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# An evaluation of fungicides for control of lettuce ringspot

A report prepared for
**New Zealand Vegetable & Potato Growers' Federation Inc.**

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CROP & FOOD RESEARCH
*Mana Kai Rangahau*

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# 1 EXECUTIVE SUMMARY

Ringspot (or anthracnose) of lettuce, caused by the fungus *Microdochium panattonianum* (syn. *Marssonina panattoniana*), was first identified in New Zealand from specimens received from Wanganui in 1939 and although not reported before then, it is probable that the disease had occurred without the cause being recognised. Ringspot was later reported to be common on lettuce throughout New Zealand, especially in late winter and early spring crops.

The disease has been a minor problem to growers in northern areas in the past, but in recent years it has become severe on many properties, with some crops being hoed in before harvest. Only two fungicides are currently registered in NZ for use on lettuce that also have label claims for ringspot control. For these reasons, lettuce growers in the Pukekohe district requested information on the efficacy of alternative fungicides for the control of ringspot on lettuce.

Six fungicides (captan, chlorothalonil, cupric hydroxide, cyproconazole, mancozeb, and prochloraz) were selected and screened for the control of lettuce ringspot under glasshouse and field conditions. Of the fungicides selected, captan, cupric hydroxide and mancozeb are currently registered in NZ for use on lettuce.

The following conclusions and recommendations were made after these studies:

- Production of ringspot disease-free lettuce plants in the nursery is essential. Chlorothalonil and captan appear to be useful protectant fungicides at this stage.

- In the field, prochloraz was shown to be the most effective of the fungicides screened for the control of lettuce ringspot. It would seem likely that if prochloraz was registered in NZ for use on lettuce, a maximum number of three applications per crop at full label rates would be stipulated (as for other crops) to minimise the risk of resistance development to this fungicide. The use of prochloraz in the earlier stages of the crop cycle and/or during prolonged periods of wet weather should help prevent early infection and/or establishment of the disease within a crop. Further work to determine the most effective spray regime incorporating prochloraz and the resulting chemical residue levels on lettuce would seem warranted.

- Under conditions of less severe infection pressure, captan and chlorothalonil may also be useful fungicides for ringspot control in the field.

- Although mancozeb and cupric hydroxide provided some control of lettuce ringspot in the glasshouse when good coverage of the leaf surfaces was ensured, they were not shown to provide satisfactory control of the disease in the field.

- Cultural practices also play an important part in the control of ringspot disease on lettuce. Practices that have been recommended elsewhere include: rotation of crops; using well-drained land and/or planting on raised beds; eradication of wild lettuce near commercial fields (hawksbeard (*Crepis capillaris*) has been recorded as a host of *M. panattonianum* in NZ); using clean seed and planting out only disease-free seedlings in the field; avoiding moving through a lettuce crop when the foliage is wet; and deep ploughing crop debris in as soon as possible after cutting.

It should be noted that some of the fungicides used in these trials are not currently registered in New Zealand for use on lettuce. Therefore, no recommendation for their use on lettuce can be made or implied until registration has been granted.

# 2 INTRODUCTION

Ringspot (or anthracnose) of lettuce, caused by the fungus *Microdochium panattonianum* (Berl.) Sutton, Galea & Price (syn. *Marssonina panattoniana* (Berl.) Magn.), was first identified in New Zealand from specimens received from Wanganui in 1939. Although it had not been reported before then, it is probable that the disease had occurred without the cause being recognised (Taylor & Li 1944). The first visible signs of ringspot are small, yellowish-brown spots on the leaves. The spots may coalesce into larger, irregular, brown patches of dead tissue which in time fall out, giving the plants a ragged, "shot-hole" appearance (Hurndell & Smith 1958). The undersides of old leaves appear to be attacked first; on the under side of the main ribs the infection appears as yellow sunken depressions which turn slightly pink as the infection ages.

The major source of inoculum in the field appears to be the infected plant debris of previous crops (Hurndell & Smith 1958; Galea & Price 1988a). A common weed, hawksbeard (*Crepis capillaris* (L.) Wall), has also been recorded as a host of the fungus in New Zealand (Dingley 1969). Under field conditions in Victoria, Australia, *M. panattonianum* was shown to survive on infected lettuce debris in the soil for up to 20 weeks (Galea & Price 1988a). Wet weather or irrigation is conducive to the production of spores, which are dispersed by water-splash or wind-blown rain and serve to spread the disease from plant to plant. Germination of *M. panattonianum* spores occurs at temperatures between 3-26°C but not in the absence of free water (Galea et al. 1986). Optimum infections occur following leaf wetness periods of more than eight hours at temperatures around 15°C (Galea & Price 1988c). All commercial lettuce cultivars available in Australia were found to be susceptible to *M. panattonianum*, although some cultivars were more susceptible than others at an increased inoculum concentration (Galea & Price 1988b). In the field, limited access in winter due to wet soil conditions, as well as the structure of the plant, make it difficult to consistently obtain good coverage with fungicides, particularly in the axils where infection is common (Parman & Price 1991).

Ringspot is reported to be common on lettuce throughout New Zealand, especially in late winter and early spring crops (Dingley 1969). The disease has been a minor problem to growers in northern areas in the past, but in recent years it has become severe on many properties, with some crops being hoed in before harvest (Wood 1994). There are only two fungicides currently registered in NZ for use on lettuce that also have label claims for ringspot control. As a result, lettuce growers in the Pukekohe district have requested information on the efficacy of alternative fungicides to control ringspot on lettuce.

This report presents the results of recent trials to evaluate six fungicides used to control lettuce ringspot under glasshouse and field conditions.

# 3 SELECTION OF FUNGICIDES FOR EVALUATION

Earlier New Zealand research workers suggested the use of Bordeaux mixture or copper oxychloride to control ringspot on lettuce (Taylor and Li 1944). Brien et al. (1957) recommended spraying crops with captan, thiram, or zineb (not marketed in NZ since the early '90s). Hurndell and Smith (1958) also recommended captan and thiram sprays, which they considered to be more effective than copper oxychloride. Jamieson (1980) reported that both captafol (withdrawn in the mid '80s) and chlorothalonil gave reasonable control of the disease. Currently in New Zealand, copper oxychloride and mancozeb are the only fungicides registered for use on lettuce that also have label claims for ringspot control (Walton & Sommerville 1995).

In the United Kingdom, prochloraz and captan were shown to give commercially acceptable control of ringspot on outdoor lettuce (Jones 1986). Prochloraz Mn and hexaconazole have given good control of the disease and increased yields under field conditions in Victoria, Australia (Parman et al. 1991). Of 16 fungicides evaluated for the control of ringspot on lettuce in South Australia, prochloraz Mn, chlorothalonil, and propiconazole were shown to be the most effective. However, propiconazole was found to severely stunt plant growth, and so was not recommended for use on lettuce (Wicks et al. 1994).

The following fungicides were selected for evaluation under glasshouse and field conditions:

- **Captan** - currently registered in NZ for use on lettuce and with a label claim for leaf spot control. It has been reported to give commercially acceptable control of ringspot on outdoor lettuce in the United Kingdom (Jones 1986).

- **Chlorothalonil** - although not registered in NZ for use on lettuce, it has been reported to provide effective control of ringspot in field experiments (Jamieson 1980; Wicks et al. 1994).

- **Cupric hydroxide** - currently registered in NZ for use on lettuce and with a label for downy mildew control. It has been reported to give marginally better ringspot control than mancozeb and thiram in the field (Parman et al. 1991).

- **Cyproconazole** - a systemic triazole (DMI) fungicide that has protectant, curative and eradicative activity. Hexaconazole and propiconazole (both other triazole (DMI) fungicides) have been reported to provide effective control of ringspot on lettuce under field conditions in Australia (Parman et al. 1991; Wicks et al. 1994). However, hexaconazole is unavailable in NZ and

propiconazole has been found to severely stunt lettuce plants. Although cyproconazole is not registered in NZ for use on lettuce, it is the only triazole (DMI) fungicide currently registered for use on leafy vegetable crops (for control of ringspot (*Mycosphaerella brassicicola* (Duby) Lindau) on vegetable and field brassicas).

- **Mancozeb** - currently registered in NZ for use on lettuce and also with a label claim for ringspot disease control. It is an industry "standard" with which other fungicides are compared.

- **Prochloraz** - a broad spectrum imidazole (DMI) fungicide that has both protectant and eradicant activity. Although not registered in NZ for use on lettuce, it has been reported to provide effective control of ringspot in field trials overseas (Jones 1986; Wicks et al. 1994).

# 4 GLASSHOUSE EVALUATION OF FUNGICIDES

## 4.1 Introduction

As most of the fungicides selected for evaluation provide only a protectant coating on leaf surfaces to prevent disease establishment, fungicide treatments were applied to plants prior to inoculation with the ringspot fungus. It was envisaged that fungicides providing effective control of the disease in these glasshouse evaluations would be further evaluated under field conditions.

## 4.2 Materials and Methods

**Plants:** Fourteen trays of lettuce seedlings, cv. Victory (240 plants/tray), were obtained from a commercial supplier in May 1995. The plants had been sprayed every 4-5 days with chlorothalonil alternating with mancozeb as part of the standard nursery regime. The trays of seedlings (4-5 weeks old) were collected from the nursery and maintained outside for about one week before being moved into a glasshouse unit (13-22°C). Plants were kept in the glasshouse unit and watered (overhead) on a daily basis until they reached the 3-4 leaf stage (5-6 weeks old). At this stage of development, it was two weeks since the last fungicide spray had been applied to the plants in the nursery.

**Fungicides:**The seven treatments used in this glasshouse evaluation are listed below:
1. Mancozeb (as Mancozeb 80W) at 1.6 g/litre a.i. (200 g/100 litres product).
2. Chlorothalonil (as Bravo 500F) at 1.5 ml/litre a.i. (300 ml/100 litres product).
3. Cyproconazole (as Alto 10L) at 0.4 ml/litre a.i. (40 ml/100 l product).
4. Cupric hydroxide (as Kocide DF) at 1.0 g/litre a.i. (200 g/100 litres product).
5. Captan (as Captan 80WP) at 1.0 g/litre a.i. (125 g/100 litres product).
6. Prochloraz (as Sportak 45 EC) at 0.45 g/litre a.i. (100 ml/100 litres product).
7. Water (as a control).

Two treatments were applied to each tray of lettuce plants; one treatment was applied to plants on one side of the tray (120 plants), and another treatment was applied to the plants on the other side of the tray (120 plants). This "division" of trays meant that four replicates per treatment (120 plants/rep) could be achieved with the 14 trays of plants available. Fungicides were suspended in tap water and plants sprayed with a hand-operated sprayer on both leaf surfaces with each fungicide suspension (approx. 1.2 ml/plant). The high volume spray ensured total coverage of all plant surfaces (equivalent to approx. 13,000 litres/ha). Plants used as

controls were treated in the same manner but with just tap water. A barrier was placed between the two sides of each tray when applying the treatments so that no "drift" occurred between treatments. Sprayed plants were left in the glasshouse for 24 hours to allow deposits to dry.

**Inoculum:** Six isolates of *M. panattonianum* were recovered from ringspot lesions on lettuce plants grown in the Pukekohe district. Conidia (spores) of the fungus were obtained from 14-day-old cultures growing on malt extract agar plates. Conidia were washed from the cultures with sterile water and adjusted to a concentration of 5.0 x $10^5$ conidia/ml. The viability of the conidia was assessed on agar plates.

**Experimental design:** The experimental design was in rows and columns with each column being a complete replicate of the treatments and was formed by starting with a cyclic design with seven blocks of size four. Rows were permuted randomly to give even spacing between treatments.

**Inoculation and incubation:** Twenty-four hours after spraying on the fungicide treatments, inoculum was applied to both leaf surfaces of plants with a hand-operated sprayer (approx. 2.0 ml/plant). The inoculated plants were then immediately placed in a glasshouse unit (14-20°C) maintained at a high relative humidity with two air humidifiers (Defensor 505, Zürich) and incubated under these conditions for 24 hours. After the incubation period the air humidifiers were removed from the glasshouse unit and the plants left for symptoms to develop. Due to the lack of ringspot infection seen on plants one week after the first inoculation (including controls), plants were inoculated a second time (at this stage it was three weeks since the last fungicide spray had been applied to the plants in the nursery). Plants were once again incubated in the glasshouse unit at high relative humidity for 24 hours.

**Disease assessment:** One to two weeks after inoculation, fifty plants from the centre of each replicate were examined and the number of ringspot lesions on the most infected leaf assessed on each plant. The number of lesions were scored on a scale of 0-5: 0, no lesions; 1, 1-10 lesions; 2, 11-50 lesions; 3, 51-100 lesions; 4, 101-150 lesions; 5, 151-250 lesions per leaf (Galea & Price 1988b).

**Statistical analysis:** Mean scores were calculated for each group of 50 plants (each replicate), and then analyzed by residual maximum likelihood analysis (Payne *et al.* 1993).

## 4.3 Results and Discussion

Most conidia used as inoculum were viable, with more than 95% of them germinating on agar plates. One week after the plants were inoculated for the first time, no significant levels of ringspot infection were seen on the plants (including controls). This lack of infection was possibly due to residual effects of the fungicide sprays applied to the plants in the nursery. After the second inoculation of the plants, significant levels of ringspot infection were seen to develop on younger leaves of plants but not on the older leaves (including controls).

The mean disease scores for each of the fungicide treatments are shown in Table 1. In these glasshouse evaluations, chlorothalonil and captan were shown to be the most effective of the fungicides screened for the control of ringspot on lettuce. Mancozeb and cupric hydroxide also provided effective control of the disease. The prochloraz and cyproconazole treatments, however, were not shown to be significantly different from controls (P=0.05).

Parman et al. (1991) also found mancozeb and cupric hydroxide effective in controlling ringspot under glasshouse conditions (chlorothalonil and captan were not included in their studies). In contrast to the results obtained in these glasshouse evaluations, prochloraz was shown to be the best fungicide screened by Parman et al. (1991). Thorough coverage of the crop and spray retention is essential with the Sportak 45 EC formulation of prochloraz (Walton & Sommerville 1995). The very high volume spraying used in these glasshouse evaluations may have resulted in a poor retention of prochloraz on the leaf surfaces of the lettuce plants.

It was decided that all the fungicides screened in these glasshouse evaluations should be further evaluated under field conditions.

**Table 1: Effect of fungicide treatments on the control of ringspot on lettuce in glasshouse trials.**

| Treatment | Mean Disease Score* |
|---|---|
| 2. Chlorothalonil (1.5 ml/litre a.i.)<br>(Bravo 500F at 300 ml/100 litres) | 0.41 |
| 5. Captan (1.0 g/litre a.i.)<br>(Captan 80WP at 125 g/100 litres) | 0.59 |
| 1. Mancozeb (1.6 g/litre a.i.)<br>(Mancozeb 80W at 200 g/100 litres) | 1.21 |
| 4. Cupric hydroxide (1.0 g/litre a.i.)<br>(Kocide DF at 200 g/100 litres) | 1.30 |
| 6. Prochloraz (0.45 g/litre a.i.)<br>(Sportak 45 EC at 100 ml/100 litres) | 2.46 |
| 3. Cyproconazole (0.4 ml/litre a.i.)<br>(Alto 10L at 40 ml/100 litres) | 2.50 |
| 7. Control (water) | 2.79 |
| LSD (pair-wise comparisons, 5% level) 0.57<br>LSD (Tukey, 5% level) 0.90 | |

* Mean disease score: 0, no lesions; 1, 1-10 lesions; 2, 11-50 lesions; 3, 51-100 lesions; 4, 101-150 lesions; 5, 151-250 lesions per leaf.

# 5 EVALUATION OF FUNGICIDES IN THE FIELD

## 5.1 Introduction

All of the fungicides screened in the glasshouse evaluations (Section 4) were evaluated for the control of lettuce ringspot under field conditions.

## 5.2 Materials and Methods

A site was selected on Pukekohe Hill, with lettuce established at the 8-9 leaf stage (approx. 50-100 mm plant size) and with ringspot disease already present in the crop. To ensure an even level of ringspot infection throughout the trial area, a spore suspension (2 x $10^5$ conidia/ml) of the ringspot fungus was applied over all plots with a small pressure sprayer at a water rate of approximately 270 litres/ha. Plots were inoculated for the first time on 5th July; 9 mm of rain followed immediately afterwards. A second inoculation was therefore carried out on 6th July. This was followed by only light showers (5 mm in the 24 hours that followed) and air temperatures of 9-12° C - conditions considered favourable for ringspot infection to establish.

The field trial lay out consisted of plots that were 5 m in length, one full bed wide (1.6 m with 4 rows of lettuce); each plot contained about 45 established plants. Seven treatments, with five replicates/treatment, in a randomised complete design were sprayed. One bed on each side of the trial was used as a guard area to protect the trial from the grower's spray programme.

The lettuce planted in the trial area were mostly cv. Victory (5.5 beds) with some cv. Triumph (1.5 beds), established as cell plants all grown and planted by the grower. Ringspot infection was present on cell plants when placed in the field. The grower's normal weed control and fertiliser practices were followed in the trial area, but no fungicides were applied to the trial area by the grower. Spray treatments were applied using a gas-powered precision plot sprayer, calibrated to apply 500 l/ha at 300 kpa, with standard hollow cone nozzles at 350 mm spacing on a 1.4 m boom. Spray timing was intended to be at weekly intervals, but because of frequent wet weather, the intervals varied slightly (Appendix 1).

The following treatments were used in the field trial (full details are included in the appendix):

1. Captan at 2.4 kg/ha a.i. (as Captan 80WP 3.0 kg/ha product).
2. Mancozeb at 1.6 kg/ha a.i. (as Mancozeb 80W at 2.0 kg/ha product).
3. Cupric hydroxide at 400 g/ha a.i. (as Kocide DF at 1.0 kg/ha product).
4. Cyproconazole at 40 ml/ha a.i. (as Alto 10L at 400 ml/ha product).
5. Prochloraz at 450 ml/ha a.i. (as Sportak 45EC at 1.0 litres/ha product),alternating with mancozeb 1.6 kg/ha a.i. (as Mancozeb 80W at 2.0 kg/ha product).
6. Chlorothalonil at 1.0 litres/ha a.i. (as Bravo 500F at 2.0 litres/ha product).
7. Control (un-sprayed).

On 17th July (6 days after the first sprays were applied), an assessment of ringspot disease levels was made on 20 lettuce plants in the centre two rows of each plot (on a scale of 0-5); 0, no ringspot infection noted; 1, few spots on lower leaves noted; 2, spots easily seen on lower leaves; 3, moderate infection, with up to 10% of leaf area infected; 4, heavy infection, with up to 50% of leaf area infected; 5, very heavy infection, with over 50% of leaf area infected. On 16th August (36 days after the first sprays were applied), ringspot disease levels were once again assessed on 20 lettuce plants in the centre two rows of each plot. The mean disease scores were calculated for each group of 20 plants and then analyzed by residual maximum likelihood analysis (Payne *et al.* 1993).

On 20th September (12 days after the final spray applications were made), representative lettuce plants from various treatments were collected and photographed. No yield data was collected as in most plots there was no useful head size to be harvested. Samples from plots treated with Sportak 45 EC were collected for residue analysis and are being held for the distributor to investigate further development with this product. On 8th October (30 days after the final spray applications were made), lettuce plants in field plots were photographed from representative treatments (see appendix).

## 5.3 Results and Discussion

Ringspot disease developed rapidly in the field during July and was seen to be more severe on lettuce cv. Triumph than on cv. Victory. An assessment of disease levels across the trial site on 17 July gave a mean disease score of 1.84 for cv. Victory, compared to a mean disease score of 4.00 for cv Triumph. The weather conditions in the trial area were well suited for ringspot infection, with frequent periods of rain throughout July and August (total rainfall during this period was approximately 440 mm). As a result, severe levels of ringspot disease developed at the trial site and the whole field was not harvested due to severe leaf spotting and stunting of plants by the disease.

The mean ringspot disease scores for each of the treatments on lettuce cv. Victory are presented in Table 2 (graphs of the scores are also presented in the appendix). Under the conditions of severe infection pressure within the field trial, only the prochloraz (alternating with mancozeb) treatment gave reasonable levels of disease control. Of the protectant fungicide treatments, captan and chlorothalonil provided some control of the disease and cupric hydroxide gave marginally better control than mancozeb. Plants treated with mancozeb were not shown to be significantly different from un-sprayed plants (P=0.05). The cyproconazole treatment, even when used in a full programme of nine sprays (which is greatly in excess of the maximum number of sprays advised for other crops), gave no more control of the disease than the captan or chlorothalonil treatments.

Photographs of representative lettuce plants from some of the treatments are presented in Figure 1. The prochloraz (Sportak 45 EC) treatment produced plants that had a reasonable appearance from above with reasonable head sizes, but when they were cut and trimmed the ringspot infection on the lower mid ribs was found to be at a level generally not acceptable for marketing. Although captan (Captan 80 WP), cyproconazole (Alto 10L) and chlorothalonil (Bravo 500F) delayed the development of ringspot on the main outer leaves of the plants, very few had sufficient head size and none were of market quality.

Lettuce plants from the cupric hydroxide (Kocide DF), mancozeb (Mancozeb 80W) and control treatments did not develop due to the loss of the outer leaves to disease, and none of the heads were of sufficient size or quality to be harvested.

**Table 2: Effect of fungicide treatments on the control of ringspot on lettuce in Pukekohe field trials.**

| Treatment | Mean Disease Score[1] |
|---|---|
| 5. Sportak 45 EC at 1.0 litre/ha (prochloraz at 450 ml/ha a.i.)[2] | 2.55 |
| 1. Captan 80WP at 3.0 kg/ha (captan at 2.4 kg/ha a.i) | 4.11 |
| 4. Alto 10L at 400 ml/ha (cyproconazole at 40 ml/ha a.i.) | 4.16 |
| 6. Bravo 500F at 2.0 l/ha (chlorothalonil at 1.0 litre/ha a.i.) | 4.26 |
| 7. Kocide DF at 1.0 kg/ha (cupric hydroxide at 400 ml/ha a.i.) | 4.61 |
| 2. Mancozeb 80W at 2.0 kg/ha (mancozeb at 1.6 kg/ha a.i.) | 4.95 |
| 7. Control | 5.03 |
| LSD (pair-wise comparisons, 5% level) 0.40 | |
| LSD (Tukey, 5% level) 0.60 | |

[1] Mean disease score: 0, no ringspot infection noted; 1, few spots on lower leaves noted; 2, spots easily seen on lower leaves; 3, moderate infection, with up to 10% of leaf area infected; 4, heavy infection, with up to 50% of leaf area infected; 5, very heavy infection, with over 50% of leaf area infected.

[2] Alternating with Mancozeb 80W at 2.0 kg/ha.

If infected lettuce are planted out in the field the disease may spread readily during suitable weather conditions. The field trial carried out at Pukekohe showed that if ringspot infection develops before a full spray programme is commenced, adequate control to produce clean lettuce becomes very difficult. The field trial also showed that products currently registered in NZ for control of ringspot on lettuce do not provide adequate control of the disease under conditions of severe infection pressure. Lettuce growers in Victoria, Australia considered that the registered fungicides (cupric hydroxide, mancozeb, thiram, and zineb) did not provide satisfactory control of lettuce ringspot (Parman et al 1991).

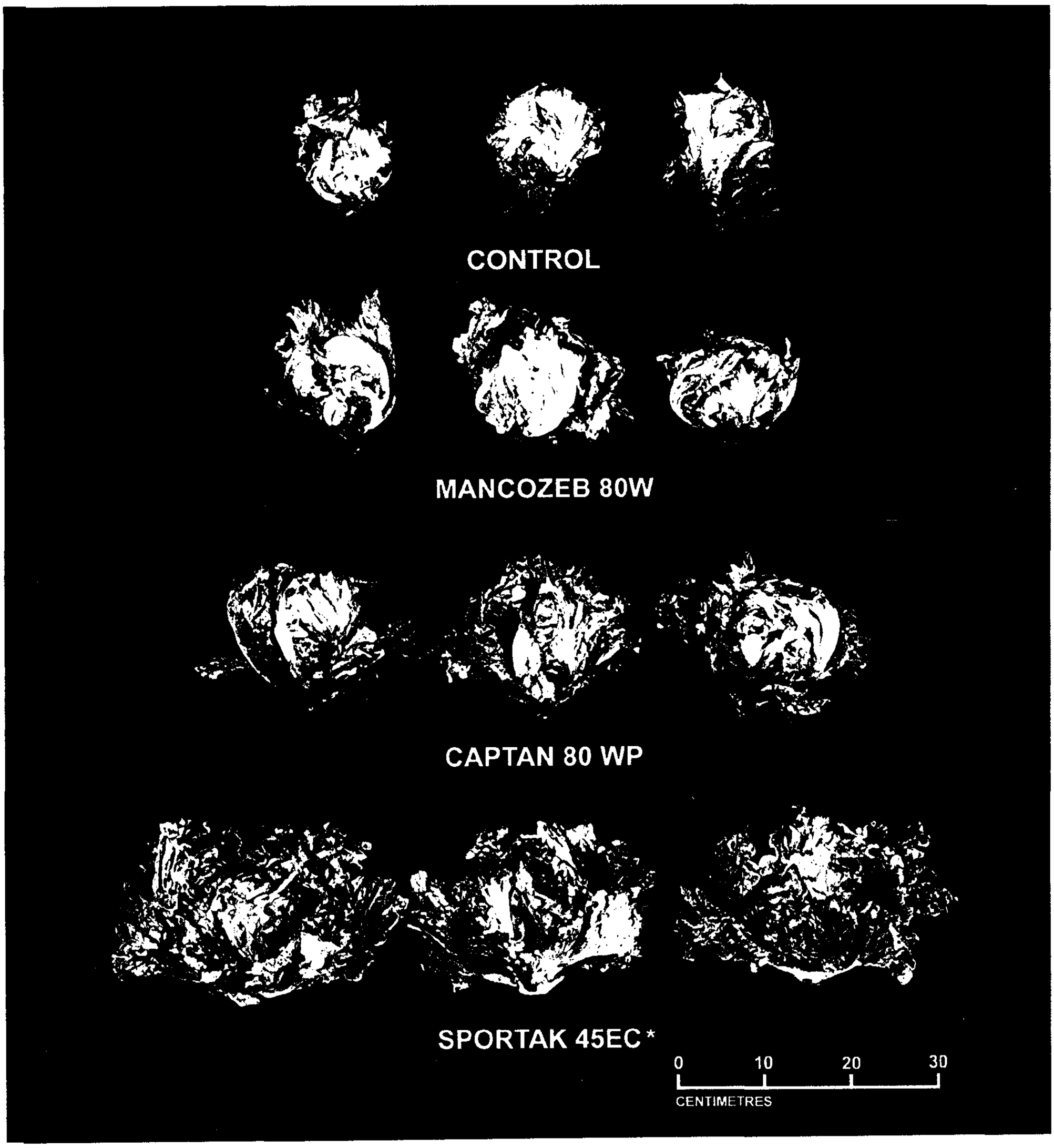


**FIGURE 1: Representative lettuce plants from various treatments of the Pukekohe field trial.** Note the loss of outer leaves from ringspot disease and the subsequent lack of head development in most treatments.

# 6 CONCLUSIONS AND RECOMMENDATIONS

As a result of the trials, the following conclusions and recommendations can be made:

- Production of ringspot disease-free lettuce plants in the nursery is essential. Chlorothalonil and captan appear to be useful protectant fungicides at this stage. Captan is currently registered in NZ for use on lettuce.

- In the field, prochloraz was shown to be the most effective of the fungicides screened for the control of lettuce ringspot. It would seem likely that if prochloraz was to become registered in NZ for use on lettuce, a maximum of three applications per crop at full label rates would be stipulated (as for other crops) to minimise the risk of resistance development to this fungicide. The use of prochloraz in the earlier stages of the crop cycle and/or during prolonged periods of wet weather should help prevent early infection and/or establishment of the disease within a crop. Further work to determine the most effective spray regime incorporating prochloraz and the chemical residue levels on lettuce would seem warranted.

- Under conditions of less severe infection pressure, captan and chlorothalonil may also be useful fungicides for ringspot control in the field.

- Although mancozeb and cupric hydroxide provided some control of lettuce ringspot in the glasshouse when good coverage of the leaf surfaces was ensured, they were not shown to provide satisfactory control of the disease in the field.

- Cultural practices also play an important part in the control of ringspot disease on lettuce. Practices that have been recommended elsewhere include: rotation of crops; using well-drained land and/or planting on raised beds; eradication of wild lettuce near commercial fields (hawksbeard (*Crepis capillaris*) has been recorded as a host of *M. panattonianum* in NZ); using clean seed and planting out only disease-free seedlings in the field; avoiding moving through a lettuce crop when the foliage is wet; and deep ploughing crop debris in as soon as possible after cutting.

# 7 DISCLAIMER

Some of the fungicides used in these trials are not currently registered in New Zealand for use on lettuce and therefore no recommendation for use on lettuce is made or implied until registration has been granted.

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# 9 ACKNOWLEDGEMENTS

The assistance of W & R Glokal Ltd with the trial site and co-operation is gratefully acknowledged.

# 10 APPENDIX

**Spray schedule of fungicide applications:**

| Treatment | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Jul 11 | Captan | Mancozeb | Kocide | Alto | Sportak | Bravo | None |
| Jul 17 | " | " | " | " | Sportak | " | " |
| Jul 25 | " | " | " | " | Mancozeb | " | " |
| Jul 31 | " | " | " | " | Sportak | " | " |
| Aug 8 | " | " | " | " | Mancozeb | " | " |
| Aug 16 | " | " | " | " | Sportak | " | " |
| Aug 23 | " | " | " | " | Mancozeb | " | " |
| Aug 30 | " | " | " | " | Sportak | " | " |
| Sep 8 | " | " | " | " | Sportak | " | " |

**Fungicide treatments:**

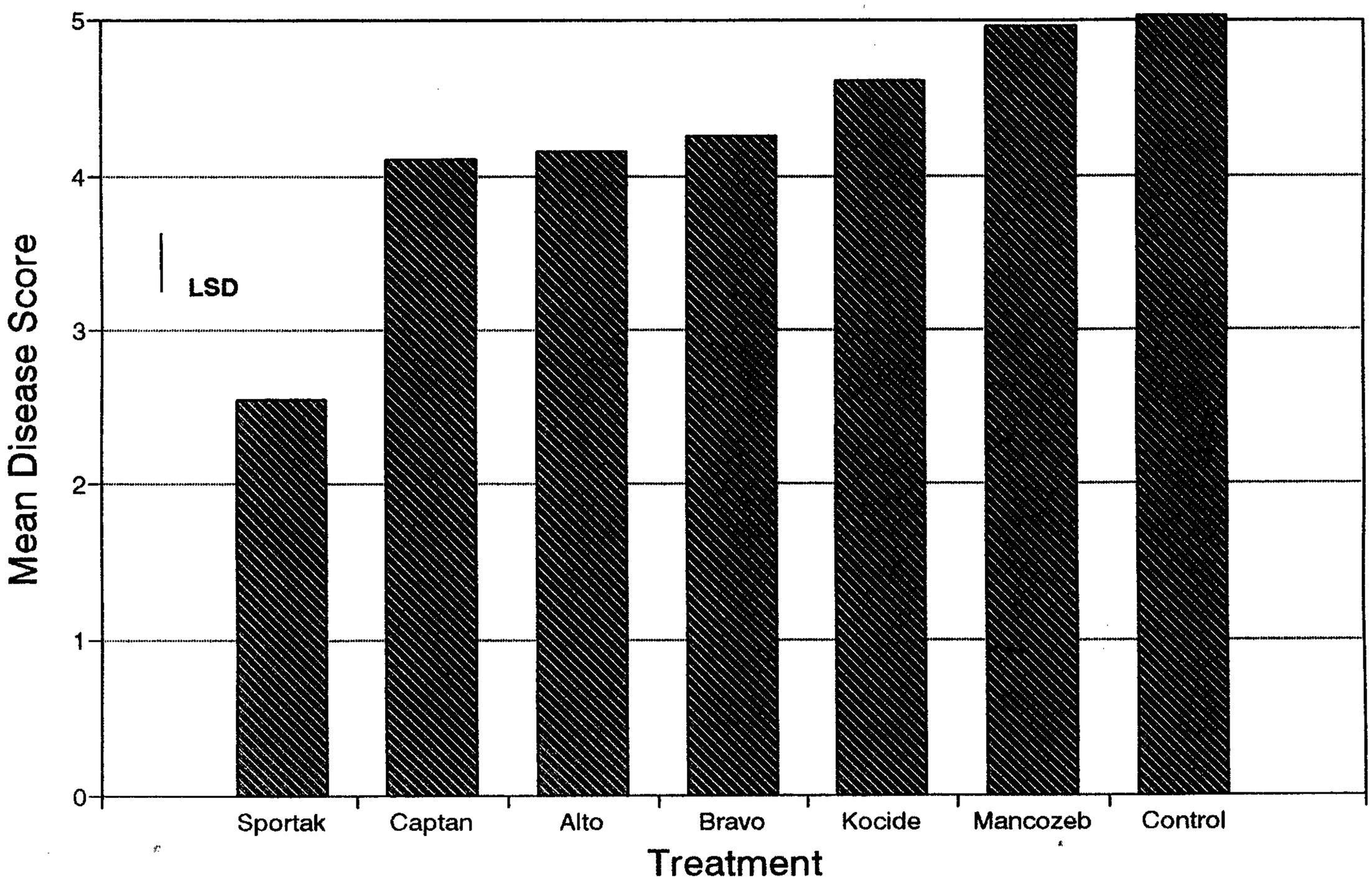
| Treatment[1] | Product rate/100 litres | Product rate/ha |
|---|---|---|
| 1. Captan 80 WP (800 g/kg captan)[2] | 600 g | 3.0 kg |
| 2. Mancozeb 80W (800 g/kg mancozeb) | 400 g | 2.0 kg |
| 3. Kocide DF (400 g/kg cupric hydroxide) | 200 g | 1.0 kg |
| 4. Alto 10L (100 g/litre cyproconazole) | 80 ml | 400 ml |
| 5. Sportak 45 EC (450 g/litre prochloraz)[3] | 200 ml | 1.0 litres |
| 6. Bravo 500F (500 g/litre chlorothalonil) | 400 ml | 2.0 litres |
| 7. Control (un-sprayed) | - | - |

[1] All treatments applied in 500 l/ha of water with hollow-cone nozzles, and with precision plot sprayer, at 300 kpa. Wetting agent as Contact (100% non-ionic surfactant) added to treatments 1, 2, 3 and 5 at 30 ml/100 litre, but not to treatments 4 and 6.

[2] The captan formulation was changed on 31 July to 500 g/kg a.i. Therefore the product rate increased to 960 g/100 l or 4.8 kg/ha.

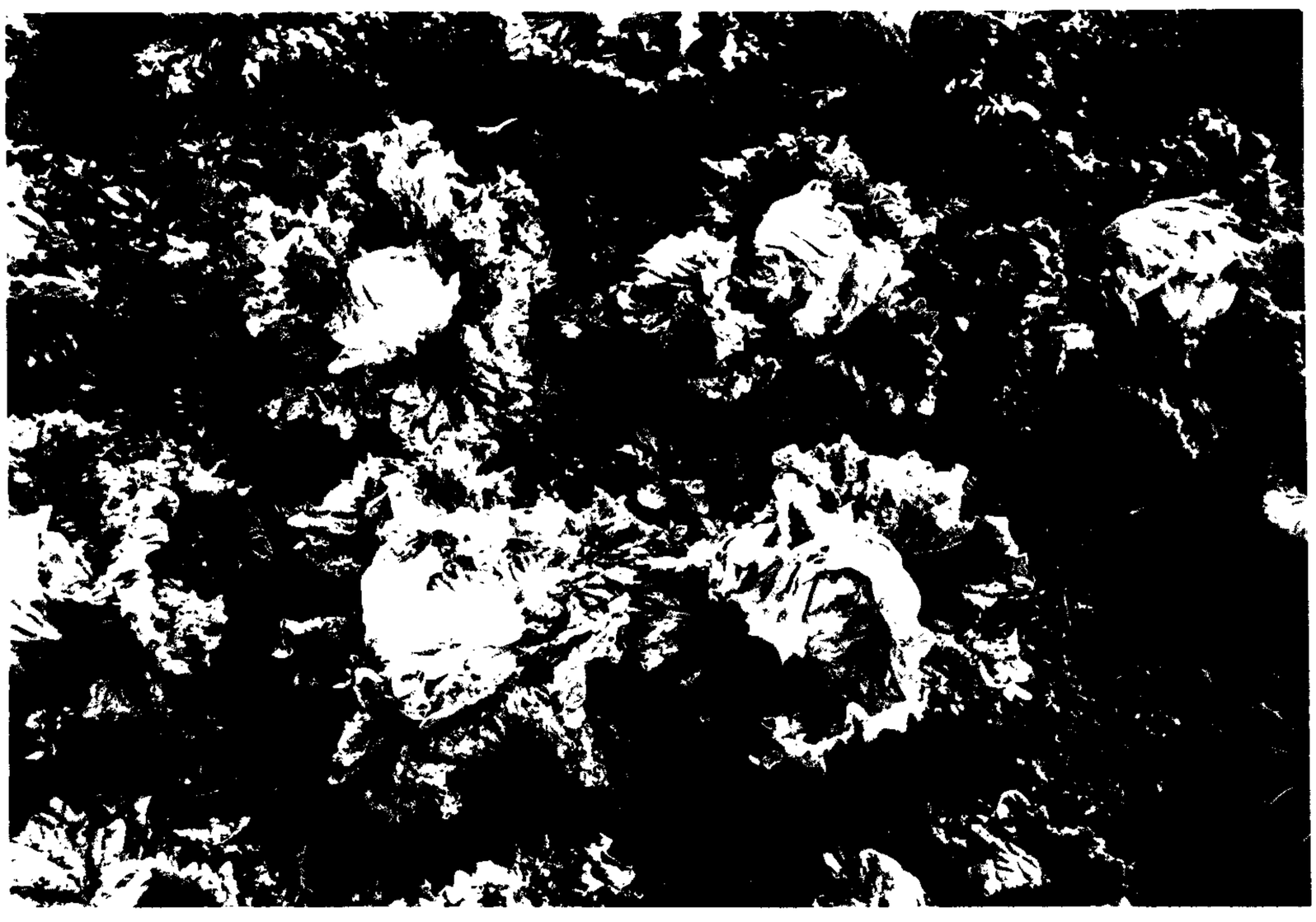
[3] Sportak 45 EC alternating with Mancozeb 80W at the above rates.

The effect of fungicide treatments on the control of ringspot on lettuce in field trials.



**Above:** Mancozeb (Treatment 2). Also typical of Kocide and Control. Note almost total loss of outer leaves.

**Below:** Sportak (Treatment 5, Rep B). Note amount of outer leaf area retained with some spotting, and adequate head size.



**Above:** Bravo (Treatment 6). Note heavy spotting on outer leaves.

**Below:** Sportak (Treatment 5, Rep. D). Note amount of outer leaf area retained with some spotting.