foram efetuadas cinco pulverizações a alto volume, de 9 em 9 dias, com a mistura mancozeb (1,5 kg/ha) e clorotalonil (0,6 kg/ha), visando o controle das doenças de parte aérea, principalmente mancha púrpura e ferrugem. Como espalhante adesivo utilizou-se o Esapon na dosagem de 25 ml/100 ℓ de solução fungicida. Em cada parcela, foi avaliado o número de plantas mortas pela podridão branca, a princípio com periodicidade de 18 dias e com o aumento da doença, de 9 em 9 dias.

Na colheita foram avaliados o número e o peso total dos bulbos sadios e calculados a percentagem e o peso médio de bulbos sadios. A proporção de área abaixo da curva de progresso da doença (PACPD) foi calculada com base na equação de Shaner e Finney (1977):

$$\text{PACPD} = \frac{\text{ACPD}}{1 \times X_n}$$

em que: $\text{ACPD} = \sum_{i=1}^{n} [(Y_{i+1} + Y_i)/2]\ [X_{i+1} - X_i]$

sendo: X_n = tempo em dias na n-ésima observação

n = número total de observações

Y_i = proporção de doença na i-ésima observação

X_i = tempo em dias na i-ésima observação

RESULTADOS E DISCUSSÃO

A comparação entre as médias dos tratamentos avaliados em cada experimento está nos Quadros 3, 4, 5, 6 e 7.

Os resultados apresentados no Quadro 3 (nível VIII de escleródios no plantio) e no Quadro 6 (nível IV de escleródios no plantio) mostraram que a aplicação de PCNB ou formaldeído no solo, combinada ao tratamento de bulbilhos com iprodione, assim como o tratamento de bulbilhos e de solo com iprodionne, proporcionaram maiores percentagens de bulbos sadios, maiores pesos totais dos bulbos e menores proporções de área abaixo da curva de progresso da doença (PACPD). Já os tratamentos com apenas formaldeído, nas dosagens 9,5; 19,0; 38,0 ou 76,0 ml/m^2 de solo, não foram eficientes no controle da podridão branca, não diferindo pois, do tratamento testemunha, quanto a estes parâmetros.

A eficiência do fungicida iprodione dependeu grandemente do nível de escleródios no solo. Esta eficiência foi melhor avaliada pelo parâmetro percentagem de bulbos sadios, o qual apresentou sempre baixos coeficientes de variação (Quadros 3 e 7) e correlacionou-se muito bem com o peso total de bulbos e com a proporção de área abaixo da curva de progresso da doença (PACPD).

Por meio da percentagem de bulbos sadios ficou evidenciado que na área de mais alta infestação (Quadro 3), a menor dosagem de iprodione capaz de se igualar estatisticamente aos melhores tratamentos foi obtida tratando-se os bulbilhos com 1000 g/100 kg e o solo com 2 g/m^2. Nas áreas experimentais com nível VI e V de escleródios no plantio do alho (Quadros 4 e 5), a dosagem mínima de iprodione que teve desempenho satisfatório foi o tratamento dos bulbilhos (1000 g/100 kg), combinado com o tratamento de solo com 1 g/m^2. Já nas áreas experimentais com nível IV e II (Quadros 6 e 7) de escleródios no plantio, o tratamento somente dos bulbilhos com iprodione (1000 g/100 kg) foi suficiente para proporcionar percentagens de bulbos sadios iguais as dos melhores tratamentos. Assim, a dosagem mínima e eficiente de iprodione no controle da podridão branca foi diretamente proporcional ao nível de escleródios de *S. cepivorum* no solo.

Na maioria dos experimentos, não se observou diferença entre os pesos médios dos bulbos nos diversos tratamentos. Cruz Fº at alii(1984), relataram maiores pesos médios dos bulbos quando utilizaram maiores dosagens de iprodione. Esse efeito seria devido a uma ação sistêmica do produto controlando também doenças da parte aérea, principalmente a mancha púrpura incita da por *Alternaria porri*. Nos experimentos conduzidos não se observou tal efeito, provavelmente porque as pulverizações preventivas realizadas com clorotalonil e mancozeb em todas as parcelas, minimizaram a ação das maiores dosagens de iprodione no controle adicional de doenças foliares do alho.

Nas Figuras 1, 2, 3, 4, 5 e 6 encontram-se as equações e as curvas de progressão da podridão branca, para cada tratamento químico. A Figura 1 (nível VIII de escleródios) mostra que os tratamentos com PCNB ou formaldeído no solo combinados com iprodione nos bulbilhos, proporcionaram de maneira geral, progressos da doença mais lentos do que os tratamentos com iprodione nos bulbilhos e solo. Esta possível ação sinérgica no controle da podridão branca quando se associam dois fungicidas foi relatada por Cruz Fº et alii (1984), quando trataram o solo com vinclozolin e os bulbilhos com iprodione. Portanto, torna-se promissor, principalmente em áreas mais infestadas, o controle da podridão branca com produto de menor custo no solo e com iprodione, produto de custo mais elevado e de bom desempenho protetor e sistêmico, nos bulbilhos.

Na área experimental com nível IV de escleródios no plantio, quando se compararam materiais de cobertura do solo (Figura 5), não se observou efeito diferencial da cobertura com polietileno escuro ou capim seco, na eficiência do formaldeído.

As Figuras de 1 a 6 mostraram que a época de início da epidemia dependeu do nível de escleródios presentes no solo por ocasião do plantio.

Assim, este início foi gradativamente retardado, a partir da área experimental de mais alta infestação (Figura 1) até a área de menor infestação (Figura 6).

Nos experimentos instalados em Amarantina, para todos os níveis de escleródios (Figuras 1 a 6), o progresso da doença foi muito rápido no tratamento testemunha e naqueles com somente formaldeído no solo. Nestes, a proporção acumulativa da doença aproximou-se a 1,00 no final do ciclo da cultura.

Os demais tratamentos mostraram efeito positivo no controle da podridão branca, expressa por progressões mais lentas da doença. Este efeito não se mostrou muito pronunciado nas áreas mais infestadas (nível VIII e VI de escleródios no plantio, Figuras 1 e 2), nas quais os tratamentos com iprodione ainda propiciaram considerável incidência da doença. Nas áreas com níveis de escleródios V (Figura 3) e IV (Figuras 4 e 5), os tratamentos com iprodione foram suficientes para reduzir a doença a níveis próximos a zero, por ocasião da colheita. Já na área experimental de menor infestação (nível II de escleródios no plantio, Figura 6), empregando-se o iprodione, não se obteve redução da doença a níveis tão baixos quanto nas áreas com níveis de escleródios imediatamente superiores.

Analisando a situação particular da área experimental com nível II de escleródios no plantio, observou-se através de análises do solo tratar-se de uma área mais úmida e fértil que as demais. Isto refletiu em maior produtividade expressa pelo peso total de bulbos (Quadro 7), em relação às outras áreas experimentais (Quadros 3, 4, 5 e 6). Considerando que o micé lio de S. *cepivorum* propaga-se de planta a planta, pelo contacto das raízes (Scott, 1956), é de esperar que, em áreas onde plantios de *Allium* spp. tenham raízes mais desenvolvidas, ocorra maior disseminação da doença no espaço, a partir de um foco de infecção inicial (Crowe e Hall, 1980). No caso da área em questão, o baixo nível de escleródios no solo contribuiu para a ocorrência tardia da infecção, enquanto que o solo fértil e úmido e o sistema radicular mais desenvolvido contribuiram para uma rápida difusão do micélio de planta a planta, difusão esta que nem as maiores dosagens de iprodione conseguiram deter.

Portanto, nas áreas experimentais com nível de escleródios VIII, VI, V e IV (Figuras 1, 2, 3, 4 e 5), o inóculo inicial foi o principal fator responsável pelo comportamento da doença. Na área com nível II de escleródios no plantio (Figura 6), outros fatores, principalmente as condições favoráveis do solo e da cultura, parecem ter exercido maior influência na epidemia que o nível de inóculo inicial.

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QUADRO 1 - Níveis de escleródios de *Sclerotium cepivorum* Berk. detectados nos solos de diferentes propriedades em Amarantina, município de Ouro Preto - MG, 1984.

Propriedade	Classes de escleródios (Nº total/g de solo seco)	Nível absoluto	Nível relativo
A	0,000 - 0,009	I	Baixo
B*	0,010 - 0,049	II	
C	0,050 - 0,099	III	
D*	0,100 - 0,199	IV	Médio
E*	0,200 - 0,399	V	
F*	0,400 - 0,799	VI	
G	0,800 - 1,599	VII	Alto
H*	1,600 - 3,199	VIII	
I	3,200 - 6,399	IX	

* Propriedades escolhidas para a instalação dos experimentos, com seus respectivos níveis de inóculo.

QUADRO 2 - Tratamentos químicos utilizados em cada experimento, visando o controle da podridão branca do alho. Amarantina, município de Ouro Preto - MG, 1984.

Bulbilhos	Solo			Área experimental (Nível de escleródios)				
Iprodione g/100 kg	Iprodione [1] g/m2	Formaldeído [2] ml/m2	PCNB [3] g/m2	VIII	VI [4]	V [4]	IV	II
Testemunha				X	X	X	X	X
1000	-	-	-	X			X	X
1000	1	-	-	X	X	X	X	X
1000	2	-	-	X	X	X	X	X
1000	4	-	-	X	X	X	X	X
1000	-	-	6	X			X	
-	-	9,5	-				X	
-	-	19,0	-	X			X	
-	-	38,0	-	X			X	
-	-	76,0	-	X				
1000	-	9,5	-				X	
1000	-	19,0	-	X			X	
1000	-	38,0	-	X			X	
1000	-	76,0	-	X				
-	-	38,0[5]	-				X	
1000	-	38,0[5]	-				X	

X = Tratamento presente

[1] Iprodione: Nome comercial Rovral, pó molhável contendo 50% do princípio ativo; produto da Rhodia.

[2] Formaldeído: Nome comercial Formalina, solução de formaldeído a 38%; produto do Grupo Química.

[3] Pentacloronitrobenzeno: Nome comercial Brassicol, pó molhável contendo 75% do princípio ativo; produto da Hoeschst.

[4] Experimentos que possuíam 6 blocos; os demais experimentos possuíram 4 blocos.

[5] Tratamentos em que as parcelas foram cobertas com polietileno escuro; nos demais tratamentos com formaldeído, após sua aplicação, as parcelas foram cobertas com capim seco.

QUADRO 3 - Efeito de fungicidas aplicados no tratamento de bulbilhos e solo, no controle da podridão branca do alho, expresso pela percentagem de bulbos sadios, peso total dos bulbos, peso médio dos bulbos e proporção de área abaixo da curva de progresso da doença (PACPD). Área experimental com nível VIII[1] de escleródios no plantio; Amarantina, município de Ouro Preto - MG, 1984.

Bulbilhos	Solo			Bulbos sadios (%)	Peso total dos bulbos (g)	Peso médio dos bulbos (g)	PACPD
Iprodione g/100 kg	Iprodione g/m^2	Formaldeído ml/m^2	PCNB g/m^2				
1000	-	-	6	90,88 A	737,50 A	8,91 AB	0,0328 A
1000	-	76,0	-	84,54 AB	648,75 A	8,85 AB	0,0672 A
1000	-	38,0	-	74,92 ABC	570,75 AB	8,93 AB	0,1122 A
1000	-	19,0	-	68,05 ABC	501,75 AB	9,07 AB	0,1128 A
1000	4	-	-	70,13 ABC	513,75 AB	8,88 AB	0,1188 A
1000	2	-	-	70,90 ABC	526,25 AB	8,72 AB	0,0929 A
1000	1	-	-	62,58 BC	543,00 AB	10,10 AB	0,1440 A
1000	-	-	-	58,69 C	354,25 B	7,35 B	0,1673 A
-	-	76,0	-	10,27 D	104,50 C	11,74 AB	0,5273 B
-	-	38,0	-	9,40 D	78,75 C	10,88 AB	0,5484 B
-	-	19,0	-	8,30 D	66,50 C	13,48 A	0,5620 B
Testemunha				8,21 D	100,50 C	9,40 AB	0,6123 B
C.V. (%)				18,06	24,59	22,24	28,00

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[1] 1,600-3,199 escleródios/g de solo seco

[2] Os dados são médias de quatro repetições.

[3] Médias seguidas pela mesma letra em cada coluna não diferem entre si, pelo teste de Tukey, ao nível de 5% de probabilidade.

QUADRO 4 - Efeito de fungicidas aplicados no tratamento de bulbilhos e solo, no controle da podridão branca do alho, expresso pela percentagem de bulbos sadios, peso total dos bulbos, peso médio dos bulbos e proporção de área abaixo da curva de progresso da doença (PACPD). Área experimental com nível VI[1] de escleródios no plantio; Amarantina, município de Ouro Preto - MG, 1984.

Bulbilhos	Solo	Bulbos Sadios (%)	Peso total dos bulbos (g)	Peso médio dos bulbos (g)	PACPD
Iprodione g/100 kg	Iprodione g/m^2				
1000	4	83,87 A	721,50 A	11,26 A	0,0543 A
1000	2	75,66 A	597,17 A	11,68 A	0,0767 A
1000	1	61,64 A	496,00 A	12,00 A	0,1336 A
Testemunha		4,08 B	38,67 B	9,56 A	0,5348 B
C.V. (%)		23,38	30,14	15,32	25,74

[1] 0,400-0,799 escleródios/g de solo seco.

[2] Os dados são médias de seis repetições.

[3] Médias seguidas pela mesma letra em cada coluna não diferem entre si, pelo teste de Tukey, ao nível de 5% de probabilidade.

QUADRO 5 - Efeito de fungicidas aplicados no tratamento de bulbilhos e solo, no controle da podridão branca do alho, expresso pela percentagem de bulbos sadios, peso total dos bulbos, peso médio do bulbos e proporção de área abaixo da curva de progresso da doença (PACPD). Área experimental com nível V [1] de escleródios no plantio; Amarantina, município de Ouro Preto - MG, 1984.

Bulbilhos	Solo	Bulbos sadios (%)	Peso total dos bulbos (g)	Peso médio dos bulbos (g)	PACPD
Iprodione g/100 kg	Iprodione g/m^2				
1000	4	96,73 A	916,67 A	12,85 A	0,0077 A
1000	2	94,41 A	835,17 A	12,39 A	0,0191 A
1000	1	93,09 A	702,17 A	11,76 A	0,0248 A
Testemunha		14,25 B	135,67 B	13,15 A	0,3564 B
C.V. (%)		7,49	25,55	24,44	37,66

[1] 0,200-0,399 escleródios/g de solo seco.

[2] Os dados são médias de seis repetições.

[3] Médias seguidas pela mesma letra em cada coluna não diferem entre sim pelo teste de Tukey, ao nível de 5% de probabilidade.

QUADRO 6 - Efeito de fungicidas aplicados no tratamento de bulbilhos e solo, no controle da podridão branca do alho, expresso pela percentagem de bulbos sadios, peso total dos bulbos, peso médio dos bulbos e proporção de área abaixo da curva de progresso da doença (PACPD). Área experimental com nível IV[1] de escleródios no plantio; Amarantina, município de Ouro Preto - MG, 1984.

Bulbilhos	Solo			Bulbos sadios (%)	Peso total dos bulbos (g)	Peso médio dos bulbos (g)	PACPD
Iprodione g/100 kg	Iprodione (g/m^2	Formaldeído ml/m^2	PCNB g/m^2				
1000	-	-	6	99,67 A	995,50 ABC	11,83 A	0,0002 A
1000	-	38,0	-	99,38 A	1163,75 AB	13,36 A	0,0009 A
1000	-	38,0 [4]	-	99,13 A	1197,50 A	13,28 A	0,0011 A
1000	-	19,0	-	97,67 A	980,00 ABC	11,33 A	0,0050 A
1000	-	9,5	-	98,57 A	842,50 C	9,97 A	0,0034 A
1000	4	-	-	99,11 A	983,75 ABC	11,67 A	0,0010 A
1000	2	-	-	98,43 A	900,75 BC	10,61 A	0,0029 A
1000	1	-	-	98,20 A	901,25 BC	10,90 A	0,0038 A
1000	-	-	-	98,10 A	978,75 ABC	11,55 A	0,0036 A
-	-	38,0	-	9,45 B	60,50 D	9,35 A	0,3336 B
-	-	38,0 [4]	-	8,77 B	95,75 D	12,90 A	0,3031 B
-	-	19,0	-	14,05 B	108,75 D	11,22 A	0,3312 B
-	-	9,5	-	12,15 B	108,25 D	10,11 A	0,3295 B
Testemunha				5,60 B	47,50 D	10,82 A	0,3909 B
C.V. (%)				10,00	16,67	21,36	50,86

[1] 0,100-0,199 escleródios/g de solo.

[2] Os dados são médias de quatro repetições.

[3] Médias seguidas pela mesma letra em cada coluna não diferem entre si, pelo teste de Tukey, ao nível de 5% de probabilidade.

[4] As parcelas pertencentes a estes tratamentos foram cobertas com polietileno escuro.

QUADRO 7 - Efeito de fungicidas aplicados no tratamento de bulbilhos e solo, no controle da podridão branca do alho, expresso pela percentagem de bulbos sadios, peso total dos bulbos, peso médio dos bulbos e proporção de área abaixo da curva de progresso da doença (PACPD). Área experimental com nível II[1] de escleródios no plantio; Amarantina, município de Ouro Preto - MG, 1984.

Bulbilhos	Solo	Bulbos sadios	Peso total dos bulbos	Peso médio dos bulbos	PACPD
Iprodione g/100 kg	Iprodione g/m^2	(%)	(g)	(g)	
1000	4	88,79 A	1679,75 A	19,57 A	0,0333 A
1000	2	86,23 A	1477,50 A	18,52 A	0,0421 A
1000	1	81,58 A	1350,00 A	17,89 A	0,0573 A
1000	-	80,05 A	1218,75 A	17,13 A	0,0653 A
Testemunha		13,60 B	225,75 B	18,57 A	0,3004 B
C.V. (%)		5,71	16,88	8,08	22,56

[1] 0,010-0,049escleródios/g de solo seco.

[2] Os dados são médias de quatro repetições.

[3] Médias seguidas pela mesma letra em cada coluna não diferem entre si, pelo teste de Tukey, ao nível de 5% de probabilidade.

LEGENDA NO GRÁFICO	BULBILHOS	SOLO			EQUAÇÃO DA CURVA DE PROGRESSO DA DOENÇA	R^2 (%)
	IPRODIONE g/100kg	IPRODIONE g/m²	FORMALDEÍDO ml/m²	PCNB g/m²		
T_1	TESTEMUNHA				$Y = -0{,}00024T^2 + 0{,}06879T - 4{,}04170$	99
T_2	1000	-	-	-	$Y = 0{,}00007T^2 - 0{,}00984T + 0{,}29554$	98
T_3	1000	1	-	-	$Y = 0{,}00007T^2 - 0{,}00100T + 0{,}31899$	99
T_4	1000	2	-	-	$Y = 0{,}00009T^2 - 0{,}01531T + 0{,}65116$	99
T_5	1000	4	-	-	$Y = 0{,}00005T^2 - 0{,}00617T + 0{,}16909$	99
T_6	1000	-	-	6	$Y = 0{,}00002T^2 - 0{,}00295T + 0{,}10359$	96
T_8	-	-	19,0	-	$Y = -0{,}00017T^2 + 0{,}05312T - 3{,}25376$	98
T_9	-	-	38,0	-	$Y = -0{,}00016T^2 + 0{,}08172T - 3{,}17654$	98
T_{10}	-	-	76,0	-	$Y = -0{,}00012T^2 + 0{,}04318T - 2{,}73100$	98
T_{12}	1000	-	19,0	-	$Y = 0{,}00008T^2 - 0{,}01356T + 0{,}54222$	98
T_{13}	1000	-	38,0	-	$Y = 0{,}00002T^2 - 0{,}00106T - 0{,}09498$	95
T_{14}	1000	-	76,0	-	$Y = 0{,}00002T^2 - 0{,}00099T - 0{,}04278$	94

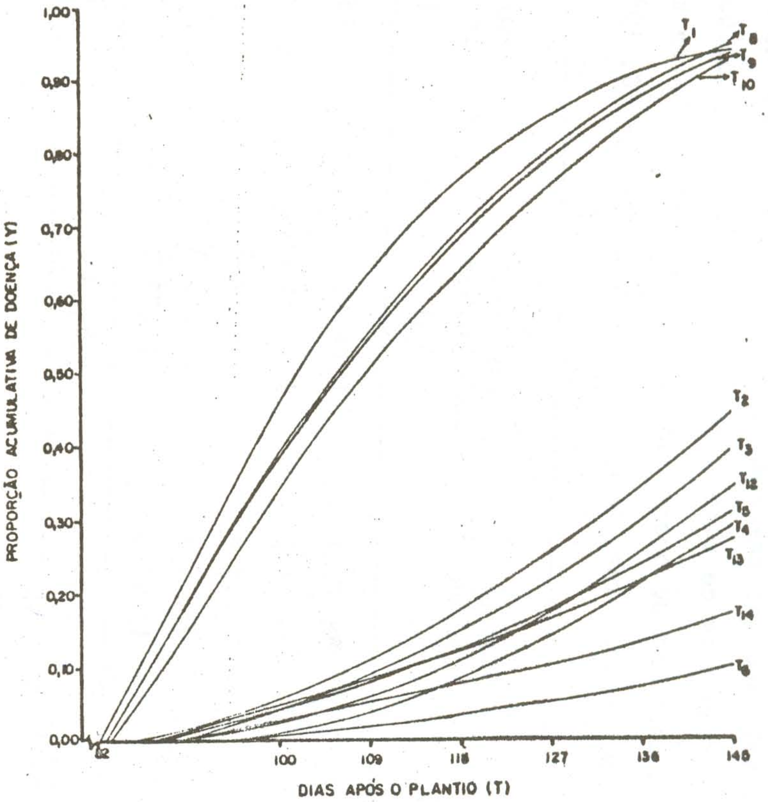

Figura 1

LEGENDA NO GRÁFICO	BULBILHOS IPRODIONE g/100 kg	SOLO IPRODIONE g/m^2	EQUAÇÃO DA CURVA DE PROGRESSO DA DOENÇA	R^2 (%)
T_1	TESTEMUNHA		$Y = -0,00009T^2 + 0,03552T - 0,02350$	99
T_3	1000	1	$Y = 0,00010T^2 - 0,01680T + 0,66188$	98
T_4	1000	2	$Y = 0,00008T^2 - 0,01480T + 0,64376$	98
T_5	1000	4	$Y = 0,00004T^2 - 0,00652T + 0,25169$	97

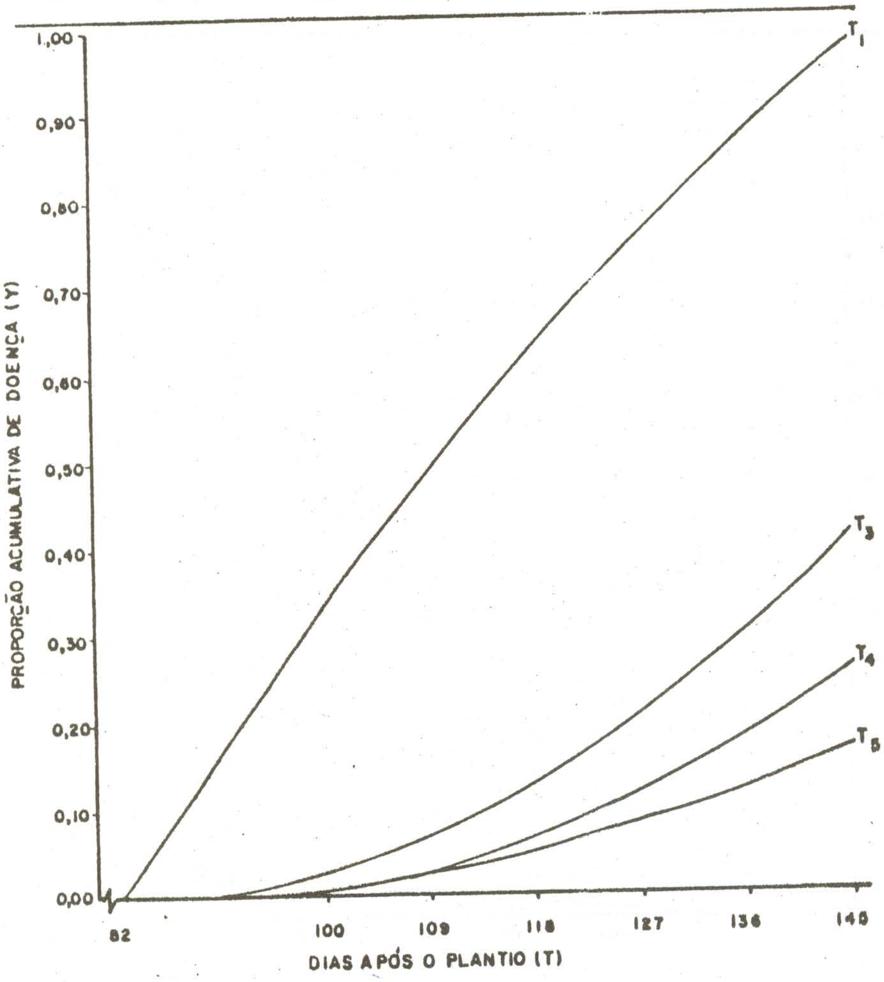

Figura 2

LEGENDA NO GRÁFICO	BULBILHOS IPRODIONE g/100 kg	SOLO IPRODIONE g/m²	EQUAÇÃO DA CURVA DE PROGRESSO DA DOENÇA	R^2 (%)
T_1	TESTEMUNHA		$Y = 0{,}00014T^2 - 0{,}01563T + 0{,}33943$	98
T_3	1000	1	$Y = 0{,}00002T^2 - 0{,}00261T + 0{,}09845$	98
T_4	1000	2	$Y = 0{,}00002T^2 - 0{,}00303T + 0{,}12656$	96
T_5	1000	4	$Y = 0{,}00001T^2 - 0{,}00264T + 0{,}12480$	98

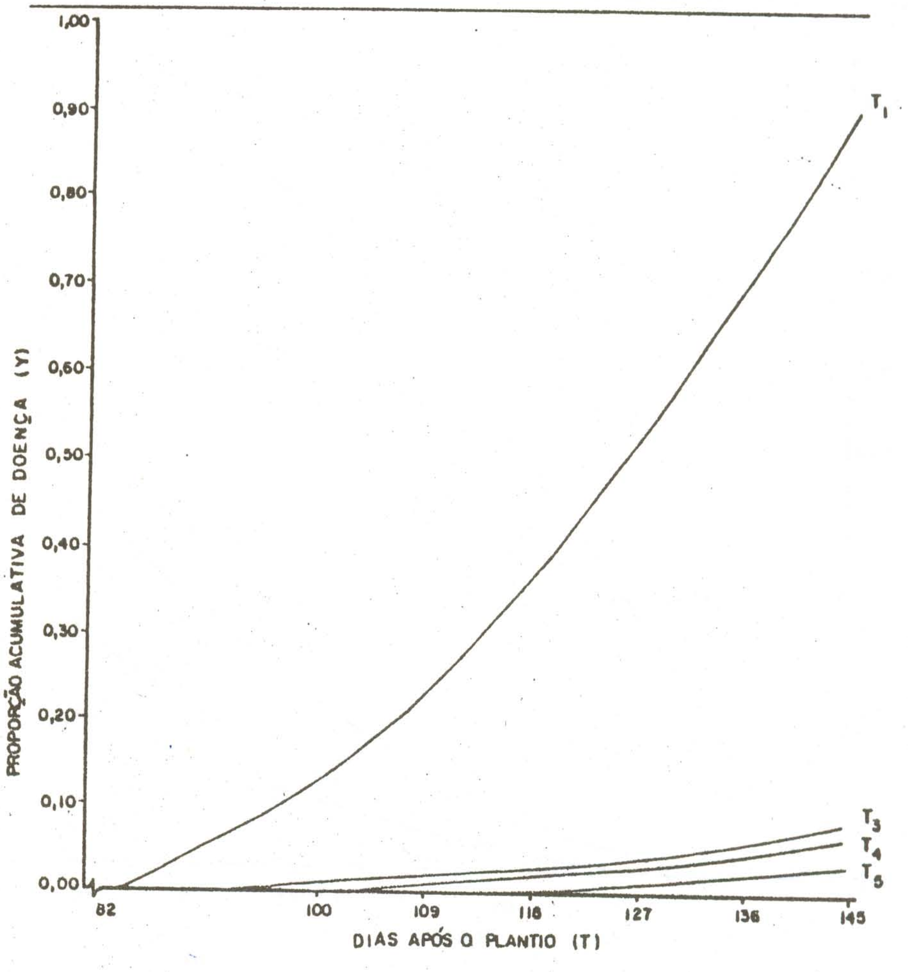

Figura 3

LEGENDA	BULBILHOS	SOLO			EQUAÇÃO DA CURVA DE PROGRESSO DA DOENÇA	R^2
NO GRÁFICO	IPRODIONE g/100kg	IPRODIONE g/m^2	FORMALDEÍDO ml/m^2	PCNB g/m^2		(%)
T_1	TESTEMUNHA				$Y = 0{,}00016T^2 - 0{,}01818T + 0{,}08820$	96
T_2	1000	-	-	-	$Y = 0{,}000006T^2 - 0{,}00180T + 0{,}08760$	96
T_3	1000	1	-	-	$Y = 0{,}000008T^2 - 0{,}00158T + 0{,}07384$	96
T_4	1000	2	-	-	$Y = 0{,}000008T^2 - 0{,}00163T + 0{,}08009$	87
T_5	1000	4	-	-	$Y = 0{,}000005T^2 - 0{,}00096T + 0{,}04789$	86
T_6	1000	-	-	6	$Y = 0{,}000001T^2 - 0{,}00031T + 0{,}01588$	66
T_7	-	-	9,5	-	$Y = 0{,}00020T^2 - 0{,}02903T + 0{,}99870$	96
T_8	-	-	19,0	-	$Y = 0{,}00018T^2 - 0{,}02461T + 0{,}78430$	97
T_{11}	1000	-	9,5	-	$Y = 0{,}000007T^2 - 0{,}00134T + 0{,}06342$	96
T_{12}	1000	-	19,0	-	$Y = 0{,}00001T^2 - 0{,}00225T + 0{,}10829$	96

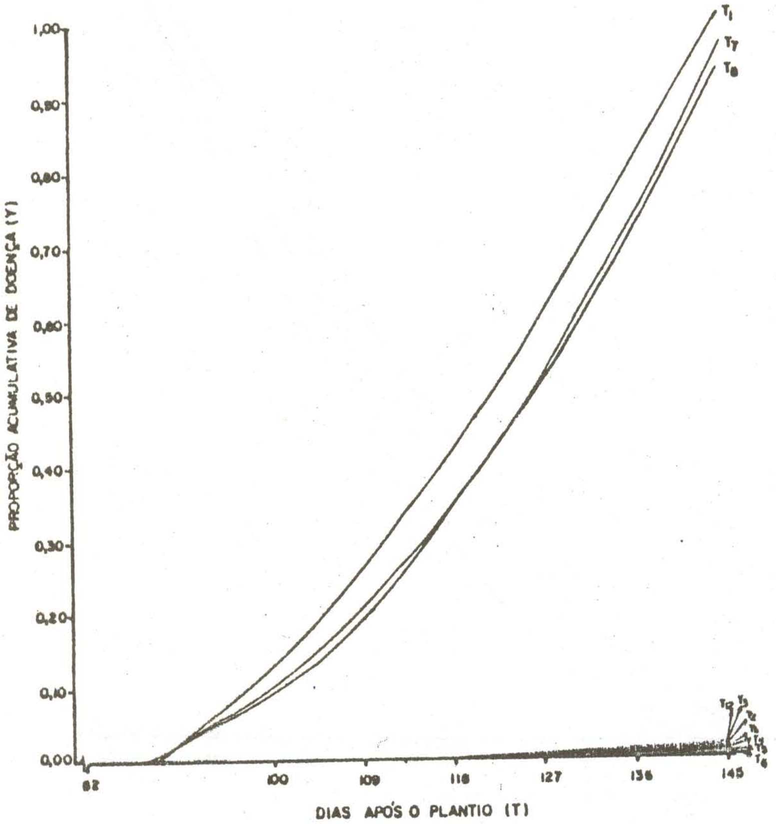

Figura 4

LEGENDA NO GRÁFICO	BULBILHOS	SOLO		EQUAÇÃO DA CURVA DE PROGRESSO DA DOENÇA	R^2 (%)
	IPRODIONE g/100kg	TRATAMENTO FORMALDEÍDO ml/m²	COBERTURA CAPIM SECO (C) POLIETILENO ESCURO (P)		
T_9	-	38	C	$Y = 0{,}00019\,T^2 - 0{,}02590\,T + 0{,}83083$	97
T_9P	-	38	P	$Y = 0{,}00029\,T^2 - 0{,}05017\,T + 2{,}12367$	97
T_{13}	1000	38	C	$Y = 0{,}000003\,T^2 - 0{,}00063\,T + 0{,}03144$	90
$T_{13}P$	1000	38	P	$Y = 0{,}000004\,T^2 - 0{,}00090\,T + 0{,}04500$	86
T_1	TESTEMUNHA		C	$Y = 0{,}00016\,T^2 - 0{,}01818\,T + 0{,}38820$	96

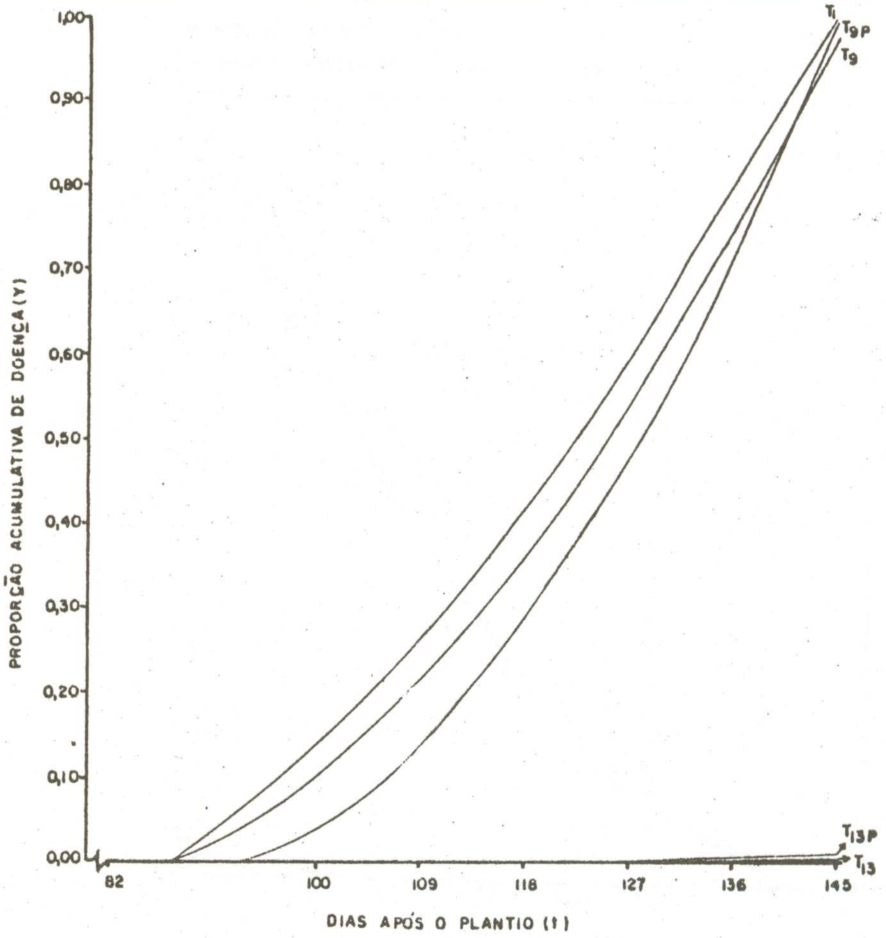

Figura 5

LEGENDA NO GRÁFICO	BULBILHOS IPRODIONE g/ 100 kg	SOLO IPRODIONE g / m^2	EQUAÇÃO DA CURVA DE PROGRESSO DA DOENÇA	R^2 (%)
T_1	TESTEMUNHA		$Y = 0,00025 T^2 - 0,04221 T + 1,70472$	95
T_2	1000	-	$Y = 0,00006 T^2 - 0,01043 T + 0,43345$	96
T_3	1000	1	$Y = 0,00006 T^2 - 0,01105 T + 0,47784$	97
T_4	1000	2	$Y = 0,00005 T^2 - 0,00890 T + 0,39026$	96
T_5	1000	4	$Y = 0,00004 T^2 - 0,00650 T + 0,28183$	98

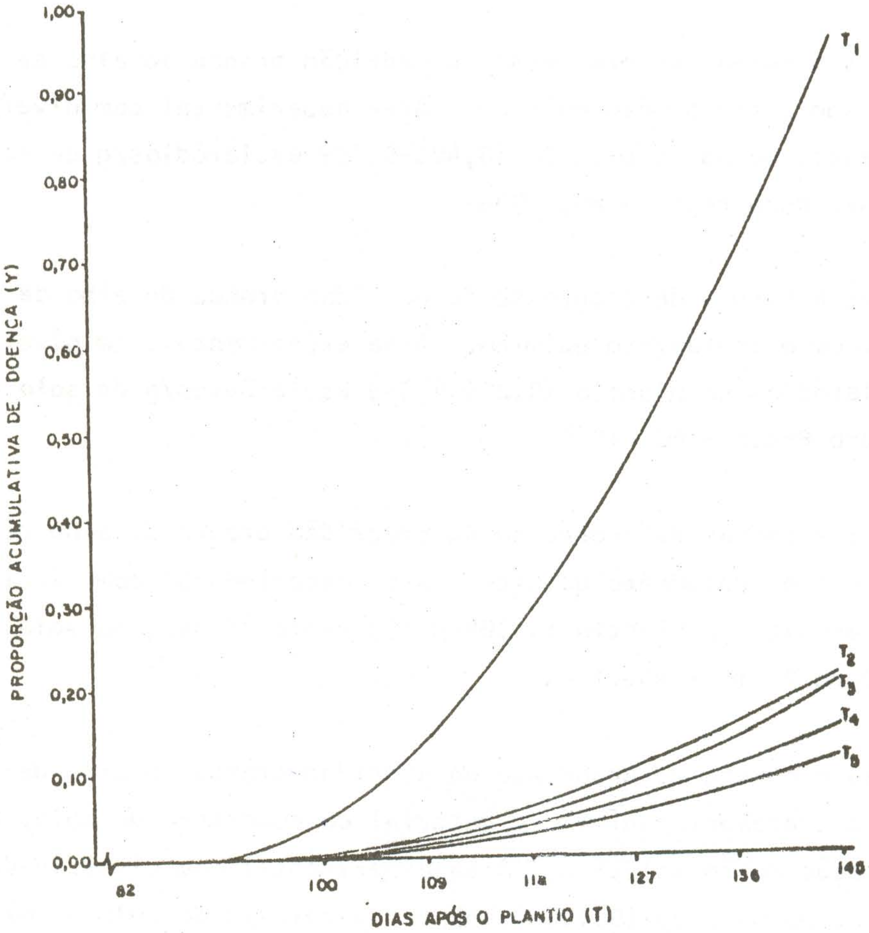

Figura 6

Legenda das Figuras enviadas em anexo

Figura 1 - Equações e curvas de progresso da podridão branca do alho de acordo com o tratamento químico. Área experimental com nível VIII de escleródios no plantio (1,600-3,199 escleródios/g de solo seco), Ouro Preto - MG, 1984

Figura 2 - Equações e curvas de progresso da podridão branca do alho de acordo com o tratamento químico. Área experimental com nível VI de escleródios no plantio (0,400-0,799 escleródios/g de solo seco), Ouro Preto - MG, 1984

Figura 3 - Equações e curvas de progresso da podridão branca do alho de acordo com o tratamento químico. Área experimental com nível V de escleródios no plantio (0,200-0,399 escleródios/g de solo seco), Ouro Preto - MG, 1984

Figura 4 - Equações e curvas de progresso da prodridão branca do alho de acordo com o tratamento químico. Área experimental com nível IV de escleródios no plantio (0,100-0,199 escleródios/g de solo seco), Ouro Preto - MG, 1984

Figura 5 - Equações e curvas de progresso da podridão branca do alho de acordo com o tratamento químico e material de cobertura do solo, após a aplicação do formaldeído. Área experimental com nível IV de escleródios no plantio (0,100-0,199 escleródios/g de solo seco), Ouro Preto - MG, 1984

Figura 6 - Equações e curvas de progresso da podridão branca do alho de acordo com o tratamento químico. Área experimental com nível II de escleródios no plantio (0,010-0,049 escleródios/g de solo seco), Ouro Preto - MG, 1984

CONTROL OF ONION WHITE ROT IN NEW ZEALAND

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Onions are one of New Zealand's major fresh vegetable crops. Annual production is about 70 000 tonnes from an area of just over 2 000 ha. Most of the crop is exported, chiefly to Japan, who took 50 000 tonnes in 1984, declining to 27 000 tonnes in 1985 (1).

Three-quarters of the onion crop comes from the Pukekohe district, South Auckland, with the rest from throughout both Islands. The climate at Pukekohe (37°S) is temperate, with a mean daily temperature in the coolest month (July) of 10°C and in the warmest month (February) of 19°C. Annual rainfall is 1400mm with a slight winter maximum (2). Soils are clay loams derived from volcanic ash (3). The principal varieties grown are brown bulb onions, Pukekohe Longkeeper (PLK) and Early Longkeeper (ELK). ELK is usually sown in June, and PLK in July, for harvest in January-February. As well as onions some garlic is grown and is regarded as a potentially valuable export crop.

White rot has been present in New Zealand since 1922. Its prevalence in the Christchurch district has led to a decline in the relative importance of this area for onion production. White rot was first recorded at Pukekohe in both onions and garlic in the 1959-60 season (4). It has not been a serious problem until recently because most farmers do not rely on onions as a sole crop and can use badly infested fields for other vegetables. However potato cyst nematode infestations have reduced the opportunity for rotation and a sigficant proportion of the land available for onions now has white rot infestation. Control measures are also losing effectiveness, so a major economic impact can be expected in the near future.

The current control program for white rot is seed treatment with vinclozolin or iprodione, with a foliar spray of these chemicals at first true leaf stage (six weeks after sowing) and three subsequent sprays at monthly intervals. However, after continued use disease control by these fungicides diminishes significantly.

Our research program is examining chemical and biological control methods. Field trials on naturally infested sites at Pukekohe have been conducted for two seasons and are being expanded for the 1986-87 season.

CHEMICAL CONTROL

The 1984-85 trial, using ELK, showed that the dicarboximide procymidone applied as a seed dressing, or as foliar sprays or a combination of both was superior to both vinclozolin and iprodione for the respective application methods. A combination of seed and spray treatments gave the best control with all fungicides, with survival at harvest of 31.8% for controls, 37.5% for vinclozolin, 42.6% for iprodione and 71.3% for procymidone.

Following the first year's trials it was decided to concentrate on application methods for procymidone. In 1985-86, procymidone was applied to PLK as seed (5g a.i./kg, commercially pelleted), spray (0.75kg a.i./ha, monthly) and seed plus spray treatments. In addition procymidone was applied as a soil drench (3kg a.i./ha) in the furrows at sowing, alone and in combination with seed treatment.

Bad weather delayed planting until late August so disease incidence was low (max 16%).

The results showed that procymidone treatments reduced disease significantly. The soil drench treatments gave the best control (1.7% disease) but were phytotoxic. Plants in these plots showed slow emergence, stunted growth and curling of leaves. Affected plants grew out of these symptoms by the end of the season. There was no indication that procymidone seed pellets were phytotoxic. Seed treatment and foliar sprays with procymidone reduced disease by 40% compared with untreated controls, while the seed plus spray treatment reduced disease by 60%. Iprodione, included for comparison, was completely ineffective.

Sixty-four isolates of S. cepivorum from iprodione treated plots from this paddock were screened for resistance to dicarboximides. Only one showed tolerance of low levels (2-5 ppm) of vinclozolin or iprodione. No tolerance of procymidone or benomyl was found. There is no evidence that tolerance of dicarboximides is common at Pukekohe, or that it is the cause of poor control in this instance.

Two trials, one each with ELK and PLK, are being conducted in 1986-87, again examining a range of application methods for procymidone including slow-release formulations. Fungicide trials are also being undertaken by the Ministry of Agriculture and Fisheries at Pukekohe. Unfortunately it seems possible that procymidone will not be registered for use on onions in New Zealand. It is also possible that control may break down with continued use in the same manner as with other dicarboximides.

BIOLOGICAL CONTROL

A range of fungi and bacteria antagonistic or parasitic to S. cepivorum have been recovered from infested field soil and from sclerotia. We are examining these for their potential for control of white rot.

Fourteen bacteria showing strong antagonism to *S. cepivorum* in vitro have been selected for study. Of these two are Gram-negative, one is an actinomycete and the rest are isolates of *Bacillus*. Pot and field trials in 1985-86 were inconclusive due to low disease levels and a planter mishap, but suggested that some reduction in disease had occurred, especially with the *Bacillus* isolates. It was decided to concentrate on producing *Bacillus* spore powders suitable for use as seed treatments.

We are currently producing spores in a medium containing peptone (10g/1), glucose (10g/1), $MgSO_4$, $MnSO_4$, $CaCl_2$ (each 1mM) and $FeSO_4$ (100uM). Cultures are shaken at 25°C and harvested when sporulation is complete (5-7 days). Harvesting is by centrifugation, with one deionised water wash followed by dehydration and precipitation in acetone (5). Lactose improves the precipitation of spores but is usually omitted. Typical yields are 2g/1 spore powder containing 10^{10}-10^{11} cfu/g. Such powders adhere to onion seeds at rates of at least 20g/kg when applied as thick suspensions without the need for stickers other than a trace of wetting agent. Two isolates selected for antagonism at 15°C, high rates of sporulation and viability of spore powders are being tested as seed dressings in field trials in 1986-87, alone and in combination with procymidone sprays. Other work in progress is the formulation of spore powders suitable for pelleting, and a study of the mechanisms of disease suppression.

Antagonistic fungi from the field and cultures of known mycoparasites were tested in vitro against *S. cepivorum*. Most of the field collections were *Penicillium*, *Trichoderma* or *Fusarium* species. From the original 82 isolates six were chosen for further work - *Coniothyrium minitans*, *Penicillium expansum*, *Gliocladium roseum*, *Trichoderma viride*, an unknown *Trichoderma* and a *Chaetomium* species with very strong antibiotic activity.

These fungi were tested in agar cultures against fungicides commonly applied to onions. Captan, iprodione, vinclozolin and procymidone had little effect on growth rate or form except at high concentrations (>25ppm). Benomyl was inhibitory to all fungi at 2ppm. This indicated that the antagonists and mycoparasites could be integrated into control regimes using captan and dicarboximides.

Fungi have been bulked up on the molasses-yeast medium of Papavizas *et al*. (6) and the mycelial mats dried and powdered. This method gives rapid production of fungal product of high concentration with little contamination or extraneous material. In 1986-87 pot trials are being conducted with all six fungi, and field trials with *T. viride* and the *Chaetomium*.

Other work in progress is light and electron microscope investigations of the biology of infection and of sclerotia.

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The effect of water volume on the efficacy of chemicals for the control of white rot in spring-sown bulb onions

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SUMMARY

Iprodione at 0.125 and 0.25 g ai m^{-1} in 1981 and iprodione and procymidone at 0.15 g ai m^{-1} in 1985 were applied as stem base sprays in 30, 100 and 500 ml water m^{-1} to spring sown bulb onions. In 1981, iprodione was more effective at controlling white rot in higher rates of water, but there was no difference between the two rates of chemical. In 1985 there was no difference in control of the disease or in the yield of bulbs with iprodione at any of the rates of water. Procymidone in 1985 gave better control of white rot and a greater yield of bulbs than did iprodione at all three rates of water, and was more effective with increased rates of water.

INTRODUCTION

Iprodione has been shown to give good control of onion white rot (*Sclerotium cepivorum* Berk.) in salad onions (Entwistle and Munasinghe, 1980, 1981), but control of the disease in bulb onions has been variable (Davies & Wafford, 1986). Several factors may be responsible for this variability. The timing of spray application has been discussed at this workshop (Wafford, 1986). Another factor which may be important is soil moisture (Gladders, Pye & Wafford, 1984). The majority of bulb onions are grown in the east of the British Isles, which is relatively drier than the traditional salad onion areas. According to Entwistle (*pers comm*), when he and Munasinghe carried out their trials on autumn-sown salad onions (Entwistle &Munasinghe, 1981), the soil was at field capacity at the time of spray applications, whereas in trials on spring-sown bulb onions, there was a severe soil moisture deficit, which may have affected the efficacy of the chemicals used. In order to test this hypothesis, chemicals with known activity against white rot were applied to bulb onions in varying quantities of water.

MATERIALS AND METHODS

1981 Trial

Spring-sown bulb onions, cv Robusta, were direct drilled at the end of April 1981, into a silt soil, known to be infested with *Sclerotium cepivorum*. Plots, 5 metres long by 4 rows wide, were marked out in the crop. Treatments were applied on 15 June, five weeks after crop emergence. The chemical used for this experiment was iprodione ("Rovral" 50% w.p., May and Baker Ltd.). Two rates of the chemical were used, 0.125 g ai m^{-1} and 0.25 g ai m^{-1}, each rate being applied in 30, 100 and 500 ml water m^{-1}. Treatments using 30 and 100 ml water m^{-1} were applied by a CDM CO_2 pressurised sprayer fitted with a hand lance, operating at 1.5 bar. Treatments using 500 ml water m^{-1} were applied with a watering can fitted with a dribble bar. All treatments were applied to a 100 mm wide band along the rows, so that the equivalent rates per hectare were 3.75 and 7.5 kg ai iprodione in 450, 3000 and 15000 litres of water.

At harvest, on 14 September, the weight of bulbs from 2 x 3m of row was recorded and bulbs were scored for the presence or absence of white rot.

1985 Trial

A similar experiment was carried out in 1985 at Kirton Experimental Horticulture Station, using the cultivar Hytan. but following reports of failure to control white rot with iprodione, (Entwistle 1983), an additional chemical, procymidone ("Sumisclex" 50% w.p. Plant Protection Ltd.) was used, both chemicals being used at a single rate of 0.15 g ai m^{-1} (9.0 kg product ha^{-1}). The chemicals were applied using the methods and rates of water described for 1981. Visual assessments of white rot were carried out on 7 June, 2 July, 31 July and 22 August. At harvest, on 28 August, bulbs were graded into healthy, slight white rot and severe white rot, and the weight of bulbs in each category was recorded. A white rot/yield index was also calculated using the formula:-

$$\text{White rot index} = \frac{\text{weight of slight} + \text{weight of severe} \times 2}{\text{total weight} \times 100/2} \times 50$$

RESULTS

The results from the 1981 experiment are shown in Tables 1 and 2. The rate of iprodione had no effect on the total yield of bulbs, which was 29.6 tonne ha^{-1} at both rates. The higher rate of iprodione, however, gave a lower percentage of bulbs with white rot (11.5% bulbs affected) than the lower rate (14.9% bulbs affected). There was no difference in the weight of bulbs where 30 and 100 ml water m^{-1} were used (27.2 and 26.6 tonne ha^{-1} respectively).

Table 1. *The effect of different rates of iprodione on the weight of bulbs (tonne ha^{-1}) and percentage number of bulbs with white rot.*

Rate of chemical (g ai m^{-1})	Weight of bulbs	Percent bulbs with white rot
0.125	29.6	14.9
0.25	29.6	11.5
SED (15 df)	1.43	1.55

Table 2. *The effect of different rates of water on the weight of bulbs (tonne ha^{-1}) and percentage number of bulbs with white rot.*

Rate of water (ml m^{-1})	Weight of bulbs	Percent bulbs with white rot
30	27.2	16.2
100	26.6	18.2
500	35.0	5.2
SED (15 df)	1.26	1.90

At 500 ml water m^{-1}, however, the weight of bulbs was significantly greater (35.0 tonne ha^{-1}) than at either of the other two rates. The number of bulbs with white rot showed a similar pattern, with 500 ml water m^{-1} giving a lower percentage bulbs affected (5.2%) than 100 ml water (18.2%) or 30 ml water (16.2%). There was no significant interaction between the rates of chemical and water.

The results of the 1985 experiment are shown in Tables 3, 4 and 5. Procymidone (index 25.8) was significantly better at controlling white rot than iprodione (index 57.6) (Table 3). This was accounted for by a greater weight of healthy bulbs and bulbs with slight white rot from plots treated with procymidone (17.9 and 13.4 tonne ha^{-1} respectively) than from those treated with iprodione (2.1 and 6.7 tonne ha^{-1} respectively) and a lower weight of bulbs with severe white rot from plots treated with procymidone (1.0 tonne ha^{-1}) compared with those treated with iprodione (3.2 tonne ha^{-1}). The effect of increasing the rate of water was to reduce the white rot index from 44.6 at 30 ml to 41.8 at 100 ml and to 38.7 at 500 ml. (Table 4.). This reduction was accounted for entirely by an increase in the weight of healthy bulbs from 6.2 tonne ha^{-1} at 30 ml to 10.0 tonne ha^{-1} at 100 ml and to 13.7 tonne ha^{-1} at 500 ml.

Table 3. *The effect of iprodione and procymidone on the weight (tonne ha^{-1}) of healthy and white rot affected onions.*

Chemical	Weight of healthy	Weight of slight	Weight of severe	Index
iprodione	2.1	6.7	3.2	57.6
procymidone	17.9	13.4	1.0	25.8
SED (25 df)	1.94	1.42	0.22	3.53

There was, however, an interaction between the chemicals and the rates of water. The effect of iprodione was the same at all rates of water, with no differences in the weight of bulbs in each disease category. (Table 5.). With procymidone, however, there was an increase in the weight of healthy bulbs and a reduction in the weight of severe bulbs, so that the index was reduced from 36.9 at 30 ml to 23.3 at 100 ml and to 17.2 at 500 ml.

Table 4. *The effect of rate of water on the weight (tonne ha^{-1}) of healthy and white rot affected spring sown bulb onions.*

Rate of water (ml)	Weight of healthy	Weight of slight	Weight of severe	Index
30	6.2	9.6	2.3	44.6
100	10.0	10.6	1.9	41.8
500	13.7	9.9	2.1	38.7
SED (25 df)	2.38	1.74	0.27	4.32

Table 5. *The effects of iprodione and procymidone applied in different quantities of water on the weight (tonne ha^{-1}) of healthy and white rot affected spring sown bulb onions.*

Chemical	Rate of water (ml)	Weight of healthy	Weight of slight	Weight of severe	Index
iprodione	30	2.8	5.5	2.4	52.3
	100	1.3	6.9	3.4	60.3
	500	2.2	7.7	3.8	60.2
procymidone	30	9.6	13.8	2.2	36.9
	100	18.8	14.3	0.5	23.3
	500	25.3	12.2	0.4	17.2
SED (25 df)		3.37	2.46	0.38	6.11

DISCUSSION

The results of these experiments indicate that the rate of water used in stem base sprays may be an important factor in controlling white rot. Entwistle and Munasinghe (1980) suggested that chemicals applied as stem base sprays would be expected to remain in the surface layers of the soil, and that this may be sufficient to suppress development of the fungus. It could further be expected that where there is ample moisture in the soil, this would allow distribution of the chemical through the surface layers. In the experiments described here, it was observed that at the lowest rate of water, the soil was barely dampened, and even at the middle rate moisture penetration was restricted to the top centimetre. At the highest rate, however, there was wetting of the soil to some depth. This would possibly have carried the chemical to the root zone, thereby allowing suppression of the fungus in that area.

It is possible that at the highest rate, the water alone may have been responsible for the increased yield of bulbs, and the comparison of water rates in 1985 lends support to this suggestion. In the absence of 'water only' plots, it is impossible to disprove this. However, the water was only applied once, and even at the highest rate was no more than the equivalent of 5 mm of rain. Furthermore, the lack of response where iprodione was used in 1985 compared with the large response where procymidone was used would seem to indicate that water alone was not responsible for the increase. When chemicals with a high potential to control white rot are used, then they may be more effective at higher rates of water. The poor control of white rot given by iprodione in the 1985 experiment may be the result of 'enhanced degradation' (Entwistle, 1983, Wafford, 1986), as iprodione had been used previously and frequently on this site.

The highest rate of water would be totally impractical to use in a sprayer. The implication from Entwistle and Munasinghe's work (1981) (Entwistle, *pers comm*) is that it is the soil moisture that is important rather than how the moisture is applied. Rainfall, therefore, ought to be as effective as a high water rate in the spray application, and following the 1981 experiment, the manufacturers recommended that iprodione be applied immediately before or after rain. However, as timing of sprays is also important rainfall cannot be relied upon. With the increased availability of irrigation, it should be possible to obtain more reliable application of water at the time of spray application. As no one method of control appears to be satisfactory in bulb onions at the present time, there is increasing interest in an integrated approach and the use of water should be considered in any integrated methods.

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COMPARISON OF THE TIMING OF FUNGICIDE APPLICATION FOR THE CONTROL OF WHITE ROT IN SPRING-SOWN MODULE-RAISED BULB ONIONS

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SUMMARY

Vinclozolin was applied as a pre-planting drench to modules or as a stem base spray five or ten weeks after planting and at all combinations of these times. The pre-planting drench was applied at the rate of 0.01 g ai module $^{-1}$ in 4 litre or 800 ml water m^{-2} to the peat blocks and Hassy units respectively. The stem base sprays were applied at the rate of 0.1 g ai m^{-1} of row in a 100 mm wide band in 100 ml water m^{-1}. All treatments reduced the level of white rot compared with an untreated control until the middle of July. The most effective treatment was the combination of all three times. The most effective single and double applications were five weeks after planting and pre-planting plus five weeks after planting. None of the treatments persisted until harvest and there were no differences in final yields.

INTRODUCTION

Iprodione has been shown to give good control of white rot (<u>Sclerotium cepivorum</u> Berk.) in salad onions (Entwistle and Munasinghe, 1980 and 1981.) Iprodione and other di-carboximide fungicides have also given good control in bulb onions (Davies and Wafford, 1986, Wafford, unpublished data), but the results have been variable (Davies and Wafford, loc. cit., Gladders, Pye and Wafford, 1984). Several factors may be involved in this variability. The effect of altering the amount of water used in stem base sprays has been discussed at this workshop (Wafford, 1986). Another factor which may affect the efficacy of chemicals is the time of application. This paper describes an experiment designed to compare different times of application of the dicarboximide fungicide, vinclozolin.

MATERIALS AND METHODS

This experiment compared the effects of two types of peat module, pre-planting drenches and post-planting stem-base sprays, five and ten weeks after planting, on the development of white rot in a spring-sown bulb onion, cv Copra, grown in a known Sclerotium cepivorum infested silt soil at Kirton Experimental Horticulture Station. The treatments were arranged in a 2^4 factorial, randomised block design with six replicates. The two types of module used were a 2.7 cm compressed peat block and a Hassy 308 loose-fill unit. The chemical used for the pre-planting drench and post-planting sprays was vinclozolin ("Ronilan" 50% wp, BASF). Pre-planting drenches were applied immediately before planting, on 10 April 1984 in place of the normal pre-planting watering. The chemical was applied at the rate of 13.75 g ai m^{-2}, equivalent to 0.01 g ai $module^{-1}$, in 4 litre or 800 ml water m^{-2} for blocks and Hassy units respectively. Stem base sprays were applied at the rate of 0.1 g ai m^{-1} (6 kg product ha^{-1}) in 100 ml water (3000 litre ha^{-1}), using a tractor mounted band sprayer operating at a pressure of 2 bar. The sprays were applied as a 100 mm band along the rows so that the amount of chemical applied to a 100 mm x 100 mm area around each module was the same as that applied to each module pre-planting. Disease assessments were carried out on 11 June, 18 June, 25 June, 2 July, 9 July, 16 July, 23 July and 30 July. At harvest on 28 August, the bulbs were graded into healthy and white rot affected and the weight in each category recorded.

RESULTS

No differences were observed between peat blocks and Hassy units. The effects of these were therefore combined and the data re-analysed as a 2^3 factorial with twelve replicates. White rot was first seen on 8 June. On 11 June, when the first assessment was carried out, an average of 3.4% plants (mean of untreated and plots to be treated 10 weeks after planting) were affected in untreated plots (Table 1.) All treated plots had fewer plants affected.

Table 1. The effect of time of chemical application on the incidence of white rot in spring-sown bulb onions.

Date of assessment

Time of application	11/6	18/6	25/6	2/7	9/7	16/7	23/7	30/7
Untreated	4.1	8.9	12.3	18.9	30.7	34.1	38.4	41.1
Pre-Planting	0.1	1.0	3.2	7.8	20.7	27.1	35.3	35.2
5 weeks	0.0	0.8	1.0	3.2	13.4	18.4	30.7	28.8
10 weeks	2.7	8.3	13.7	19.6	26.7	30.5	35.8	31.4
Pre-planting + 5 weeks	0.1	0.8	1.2	3.9	14.6	24.5	34.3	33.0
Pre-planting + 10 weeks	0.3	1.1	2.8	7.7	16.3	23.3	33.0	32.4
5 + 10 weeks	1.0	2.1	3.0	4.8	13.3	24.1	33.9	32.3
Pre-planting + 5 weeks + 10 weeks	0.1	0.2	0.7	2.3	10.7	19.3	28.2	26.8
SED (75 df)	0.69	1.56	2.28	2.93	4.48	5.10	6.00	6.25

White rot increased rapidly in the untreated plots and by 2 July, 18.9% plants were affected. Plots treated 10 weeks after planting (18 June) showed a similar increase and on 2 July 19.6% plants were affected. All other treatments had fewer plants affected, but the proportion of plants affected in plots treated pre-planting and pre-planting plus 10 weeks after planting was greater than in the other treated plots. The most effective treatment was vinclozolin applied at all three times (2.3% plants affected on 2 July), but this was not significantly better than any other plots which included an application five weeks after planting. From 2 July onwards, the percentage plants affected in all treatments increased and by 30 July, there were no differences between any of the treatments. None of the treatments gave weights of affected or healthy bulbs different from those of the untreated plots (Table 2.)

Table 2. The effect of time of chemical application on the weight (tonne ha^{-1}) of healthy and white rot affected spring-sown bulb onions.

Time of application	Weight of clean bulbs	Weight of affected bulbs	Total weight
Pre-planting	19.0	5.6	24.6
Untreated	17.7	7.2	24.9
5 weeks	26.0	9.3	35.3
10 weeks	28.2	3.9	32.1
pre-planting + 5 weeks	26.2	8.0	34.2
pre-planting + 10 weeks	29.1	8.0	37.1
5 weeks + 10 weeks	20.9	8.2	29.1
pre-planting + 5 weeks + 10 weeks	27.5	8.0	35.5
SED (75 df)	6.56	1.48	6.54

DISCUSSION

Vinclozolin applied as a pre-planting drench plus stem-base sprays five and ten weeks after planting was the most effective treatment at controlling white rot. However, the cost of this programme would be uneconomic and most growers would prefer to use no more than two applications and preferably one. Of the single treatments, a stem-base spray five weeks after planting was the most effective and the most effective double application was a pre-planting drench plus a stem-base spray five weeks after planting. However, none of the treatments persisted beyond the middle of July and subsequent control was commercially unacceptable. Similar results were obtained in an earlier trial (Wafford, unpublished data) using iprodione. These results are in contrast to the findings of Entwistle and Munasinghe (1981), who showed that iprodione applied as a seed dressing at 250 g ai kg^{-1} to autumn-sown salad onions controlled white rot until July, and that a single stem-base spray of iprodione at 0.125 g ai m^{-1} in the spring gave complete control of the disease. A factor which may in part be involved is the phenomenon of 'enhanced degradation', described by Entwistle (1983). As both this trial, and the previous trial referred to, were carried out on land which had previously received applications of both vinclozolin and iprodione, it is possible that the chemicals were subjected to 'enhanced degradation'. Later trials, comparing chemicals (Davies and Wafford, 1986) have shown that either di-carboximide fungicides can persist throughout the season when applied as pre-planting drenches and stem-base sprays applied five weeks after planting. Despite the poor control obtained in this trial, the results from the early part of the season are sufficiently encouraging to warrant further investigation and it is recommended that in any future trials on the timing of comparison of chemicals a pre-plant drench plus stem-base spray five weeks after planting should be included as one of the treatments.

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Application of Procymidone to Seed and Fertilizer for the Control of *Allium* White Rot in Bulb Onions

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Bulb onions are a major vegetable crop in Tasmania. Production in 1984/85 was 29,383 tonnes (607 ha), with a gross value of $10.9 million. Two-thirds of Tasmania's onion crop are exported overseas, representing three-quarters of the total Australian onion export.

In recent years *Allium* white rot (*Sclerotium cepivorum*) has become increasingly prevalant in commercial onion crops in Tasmania and over 35 outbreaks have now been reported, some of which were very severe. In the past, the Department of Agriculture had recommended strict quarantine of areas affected and to grass down these areas for many years or even permanently so as to avoid spread of the disease. The scope for this approach is now no longer acceptable to growers whose land is too valuable to be grassed down for a long period.

In 1983, a research program to control *Allium* white rot was initiated. Emphasis has been on chemical control and initial studies were based on published studies of other workers, particularly those of Entwistle and Munasinghe (e.g. Entwistle and Munasinghe, 1981), Utkehede and Rahe (1979), Adams and Johnson (1983) and Merriman et al (1981).

Trials were carried out on grower properties known to have serious white rot in the past. The soil type in the main onion growing areas is krasnozem, a clay-loam.

FIELD TRIALS: 1983 TO 1986

Year 1: 1983/84

Year 1 trials consisted mainly of iprodione, vinclozolin and metham-sodium treatments, all of which were based on published studies. Application of fungicides as drenches along rows were found to be impractical for bulb onions and boom sprays were used instead.

Year 2: 1984/85

Trial 1 (Forth) Sown 12 June, 1984. - 6 treatments:

1. Iprodione seed dressing* + 4 kg a.i./ha with fertilizer
2. Vinclozolin seed dressing** + " " " "
3. Procymidone seed dressing** + " " " "
4. Metham-sodium 240 L product/ha (1/3 rate) in irrigation water (200 mm irrigation).
5. Dazomet 500 kg product/ha, to 200 mm soil depth with tarping
6. Untreated control

* 100 g a.i./kg seed ** 50 g a.i./kg seed

Trial 2 (Forest) Sown 10 October 1984. 6 treatments similar to above.

Year 3, 1985/86

Trial 1 (Forth). Sown 7 June, 1985 - 10 treatments:

1 SD4 = Procymidone seed dressing (s.d.)* + 2 kg a.i./ha with fertilizer
2 SD6 = Procymidone s.d. + 3 kg a.i./ha with fertilizer
3 SD8 = Procymidone s.d. + 4 kg a.i./ha with fertilizer
4 SD4 + 4 = Procymidone s.d. + 2 kg a.i./ha with fertilizer + 2 kg a.i. spray/ha
5 SD4 + oil = Procymidone s.d. + 2 kg a.i./ha with fertilizer + 5 L onion oil/ha
6 SD8 + oil = Procymidone s.d. + 4 kg a.i./ha with fertilizer + 5 L onion oil/ha
7 SD + oil = Procymidone s.d. + 5 L onion oil/ha
8 SD = Procymidone s.d.
9 PPSD8 = Fungicide PP192 s.d.* + 4 kg a.i. PP192/ha with fertilizer.
10 Untreated = Untreated control.

* Procymidone & PP192 seed dressing rates : 50 a.i./kg seed

Trial 2 (Thirlstane) Sown 21 June, 1985. Treatments as above.

Trial 3 (Forth) Sown 22 August, 1985. Treatments as above.

For all the trials above, seeds were coated with methyl cellulose (100 mls of 1.5% methyl cellulose per kg seed) prior to adding of fungicides. The fungicide-fertilizer mix was prepared by adding the fungicide to fertilizer and then mixed thoroughly, and the mixture applied to the soil in a narrow band at 50 mm below the seeds at the same time when seeds were sown. Onion oil was applied with a boom spray 4 weeks prior to sowing and rotary-hoed to a depth of 200 mm.

Observations were made on disease development at regular intervals with final yield assessment made at commerical harvest. Studies were also carried out on aspects of disease epidemiology, level of sclerote inoculum in soil, phytotoxicity of fungicides and fungicide residue levels in onions.

RESULTS

DISEASE PROGRESS

Disease (wilt) curves for year 2 and year 3 trials are shown in graphs 1 & 2.

The disease curves in Graph 1 show that the protective effects of procymidone had been sustained over a much longer period that those of iprodione and vinclozolin.

In Graph 2, all procymidone treatments can be seen to provide very good disease control up to several months after sowing, after which the disease increased very gradually, with the increase more rapid in seed-dressed only treatments. The results of the trial at Thirlstane also gave very similar disease curves.

WILT INCIDENCE AND YIELDS

Year 1: 1983/84

Both iprodione and vinclozolin seed treatments plus 2 sprays increased yields significantly but the increases were small. Spraying alone did not significantly increase yield, indicating that the beneficial effects of iprodione and vinclozolin were due mainly to seed treatment. Metham-sodium at 1/3 rate in irrigation water did not provide any disease control.

Year 2: 1984/85

Table 1: Forth trial - wilt incidence & yields (sown 12 June 84)

Treatment	% wilt	No. of harvestable bulbs/plot	Yield kg/plot
	Dec. 27, 1984	Jan. 31, 1985	
Procymidone	6.2a*	116.0a*	15.42a*
Dazomet	14.3a	112.2a	16.78a
Iprodione	42.9b	71.0b	10.37b
Metham-sodium	54.9b	51.5bc	8.09bc
Vinclozolin	49.4b	51.2bc	8.20bc
Untreated	60.7b	39.2c	6.66c

* Results with the same letter do not differ significantly at P = 0.05 (DMRT).

Procymidone treatment was found to be very effective in controlling Allium white rot. Wilt incidence was reduced to 6.2% from 60.7%. Yield increases were 3 folds for bulb numbers and 2.3 folds for weights. The results were comparable to those achieved by soil fumigation by dazomet. Iprodione and vinclozolin treatments did not significantly decrease wilt incidence. Iprodione treatment however significantly increased weight yields by 1.5 folds. Vapam at 1/3 rate was ineffective in controlling white rot.

The level of wilt was low at the Forest site and data obtained was not sufficiently meaningful for analysis.

Year 3: 1985/86

Table 2. Forth & Thirlstane trial - wilt incidence & yields

	Forth - sown 7 June 85			Thirlstane - sown 21 June 85		
Treatment	% Wilt 9.1.86	Number of harvestable bulbs/plot 4.2.86	Yield kg/plot 4.2.86	% Wilt 9.1.86	Number of harvestable bulbs/plot 4.2.86	Yield kg/plot 4.2.86
SD4	13.0*	150.8*	9.08*	20.5*	104.6*	11.93*
SD6	14.8*	147.3*	9.65*	15.3*	107.6*	11.18*
SD8	12.9*	149.5*	9.00*	12.8*	113.2*	13.15*
SD4+4	12.8*	152.4*	9.30*	18.3*	112.6*	13.18*
SD4 + oil	11.6*	154.1*	9.23*	25.6*#	87.7*#	10.63*
SD8 + oil	11.4*	154.0*	10.35*	13.2*	111.8*	12.04*
SD + oil	24.6*#	126.0*	9.73*	29.1*#	104.2*	11.88*
SD	23.9*#	131.0*	10.77*	26.8*#	107.1*	11.98*
PPSD8	59.1	68.4	5.94	77.0	35.8	7.78
Untreated	81.5	33.1	4.24	86.5	20.2	3.31

Two square metres plots.

* Differed significantly from untreated control ($P = 0.05$)
\# Differed significantly from other procymidone treatments ($P = 0.05$)

Note: No comparisons made for PP192 as yet.

The above data have yet to be analysed thoroughly. Preliminary analyses indicated that all procymidone treatments differed significantly from the untreated for both wilt% and yields. For wilt incidence, there were significant differences between the procymidone treatments. Seed-dressed only treatments had significantly higher wilt incidence compared with those that had both seed-dressing and supplementary placement of fungicide below the seeds (with the possible anomaly of treatment SD4 + oil at the Thirlstane site).

Because wilt incidence towards harvest can become increasingly difficult to determine due to masking by natural senescence, assessment of wilt usually ceased at 2 to 4 weeks before harvest. Wilt incidence at 4 weeks prior to harvest and the actual disease level (i.e. presence of typical white rot mycelia and/or sclerotia) as determined by destructive sampling at harvest were compared at 2 sites and the data are presented in Table 3, together with the sclerote inoculum level at each site.

Table 3. Comparison of % wilt and % disease

	FORTH (sown 7 June 85)		THIRLSTANE (sown 21 June 85)	
Treatment	% wilt (at 9.1.86)	% disease at harvest (on 4.2.86)	% wilt (at 9.1.86)	% disease at harvest (on 4.2.86)
SD4	13.0	13.7	20.5	30.6
SD6	14.8	17.2	15.3	26.8
SD8	12.9	14.5	12.8	23.4
SD4+4	12.8	14.2	18.3	26.9
SD4+OIL	11.6	13.7	25.6	39.8
SD8+OIL	11.4	12.9	13.2	28.3
SD+OIL	24.6	29.8	29.1	30.4
SD	23.9	24.9	26.8	29.6
PP192 SD8	59.1	62.2	77.0	76.5
Untreated	81.5	81.8	86.5	86.2
Sclerote density	80/kg soil		196/kg soil	

Percent wilt incidence as a prediction of % disease was good at the Forth site. At the Thirlstane site, prediction was good for seed-dressed only treatments, PP192 treatment and the untreated control, but there was about 10-15% difference between % wilt and % disease for procymidone treatments where there were supplementary placement of fungicide below the seeds.

DISCUSSION

Procymidone was found to be outstanding amongst the 3 dicarboximide fungicides tested for the control of Allium white rot in long-season bulb onions. The results were comparable to those of dazomet fumigation.

Use of dazomet, however, is not considered a practical proposition because of its high costs, but it may be economic under some situations.

The failure of metham-sodium in controlling Allium white rot could be due to absorption of the chemical by the clay particles of the krasnozem soil (P.B. Adams, per. communication). Artificial onion oil also did not appear to be effective in our studies and further investigations may be warranted, especially its method of incorporation.

The protective effects of procymidone come primarily from the fungicide on the seeds and secondarily from the fungicide band-placed beneath the seeds with fertilizer. The placement of fungicide at 50 mm below the seed (the depth where fertilizer is normally placed for onion crops grown in Tasmania) is probably a little too deep and it is very probable that closer placement (e.g. 20 mm below seed) would increase its effectiveness.

The success of procymidone is thought to be due to its greater stability in the soil, its presence in the critical soil zones around the seed and base plates of onions, and possibly also to its translocation within the root system. Procymidone has been found to be translocated from the roots to other parts of the onion, especially the leaves (Wong & Brown, unpublished data).

The successful trials conducted with procymidone in Tasmania have prompted researchers in Victoria (I. Porter & P.R. Merriman), and New Zealand (R. Wood) to conduct trials with procymidone with a similar approach.

Major findings of our studies have been communicated previously (Wong and Maynard, 1985; Wong & Merriman, 1986).

A temporary registration of procymidone (Sumisclex R) as a seed-treatment for Allium white rot control has now been made for Tasmania.

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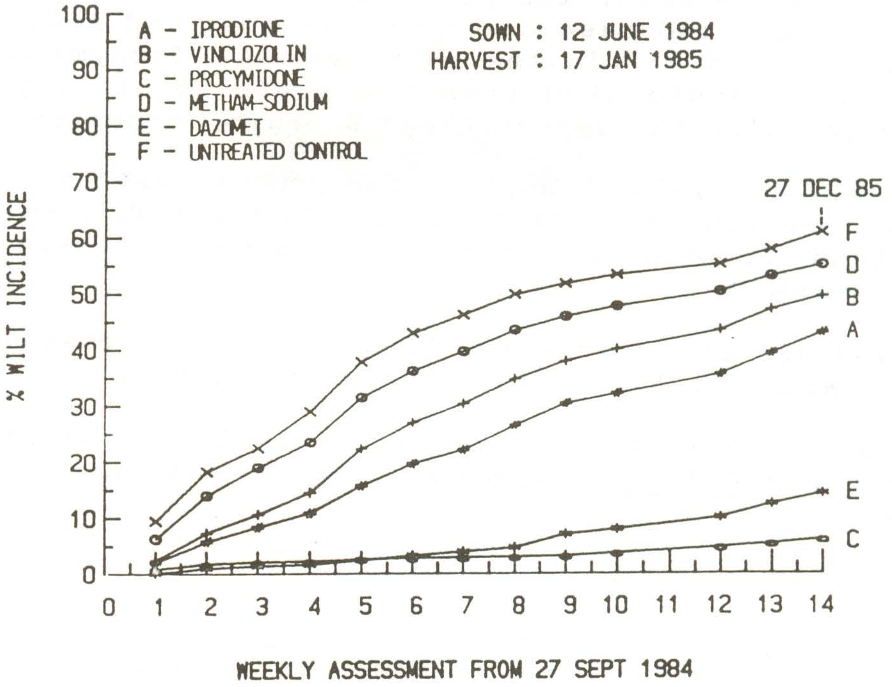
GRAPH 1

ONION WHITE ROT - FORTH 84/85



GRAPH 2

ONION WHITE ROT - FORTH 85/86