VG033

Reduced pesticide use on lettuce

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Know-how for Horticulture™

VG033

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V/0033/R1 - Reduced Pesticide Use on Lettuce

FINAL REPORT

SUMMARY

Field and laboratory experiments were carried out in 1990 and 1991/92 to evaluate methods of reducing fungicide use in the control of anthracnose (Microdochium panattonianum) and downy mildew (Bremia lactucae) the two most destructive fungal diseases of lettuce.

Prochloraz and Chlorathalonil were the most effective of 16 fungicides evaluated for the control of anthracnose and dimethomorph and phosphonic acid the most effective of 6 fungicides evaluated for the control of downy mildew.

Applying fungicides only after periods of leaf wetness that were suitable for infection reduced the pesticide use on lettuce, but did not provide acceptable levels of control for either disease. Fungicides applied on a weekly basis were more effective than those applied on a 14 day schedule. Overall this project showed that pesticide use on lettuce can be reduced by applying fungicides early in the season rather than applying them after the disease first appears.

IMPLICATIONS AND FUTURE DIRECTIONS

As a result of this work growers are now aware of the excellent control of anthracnose provided by Octave (prochloraz) and many have used this material although it is presently not recommended for use on lettuce. Similarly, phosphonic acid has been used by lettuce growers to control downy mildew where Ridomil resistant strains have developed.

Several field days and grower seminars have been conducted in relation to this project and lettuce growers in South Australia are now aware of the incidence of fungicide resistant strains of downy mildew in the State.

The results obtained from this project should also enable the manufacturers/distributors of prochloraz and phosphonic acid to proceed with the application to register these materials for use on lettuce.

This work showed the debilitating effect of fungal diseases on lettuce as in most trials marketable produce was not obtained from the unsprayed plots. This emphasises the need for further work on these problems.

Future work needs to be conducted on:

(1) Determining dose response relationships for newly released chemicals to provide base line data to detect resistance.

(2) Evaluation of new fungicides for eradicant activity.

(3) Fine tuning of spray timing (e.g. when to stop spraying).

(4) Spray application - ground vs. aerial spraying - critical volume/ha.

(5) Evaluation of resistant cultivars.

(6) Evaluation of soil fumigation in continuously cropped plantings.

The technical report of this project has been written up for publication in the Australian Journal of Experimental Agriculture and will appear as two papers.

(a) Fungicidal control of downy mildew (Bremia lactucae) on lettuce which will appear in Volume 33 - Issue 3.

(b) Fungicidal control of anthracnose (Microdochium panattonianum) on lettuce - presently being reviewed.

A copy of the downy mildew manuscript is attached and the other will be forwarded in due course.

Fungicidal control of downy mildew (*Bremia lactucae*) on lettuce

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Summary. Field experiments to evaluate fungicides for the control of downy mildew (*Bremia lactucae*) on lettuce were undertaken as growers had reported poor disease control with acylalanine fungicides and there was the potential withdrawal from market of ethylene bisdithiocarbamate fungicides.

Of the 6 fungicides evaluated, dimethomorph at 0.375 and 0.75 g a.i./L and phosphonic acid at 2.4 g a.i./L were amongst the most effective. Dimethomorph and phosphonic acid controlled downy mildew where acylalanine and in most cases acylalanine plus mancozeb formulations were in effective.

The use of lettuce cultivars with resistance to downy mildew and alternating spray programmes of either dimethomorph or phosphonic acid should prolong the effectiveness of both the cultivars and the fungicides.

Introduction

Downy mildew caused by *Bremia lactucae* Regel is a major disease of lettuce that occurs in most lettuce growing areas of the world (Crute and Dixon 1981). The disease has been controlled by the use of resistant cultivars and the application of fungicides, but cultivar resistance has broken down and the development of isolates of *B.lactucae* insensitive to acylalanine fungicides has resulted in poor control in many areas (Crute 1987; Schettini *et al.* 1991; Wicks and Trimboli unpublished data). In addition the potential withdrawal from market of ethylene bisdithiocarbamate (EBDC) fungicides such as mancozeb, maneb, metiram, and zineb, that are widely used on lettuce has further reduced the options for downy mildew control (Raid and Datnoff 1990).

This study was undertaken to evaluate a range of fungicides for the control of *B. lactucae* as in Australia resistant cultivars are not widely used and resistance to acylalanine fungicides has recently been established.

Materials and methods

All experiments were conducted in the field, either on growers' properties in the lettuce growing district of Virginia 30 km north of Adelaide or at the Lenswood Research Centre 30 km east of Adelaide during 1991.

Seedlings were planted mechanically on commercial properties or by hand on the Research Centre in beds of 4 rows, each row 45 cm apart and plants 30 cms apart in the row. Fungicide programmes were usually started within 4 weeks from planting and then applied every 7 to 10 days with knapsack sprayer using 800 L/ha.

Debris infected with downy mildew was collected from naturally infected plants and scattered evenly over the trial area to ensure an even development of disease.

Other operations such as weed control, irrigation, fertiliser applications and insect control were carried out by the grower while at the Research Centre these were similar to commercial practices.

At all sites, plots each of at least 50 plants were replicated 5 or 6 times and arranged in a randomised blocks design. Twenty plants from the centre of each plot were assessed for incidence and severity of disease on 3 or more occasions and at harvest.

Downy mildew severity was assessed using a 0 to 5 scale similar to that described by Dixon *et al.* (1973) where 1, 1 to 5; 2, 6 to 10; 3, 11 to 25; 4, 26 to 50 and 5 > 51% of the basal area infected with *B.lactucae*.

The fungicide active ingredient (a.i.) in the formulations used in these experiments were, 80g/Kg benalaxyl plus 650 g/Kg mancozeb (Galben M); 500 g/Kg chlorothalonil (Bravo 500); 100 and 150 g/L and 150 g/Kg dimethomorph; 800 g/Kg mancozeb (Dithane M45); 250 g/Kg metalaxyl (Ridomil); 80 g/Kg metalaxyl plus 640 g/Kg mancozeb (Ridomil MZ); 462 g/Kg prochloraz (Octave) and 200 g/L phosphonic acid neutralised with an equal amount of KOH (Foli-R-Fos).

Data was analysed using analysis of variance of a randomised block design in the statistical package "Statistix" (NH Analytical Software - 1958 Eldridge Ave, Roseville MN-USA).

Lenswood experiments.

Experiment 1

Benalaxyl at 0.2 g/L plus mancozeb at 1.6 g/L as Galben M was compared with 0.75 g/L dimethomorph, 1.2 g/L phosphonic acid and 0.25 g/L metalaxyl. The fungicides were applied on 11 occasions to seedlings of cv El-Toro planted on 2 May. Plants were harvested and assessed for disease 87 days after planting.

Experiment 2

Phosphonic acid at 1.2 and 2.4 g/L was compared with 1.2 g/L mancozeb. Seedlings of cv El-Toro were planted on 30 October and fungicides were applied on 8 occasions. The incidence and severity was assessed 70 days after planting.

Experiment 3

Weekly applications of 1.15 g/L chlorothalonil were compared with tank mixtures of the same rate of chlorothalonil and either 0.75 g/L dimethomorph or 2.4 g/L phosphonic acid, a tank mixture of 0.23 g/L prochloraz with either 2.4 g/L phosphonic acid, or 0.75 g/L dimethomorph. The latter two treatments were also applied only after the appearance of chlorotic lesions and seven days later. These treatments were applied to seedlings cv El-Toro planted on 10 October and the disease assessed 60 days later.

Virginia experiment

Experiment 4

Applications of 0.375 and 0.75 g/L dimethomorph, 1.2 and 2.4 g/L phosphonic acid, 1.15 g/L chlorothalonil, a formulated mixture of 0.2 g/L benalaxyl and 1.6 g/L mancozeb, a similar formulation at double the previous rate, a formulation of 0.2 g/L metalaxyl and 1.6 g/L mancozeb, and 0.25 g/L metalaxyl were compared as weekly applications. Seedlings of cv Salinas were planted on September 2. Fungicides were applied on four occasions before the trial was harvested on 18 October. At the final assessment 10 infected leaves per plot were placed in a sealed plastic bag overnight and the percent of lesions sporulating counted the following morning. Spore production was also estimated by taking leaf disks from lesions, shaking 10 disks per treatment in water and counting the spores with the aid of a haemocytometer.

Results

Lenswood -

May planting -

By the end of the season downy mildew had developed on most plants with those in the untreated plots being severely diseased (Table 1). Although the severity in the metalaxyl treatment was less than that in the unsprayed plots, it was significantly higher than the severity in either the benalaxyl plus mancozeb, dimethomorph or phosphonic acid treatments.

Yield was severely reduced by downy mildew infection as mean head weights of 234 g were achieved in the benalaxyl plus mancozeb treatment compared to 101 g in the untreated plots. No significant yield differences were detected between the fungicide treatments.

30 October planting

Downy mildew developed on all unsprayed plants, but the severity was less than that in Experiment 1 (Table 1). Significantly less downy mildew developed in all fungicide treatments with least in the 2.4 g/L phosphonic acid treatment.

10 October planting

Downy mildew developed on all unsprayed plants and most of the plants where prochloraz plus dimethomorph was applied only after the first appearance of symptoms (Table 1). By contrast the lowest incidence of downy mildew occurred in the chlorothalonil plus phosphonic acid treatment where 24% of plants were infected. The lowest severity of disease also occurred in this treatment but this did not differ significantly from the severity in the chlorothalonil plus dimethomorph and prochloraz plus phosphonic acid treatments. The severity in all except prochloraz and dimethomorph applied after appearance of symptoms was significantly less than that in the unsprayed plots.

Virginia -

September planting

At the completion of this experiment downy mildew had developed on all plants of cv Salinas, but there were significant differences in the severity of different treatments (Table 2).

For example the severity was significantly lower in the 0.75 g/L dimethomorph and the 2.4 g/L phosphonic acid treatments compared to most other fungicide treatments.

The production of conidia was inhibited significantly by dimethomorph, whereas metalaxyl and the metalaxyl-mancozeb formulation were not inhibitory (Table 2).

Discussion

These results show that dimethomorph and phosphonic acid provide acceptable control of downy mildew and warrant further evaluation as alternatives to fungicides presently registered for use on lettuce. These experiments have also shown that isolates of *Bremia lactucae* insensitive to acylanaline fungicides are now present in South Australia and that these isolates are controlled by both dimethomorph and phosphonic acid. Laboratory tests have confirmed the reduced sensitivity of South Australian isolates (D. Trimboli personal communication) but it is unknown whether these isolates are widespread in this State or confined to certain areas or properties. Further sampling needs to be done to clarify this as the distribution of insensitive isolates in South Australia and other lettuce growing areas of Australia has important implications for future fungicide use on lettuce and the selection of lettuce cultivars.

The efficacy of phosphonic acid against *B. lactucae* was not unexpected as it is the active ingredient of Aliette, a fungicide that has been shown elsewhere to control downy mildew (Crute 1978, Raid 1991, Raid and Datnoff 1991). Our results showed that the higher rate of 2.4 g/L (1.9 kg/Ha) was most effective and at that rate was not phytotoxic to lettuce. In exploratory glasshouse experiments we tested a wide range of phosphonic acid concentrations for phytotoxicity on El-Toro seedlings, and found marginal leaf burning developed only at concentrations of 10 g a.i./L and greater (Wicks unpublished data). By comparison Sommerfield and Raid (1990) reported fosetyl-Al (Aliette) as phytotoxic when applied to a range of lettuce cultivars in Florida although they did not report the rate used.

As phosphonic acid is a mobile yet persistent chemical in plant tissue (Guest and Grant 1991) further studies should determine if downy mildew can be controlled by applying high rates of phosphonic acid to seedlings either before or immediately after planting. In these situations it would be necessary to determine how long protection is provided by an early application before further applications were required.

Both phosphonic acid and dimethomorph have excellent curative activity against other downy mildews (Wicks and Hall 1990, Wicks *et al.* 1991). It may be feasible to reduce the frequency of fungicide applications and control lettuce downy mildew by applying these fungicides within a few days of identifying an infection period. However, for the curative properties of these fungicides to be used effectively, further studies similar to those of Scherm and van Bruggen (1991) are need to define the conditions that give rise to infection.

Anthracnose, caused by *Microdochium panattonianum*,(Berl.) Sutton Galea and Price, is a serious foliar disease of lettuce and often develops during conditions that are suitable for downy mildew. Dimethomorph and phosphonic acid had little effect on the disease (Wicks - unpublished data). However, our results showed that these fungicides mixed with either chlorothalonil or prochloraz, for the control of anthracnose, still controlled downy mildew and the mixture should be suitable for use on lettuce.

A range of lettuce cultivars resistant to Australian isolates of *B. lactucae* are now available (Trimboli, personal communication, Trimboli and Crute 1983) and the use of these in combination with either dimethomorph or phosphonic acid should prolong the effectiveness of both the cultivars and the fungicides. Alternating spray programmes may further reduce the possibility of fungicide resistance developing.

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Table 1. Fungicide treatments, incidence and severity of *Bremia lactucae* and yield of lettuce - cv El-Toro Lenswood 1991.

Treatment applied	Lenswood						
(g a.i./L)		May		30 Oct		10 Oct	
	In[v]	Sev[w]	Yield[z]	In	Sev	In	Sev
Benalaxyl(0.2)and mancozeb(1.6)	93	1.5	234	[u]	-	-	-
Dimethomorph (0.75)	87	2.2	187	-	-	-	-
Phosphonic acid (1.2)	100	2.6	172	50	0.5	-	-
Phosphonic acid (2.4)	-	-	-	18	0.2	-	-
Metalaxyl (0.25)	100	3.0	180	-	-	-	-
Mancozeb (1.2)	-	-	-	28	0.3	-	-
Chlorothalonil (1.15)	-	-	-	-	-	92	1.6
Chlorothalonil (1.15)plus dimethomorph[x] (0.75)	-	-	-	-	-	49	0.6
chlorothalonil(1.15) plus phosphonic acid(2.4)	-	-	-	-	-	24	0.3
Prochloraz (0.23) plus dimethomorph[x] (0.75)	-	-	-	-	-	65	0.9
Prochloraz(0.23)plus phosphonic acid (2.4)					-	42	0.6
Prochloraz (0.23) plus dimethormorph[x] (0.75)	-	-	-	-	-	98	2.7
Prochloraz (0.23) plus phosphonic acid[y] (2.4)	-	-	-	-	-	92	1.8
Unsprayed	100	4.4	101	100	2.0	100	2.7
l.s.d. (P = 0.05)		0.2	78		0.1		0.3

[u] not tested

[v] Incidence = percent of plants diseased.

[w] Severity, based on a 0 to 5 scale where 1 = 1 to 5, 2 = 6 to 10, 3 = 11 to 25, 4 = 26 to 50 and 5 = 51% or more of the basal area infected with *Bremia lactucae*.

[x] Applied as a EC 150g/L formulation.

[y] Applied after first appearance of chlorotic lesions and 7 days later.

[z] Mean plant weight (g)

Table 2. Fungicide treatments, severity and spore production of *Bremia lactucae* on Salinas lettuce - Virginia 1991

Treatment applied (8 a.i./L)	Severity[y]	Sporulating lesions[z]	10^{-3}xConidia/mL
Dimethomorph (0.375)	1.6	20	16
Dimethomorph (0.75)	1.5	14	15
Phosphonic acid (1.2)	1.8	28	89
Phosphonic acid (2.4)	1.4	22	32
Chlorothalonil (1.15)	2.1	32	66
Benalaxyl (0.2) plus (1.6) Mancozeb	2.1	26	22
Benalaxyl (0.4) plus (3.2) Mancozeb	1.6	29	27
Metalaxyl (0.2) plus (1.6) Mancozeb	2.2	31	82
Metalaxyl (0.25)	2.2	28	100
Unsprayed	2.8	35	73
l.s.d. (P = 0.05)	0.16		21

[x] Applied as a 150g/Kg WP formulation.

[y] Based on a 0 to 5 scale as in Table 1.

[z] Percent of lesions with sporangiophores