EPIDEMIOLOGY AND CONTROL OF RINGSPOT IN CABBAGES AND CAULIFLOWERS

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Summary

Ringspot symptoms did not appear on cabbages or cauliflowers until leaves were fully expanded. Only a small proportion of ascospores germinated when placed on young leaves, but many germinated on old leaves. Ascospores were released from leaf lesions in daylight when the leaves were wet. Fungicide applications were not required for ringspot control until the oldest leaves were fully expanded. Some benzimidazole fungicides gave effective control, particularly when used in combination with a spraying oil.

INTRODUCTION

Ringspot disease of brassicas is caused by an ascomycete, *Mycosphaerella brassicicola*, which also has a pycnidial state, *Asteromella brassicae*. Only the ascospores are infectious; germination of the pycnosporos has not been observed, and they may function as spermatia (Synder 1946, Dring 1961). *M. brassicicola* is pathogenic to a wide range of brassicas in New Zealand, e.g. cabbages (including F1 hybrids and savoy), cauliflowers, broccoli, brussels sprouts, rape and chou-mollier. On cabbages the first symptoms are small, black, irregularly-shaped lesions ('juvenile' spots) in which pycnidia develop. Later, these lesions develop into round, brown to grey, ringspots; rings of black dots marking the positions of pseudothecia. On many brassica species, including sprouting broccoli and cauliflower, the ringspots may develop directly without the prior appearance of 'juvenile' spots.

Ringspot disease can be destructive in New Zealand but infection is usually confined to the outer or 'packing' leaves. In seed crops it frequently spreads to the siliques. In this paper I report some recent investigations into the epidemiology and control of the disease.

METHODS

(a) **Epidemiological studies.** Fortnightly plantings of F1 hybrid cabbage, cv 'Green Acre', and cauliflower, cv 'Phenomenal Y505', were made at the DSIR Pukekohe Vegetable Research area between 8 February and 18 June 1974. From each planting 10 plants were used to follow disease progress. Each of the selected plants was inspected at weekly intervals. Newly developed leaves were tagged with coloured plastic-covered wire when they were approximately 4 cm long. Seedling leaves were removed after plants had become established. In the two final cauliflower plantings midrib lengths were measured weekly to determine the stage of leaf expansion. The numbers of 'juvenile' spots and ringspots on each leaf were recorded. All leaves on cauliflower plants were inspected, but on cabbages it was not possible to inspect leaves within the 'packing' leaves.

Proc. 30th N.Z. Weed and Pest Control Conf.

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The plots were situated 50 m from a meteorological station where weather data such as wet and dry bulb temperatures, rainfall (amount and duration), wind (speed and direction) and surface wetness duration were recorded at hourly intervals. The number of *M. brassicicola* ascospores present in the air over the plots were recorded at hourly intervals, with a Hirst spore trap.

(b) **Fungicide trials.** Fungicides were applied at 1100 litres/ha with a boom sprayer operating at approximately 700 kPa. A standard plot size of 3 rows x 10 plants was used in all trials, and each treatment was replicated four times. The first sprays were applied when the oldest true leaves appeared to be fully expanded.

Mature heads were harvested at intervals, as in commercial practice. Heads were cut as uniformly as possible, taking the heart, or curd, together with a similar number of 'packing' leaves. 'Packing' leaves were removed and graded according to the number of spots present. When disease incidence was low, all spots were counted. When disease incidence was severe, the proportion of leaves with more than 50 spots, or of cabbage heads with more than 200 spots, was recorded. Cabbages were weighed before the 'packing' leaves were removed, but only the curds of cauliflowers were weighed.

RESULTS

(a) **Infection pattern.** Few ringspots appeared before June. The incidence of spotting then increased, until leaves that completed expansion in October were almost completely destroyed. After October the severity of infection declined.

There was an infection pattern common to all plantings. Spots did not appear on the first-developed leaves until 6-8 weeks after tagging at the 4 cm-long stage but they appeared progressively earlier on the later-formed leaves. On individual leaves, symptoms rarely developed until leaf expansion was complete, and never developed on rapidly expanding leaves (Fig. 1). Ringspot development was also related to rainfall, relatively large numbers of spots appearing approximately one week after persistent rainfall in spring and autumn, and approximately two weeks after rainfall in winter.

(b) **Spore release and germination.** Over a two month trapping period almost all the ascospores trapped were caught in daylight when the leaves were wet (e.g. Fig. 2). Some spores were trapped when there was morning dew on the leaves, but many more were trapped after rain. Few spores were trapped at night, and those only when rain had fallen earlier in the day.

In laboratory experiments, spores germinated between 5°C and 30 °C (optimum 23 °C) when incubated at 100% RH on glass slides. They did not germinate below 93% RH. Few spores germinated on discs cut from young cabbage leaves and incubated at 23°C, 100% RH, but the majority of spores placed on discs from old leaves germinated.

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Fig. 1. Growth of cauliflower leaves and the development of ringspot lesions

Fig 2. Numbers of *M. brassicicola* ascospores in air over brassica crops in relation to weather, June 7-8 1974.

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(c) **Disease control.** In preliminary trials benomyl, cypendazole and thiophanate-methyl sprays consistently reduced leaf spotting by at least 50%; carbendazim, thiabendazole, propineb and tridemorph were less effective, and plants sprayed with maneb, copper oxychloride, captafol or anilazine were no less infected than untreated plants.

Benomyl reduced infection by more than 60% when the first application was made after the first-developed leaves had completed expansion, or when applied two weeks later, but not when the initial application was further delayed (Table 1). In further trials, where the concentration of fungicide in the spray was adjusted to provide the same total amount to all plots during the season, similar levels of disease control were obtained whether the sprays were applied at 2- or 3-week intervals (Table 2). However, in another trial plants sprayed every 4 weeks were more spotted than plants sprayed every 2 weeks.

TABLE 1: Number of ringspots developing on cauliflower leaves sprayed with benomyl (1.12 kg/ha/spray) at fortnightly intervals commencing at different times

Initial application	Ringspots/plant
When first leaves fully expanded	87 b
2 weeks later	67 b
4 weeks later	163 a
unsprayed throughout	230 a

TABLE 2: Intervals between spray applications for control of ringspot in cabbages; application rates adjusted to provide the same total amount of fungicide per treatment over the life of the crop

Fungicide	Interval between sprays(weeks)	Rate/application (kg/ha)	Heads with 200 spots (%)	Head wt. (kg)
benomyl	2	0.6	2 b	1.9
	3	0.9	1 b	1.9
thiophanate-methyl	2	0.6	3 b	1.9
	3	0.9	1 b	1.8
carbendazim	2	0.6	2 b	1.8
	3	0.9	4 b	1.7
unsprayed controls			16 a	1.6

Note: spraying commenced when the first leaves were fully expanded and continued until harvest.

Another series of trials was conducted to investigate the effect of using a spraying oil (Shell Universal Orchard Oil). Application of oil alone usually caused only small reduction in the incidence of spotting, but occasionally it was highly effective (compare Figs. 3 and 4). However, oil always improved the level of disease control obtained when added to benzimidazole fungicides (Fig. 3). Oil was particularly effective when added to benomyl sprays, and in these experiments

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250-375 ppm benomyl (270-400 g/ha), used with oil, gave a high level of disease control. There appeared to be little advantage in using more than 1% v/v oil in the spray (Fig. 4).

In most of these trials effective disease control resulted in small, statistically non-significant, increases in yield.

Fig 3: Ringspot infections in cabbages treated with combinations of fungicides and a spraying oil (severe spotting denotes leaves with more than 50 lesions). In other trials oil alone was less effective in controlling disease.

Fig 4: Ringspot infections in cauliflowers treated with different proportions of a spraying oil (severe spotting denotes leaves with more than 50 lesions).

DISCUSSION

The requirement for the leaf surface to be wet during daylight before spores are released in large numbers, and for the humidity to approach saturation before spores germinate, is more likely to be met in the winter and spring months, and this is when epidemics occur. Ringspot is rare in dry summers, but not in wet summers; the rapid onset in autumn appears to coincide with the onset of morning dews.

The inhibition of spore germination on expanding leaves appears to be due to the presence of an inhibitor in the leaf rather than to a nutritional effect, since spores germinated well on clean glass slides. This inhibition explains why prophylactic control measures are not required in young crops.

The addition of a spraying oil to sprays based on benzimidazole fungicides led to a marked improvement in disease control. Although the oil used had a direct fungicidal effect in some trials, it may also have aided in spreading the fungicides over the leaf surface, ensuring good coverage, and possibly increased persistence.

ACKNOWLEDGEMENTS

I wish to thank Mr A.W. McGowan for help with epidemiological recording, Mr P.G. Sutton for technical assistance in laboratory studies, and Messrs R. Schappi, W.E. Fell and A. Levine for assistance in spray trials.

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