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Protected Lettuce: Efficacy of  
fungicides and phytotoxicity risk  
associated with Off-Label Approval  
of Aliette for the control of downy  
mildew (Bremia lactucae)



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## SUMMARY

Four trials were conducted during the period 1989-1990 to examine the risk of phytotoxicity associated with the use of Aliette applied according to the "Off - Label" Approval (No. 0982/88). A further two trials carried out in the Autumn of each year evaluated Aliette alongside a range of other fungicides for the control of downy mildew caused by Bremia lactucae.

Symptoms of phytotoxicity directly attributable to Aliette did not occur in any of the trials in the series. Damage did however occur during propagation in two trials but appeared to be associated with applications of dithiocarbamate fungicide rather than Aliette. However, it is not possible to eliminate a synergistic effect between the two fungicides as the dithiocarbamate was not applied alone in this trials series.

In two Autumn trials to compare efficacy of various fungicides a metalaxyl sensitive pathotype of B. lactucae was established artificially. Aliette applied according to the Off-Label Approval provided little control though was significantly improved where irrigation was not applied following treatment and the product was retained on the foliage.

Aliette applied as a block incorporation treatment and dithiocarbamate applied as a repeat spray programme were effective in the early stages of the trials though failed to persist through to harvest. In contrast, products containing phenylamides, e.g. Favour 600FW, Doz 071 provided effective control throughout. Unfortunately these products could not be relied upon to provide effective control in situations where metalaxyl resistant pathotypes predominated. The latter product however contains cymoxanil which should, in theory at least, be active against these resistant pathotypes. Filex (propamocarb hydrochloride) gave moderate though variable control of the disease and certainly offers potential for the control of both metalaxyl sensitive and resistant pathotypes of B. lactucae.

Finally, there was a very good correlation between the incidence of downy mildew, bottom-rot caused by Botrytis cinerea and lettuce head weights at harvest in these trials.

## INTRODUCTION

Downy mildew of lettuce caused by the fungus Bremia lactucae is a common and sometimes very damaging disease of protected lettuce. It is necessary to take precautionary control measures and both fungicides and varietal resistance have been used.

Following the development of resistance (insensitivity) to the widely used fungicide metalaxyl (in Ridomil 25WP and Fubol 58WP) in populations of the downy mildew fungus in 1983, ADAS in conjunction with the Institute of Horticulture Research, Wellesbourne (now forming part of Horticulture Research International), devised a control strategy which advocated a continued use of metalaxyl but in conjunction with lettuce cultivars containing appropriate resistance genes. The strategy has been successful and widely adopted by growers.

However, since 1987 a number of different metalaxyl-resistant pathotypes of Bremia lactucae have been detected in the UK which can attack some of the resistant cultivars. This threatened the continued success of the control strategy because of restricted choice of resistant cultivars remaining. It also focussed attention on the need for alternative fungicides.

In order to maintain effective control of downy mildew it became necessary to make other fungicides available and emergency "Off-Label" Approval (No.0982/88) was granted in 1988 for Aliette, which contains fosetyl-aluminium, a systemic fungicide. It was already being used on lettuce crops in Holland and the UK "Off Label" Approval allowed it to be used according to the Dutch recommendations. These recommendations took into account possible phytotoxicity, especially to the leaves in the later stages of crop growth. At the time only limited information on the risk of phytotoxicity was available from Holland and none from the UK. It was, therefore, necessary to examine the Aliette treatment, as recommended in Holland, for phytotoxicity under UK conditions when applied alone or with other fungicides in integrated programmes necessary to obtain complete disease control.

The objectives of this project were, therefore, to determine the risk of phytotoxicity from the "Off-Label" use of Aliette and to examine the efficacy of this and other fungicides for the control of downy mildew in protected butterhead lettuce.

## MATERIALS AND METHODS

### Site

All the trials reported here were located at Horticulture Research International, Stockbridge House, Cawood, Selby, North Yorkshire, YO8 OTZ.

### Duration

Six trials were carried out during 1989 and 1990.

Four phytotoxicity studies with Aliette were undertaken at different times of the year so that the crops were grown and the sprays were applied under a variety of weather conditions:

Trial 1, February - May 1989

Trial 2, May - June 1989

Trial 3, July - September 1989

Trial 5, June - July 1990

The efficacy of fungicides was examined in two trials during the early autumn when environmental conditions tend to favour downy mildew:

Trial 4, August - October 1989

Trial 6, August - October 1990

### Husbandry

All crops were grown according to standard commercial practice.

### Cultivar

The cv Sitonia, known to be susceptible to the isolate of the downy mildew fungus used to inoculate infector plants, was used in both the trials (No. 4 in 1989 and No.6 1990) concerned with fungicide efficacy and also in the 1990 trial (No.5) on Aliette phytotoxicity. In the other three trials on Aliette phytotoxicity (No 's. 1, 2, and 3 in 1989) the cv Virginia (R16, Enza-Zaden) was used.

## Downy mildew inoculum

For the two trials, No's. 4 and 6, in which fungicides were tested for their efficacy in controlling downy mildew it was necessary to ensure the presence of the disease during the whole of the trial period. To do this infected plants were placed in the crop. Seedlings of cv Sitonia were inoculated with the Tv strain of B. lactucae at Horticulture Research International, Wellesbourne. The seedlings were subsequently grown in pots. These infector plants were placed between trays of plants during propagation and covered when a fungicide was applied. Infector plants were also placed in the outside rows of each plot (4 plants/plot) 7-10 days before planting the main trial. Downy mildew was encouraged during the establishment period by covering each infector plant and thus maintaining a high relative humidity. The covers were removed when the main trial was planted but replaced temporarily during the periods of fungicide application.

## Fungicides and rates of use

### Aliette

wettable powder, marketed by Hortichem Ltd.

contains fosetyl-aluminium 80% w/w

Label recommendation:-

Block incorporation: 900g product/cu m blocking compost

"Off-Label" Approval (No 0982/88):-

3 - 4 leaf stage: 10g product/2 litres water/sq m blocks

post-planting: 30g product/20 litres water/100 sq m after 7 and 21 days

### Hortag Zineb Wettable (phytotoxicity trials)

wettable powder, marketed by Avon Packers Ltd.

contains zineb 70% w/w

### Hortag Thiram Flowable (phytotoxicity trials)

suspension concentrate, marketed by Avon Packers Ltd.

contains thiram 600g/L

propagation: 10g zineb product + 20g thiram product/10 litres water/100 sq m

post-planting: 20g zineb product + 40g thiram product/10 litres water/100 sq m

The dithiocarbamate mixture in the Aliette phytotoxicity trials contained a 50:50 mixture of the zineb and thiram products above.

Doz 071WDG

water dispersible granules, an experimental product from Sandoz Products Ltd.  
contains oxadixyl + cymoxanil, 32g + 80g/l  
propagation: 2.70g product/10 litres water/100 sq m blocks  
post-planting: 4g product/10 litres/100 sq m

Favour 600FW

suspension concentrate (flowable), marketed by Ciba Geigy Agrochemicals  
contains metalaxyl + thiram, 100g + 500g/l  
propagation: emergence, 1-2 leaf stage:  
7 ml product/3 litres water/ 100 sq m blocks  
3-5 leaf stage:  
10 ml product/4 litres water/100 sq m blocks  
post-planting: 15 ml product/5 litres water/100 sq m

Filex

soluble concentrate, marketed by Fisons plc.  
contains propamocarb hydrochloride 722g/l  
propagation: as a drench 750ml/300 litres water/100 sq m blocks  
post-planting: treatment 9: 15ml product/10 litres water/100 sq m  
treatments 10 & 11: 20ml product/10 litres/100 sq m

Rovral WP

wettable powder, marketed by Embetec Crop Protection  
contains iprodione 50% w/w  
propagation & post-planting: 5g product/10 litres water/100 sq m

Zineb (fungicide efficacy trials)

Hortag Zineb Dust, marketed by Avon Packers Ltd.  
contains zineb 7% w/w  
propagation: 200g product/100 sq m blocks (1/4 rate)  
Hortag Zineb Wettable, wettable powder, marketed by Avon Packers Ltd.  
contains 70% zineb w/w  
post-planting: 20g product/10 litres/100 sq m

In the fungicide efficacy trials a dust formulation was used during propagation and a wettable powder post-planting.



The fungicides were applied with a knapsack sprayer using a single nozzle and carbon dioxide pressured. Dusts were applied by pepper pot.

Overhead Irrigation (Off-Label Approval of Aliette only)

As a means of removing or reducing the fungicide deposit on the leaves ca 2mm water was applied by overhead irrigation lines.

### Design

Randomised block design with 4 replicates of each treatment. Each plot consisted of 5 rows, each row containing 18 plants, 90 plants per plot. Plant spacing was 203 x 203 mm (8 x 8 inches) giving a plot size of 3.71 sq m.

### Disease and yield assessments

#### Downy mildew

Assessments were made visually from above the plant using a 0 - 3 scale of severity:

Interim assessments during growing period:

- 0 = no leaf infection
- 1 = single leaf lesion
- 2 = several discrete leaf lesions
- 3 = numerous leaves infected, lesions spreading to infect entire leaf surface

Assessment at harvest:

- 0 = no sign of leaf infection
- 1 = occasional lesions on lower leaves
- 2 = frequent lesions tending to coalesce on the lower leaves and limited spread to the top leaves
- 3 = severe infection, rotting of the lower leaves, infection common on the top leaves

#### Bottom rot

Bottom rot was associated mainly with infection by Botrytis cinerea and was assessed on harvested plants on a 0 - 3 scale of severity:

- 0 = no disease
- 1 = slight bottom rot, no additional trimming required, marketable

2 = moderate bottom rot, additional trimming required, marketable

3 = severe bottom rot, unmarketable

For both diseases a disease index was calculated as follows:

$$\frac{(\text{no. plants in category 1} \times 1) + (\text{no. in cat 2} \times 2) + (\text{no. in cat 3} \times 3)}{\text{total no. plants assessed}} \times \frac{100}{3}$$

The range of the index is, therefore, 0 (no disease) to 100 (most severe disease).

#### Phytotoxicity

This was assessed on a 0 - 10 scale of severity where 0 = no damage and 10 = severe scorching.

Interim assessments of downy mildew were made during the growing period on 10 plants in the middle row of each plot in trials 4 (1989) and 6 (1990) (16 plants on 1 October 1990). At harvest downy mildew and Botrytis bottom rot were assessed on 24 plants per plot except in trial 6 (1990) when 10 plants per plot were assessed. In Trial 6 (1990) immediately before harvest, an overall whole plot assessment of disease was made on a scale 0 (no disease) - 3 (severe disease). At harvest in the 1989 Trials 1 - 4, 24 heads per plot were weighed in bulk as cut (untrimmed). In the 1990 Trials 5 and 6, 10 heads per plot were weighed untrimmed and again after the damaged leaves had been removed to make them suitable for market (trimmed).

#### Statistical Analysis

Data were subjected to analysis of variance and treatment means were separated using Duncan's Multiple Range Test. In this test, means with the same suffix within each column do not differ significantly ( $p = 0.05$ ).

## I Phytotoxicity studies with Aliette

### Treatments

1. Untreated
2. Aliette at 2-3 true leaf stage;  
no irrigation.
3. Aliette at 2-3 true leaf stage;  
irrigate immediately.
4. Aliette at 2-3 true leaf stage and 7 days after planting;  
no irrigation.
5. Aliette at 2-3 true leaf stage and 7 days after planting;  
irrigate immediately after each application.
6. Aliette at 2-3 true leaf stage and 7 and 21 days after planting;  
no irrigation.
7. "Off-Label" Approval.  
Aliette at 2-3 true leaf stage and 7 and 21 days after planting;  
irrigate immediately after each application.
8. Aliette as in treatment 7 in an integrated programme with Favour 600FW.  
Favour at 1-2 true leaf stage, 4-5 true leaf stage and 2 applications after  
planting at 14 day intervals.
9. Aliette as in treatment 7 in an integrated programme with dithiocarbamates.  
Dithiocarbamates applied as a 50:50 tank mix of zineb and thiram, at 2-3 day  
intervals during propagation and 2 applications after planting (maximum of 2  
applications within 2 weeks of planting out).
10. Aliette as in treatment 7 in an integrated programme with Rovral WP.  
Rovral applied twice during propagation and twice after planting but  
maintaining a 7 day harvest interval.

11. Aliette as in treatment 7 in an integrated programme with Favour 600FW, zineb/thiram and Rovral WP applied as in treatments 8, 9 and 10 above.
12. Aliette applied as a block incorporation treatment (as in full label recommendation).
13. Aliette applied as a block incorporation (Treatment 12) in an integrated programme with Aliette applied 7 and 21 days after planting.  
Irrigate immediately after each spray application.
14. Aliette applied as a block incorporation (Treatment 12) in an integrated programme with Aliette applied as foliar sprays during propagation and after planting out.  
Irrigate immediately after each spray application (as in treatment 7).

Overhead irrigation ca 2mm was applied to some Aliette treatments to reduce or remove the fungicide deposit from the leaves.

A list of the fungicides and the rates of use is included previously in the Materials and Methods section.

#### Diary

The actual dates when the various treatments were applied in each of the 4 trials are presented in Tables 1 - 4.

Table 1 : Aliette Phytotoxicity Trial 1, February-May 1989  
Diary of applications of treatments

Treatments+	Propagation														Post-planting				
	February							March							April				
	7 (S)	17	21	27	1	2	3	7	9	10	13	14	15	21 (P)	22	29	4	11	12
1. Untreated																			
2. 1 spray/-									A										
3. 1 spray*/-									A*										
4. 1 spray/1 spray									A				A						
5. 1 spray*/1 spray*									A*				A*						
6. 1 spray/2 sprays									A				A				A		
7. 1 spray*/2 sprays*									A*				A*				A*		
8. As 7 + Favour 2 sprays/2 sprays					F				A*		F		A*		F	A*		F	
9. as 7 + dithiocarbamates every 2-3 days/2 sprays		D	D	D		D		D	A*	D			A*			A*			
10. As 7 + Rovral 2 sprays/2 sprays							R		A*		R		A*	R		A*	R		
11. As 7 + Favour+Dithio+Rovral as in 8 - 10		D	D	D	F	D	R	D	A*	D	F	R	A*	R	F	A*	R	F	F
12. block incorporation	A																		
13. block incorporation + Aliette -/2 sprays*	A												A*			A*			
14. block incorporation + Aliette as in 7 1 spray*/2 sprays*	A								A*				A*			A*			

+ during propagation/after planting \* overhead irrigation

(S) Seed sown: 7 February  
(P) Planted out: 15 March  
Harvested: 12 May

A - Aliette  
F - Favour 600FW  
D - Dithiocarbamate  
R - Rovral WP

Table 2 : Aliette Phytotoxicity Trial 2, May - June 1989  
Diary of applications of treatments

Treatments+	Propagation										Post-planting							
	May										June							
	4 (S)	11	15	18	19	20	22	23	24	25 (P)	30	31	2	5	8	15	16	20
1. Untreated																		
2. 1 spray/-								A										
3. 1 spray*/-								A*										
4. 1 spray/1 spray								A			A							
5. 1 spray*/1 spray*								A*			A*							
6. 1 spray/2 sprays								A			A				A			
7. 1 spray*/2 sprays*								A*			A*				A*			
8. As 7 + Favour 2 sprays/2 sprays				F				A*	F		A*	F			A*	F		
9. as 7 + dithiocarbamates every 2-3 days/2 sprays		D	D	D		D	D	A*	D		D	A*		D		A*		
10. As 7 + Rovral 2 sprays/2 sprays					R			A*	R		A*			R	A*		R	
11. As 7 + Favour+Dithio+Rovral as in 8 - 10		D	D	DF	R	D	D	A*	R		D	A*	F	D	R	A*	F	R
12. block incorporation	A																	
13. block incorporation + Aliette -/2 sprays*	A							A*			A*							
14. block incorporation + Aliette as in 7 1 spray*/2 sprays*	A							A*			A*				A*			

+ during propagation/after planting \* overhead irrigation

(S) Seed sown: 4 May  
(P) Planted out: 25 May  
Harvested: 28 June

A - Aliette R - Rovral WP  
F - Favour 600FW  
D - Dithiocarbamate

Table 3 : Aliette Phytotoxicity Trial 3, July - September 1989  
Diary of applications of treatments

Treatments+	Propagation									Post-planting							
	July																
	13 (S)	20	22	24	26	27	28	1	2	3	7	9	10	15	18	22	23
1. Untreated																	
2. 1 spray/-						A											
3. 1 spray*/-						A*											
4. 1 spray/1 spray						A						A					
5. 1 spray*/1 spray*						A*						A*					
6. 1 spray/2 sprays						A						A				A	
7. 1 spray*/2 sprays*						A*						A*				A*	
8. As 7 + Favour 2 sprays/2 sprays					F	A*		F				F	A*		F		A*
9. As 7 + dithiocarbamates every 2-3 days/2 sprays		D	D	D	D	A*	D	D			D	A*	D				A*
10. As 7 + Rovral 2 sprays/2 sprays						A*	R		R			A*	R		R		A*
11. As 7 + Favour+Dithio+Rovral as in 8 - 10		D	D	D	DF	A*	DR	DF	R		D	F	A*	DR	F	R	A*
12. block incorporation	A																
13. block incorporation + Aliette -/2 sprays*	A											A*					A*
14. block incorporation + Aliette as in 7 1 spray*/2 sprays*	A					A*						A*					A*

+ during propagation/after planting \* overhead irrigation

(S) Seed sown: 13 July      A - Aliette  
(P) Planted out: 3 August    F - Favour 600FW  
Harvested: 6 September    D - Dithiocarbamate  
R - Rovral WP

Table 4 : Aliette Phytotoxicity Trial 5, July - September 1990  
Diary of applications of treatments

Treatments+	Propagation						Post-planting		
	May 31 (S)	14	19	June 22	26	29 (P)	3	July 5	9
1. Untreated									
2. 1 spray/-				A					
3. 1 spray*/-				A*					
4. 1 spray/1 spray				A				A	
5. 1 spray*/1 spray*				A*				A*	
6. 1 spray/1 spray				A				A	
7. 1 spray*/1 spray*				A*				A*	
8. As 7 + Favour 2 sprays/1 spray			F	A*	F		F	A* F	
9. as 7 + dithiocarbamates every 2-3 days/2 sprays		D	D	A*	D		D	A* D	D
10. As 7 + Rovral 2 sprays/2 sprays			R	A*	R		R	A* R	R
11. As 7 + Favour+Dithio+Rovral as in 8 - 10		D	DF R	A*	DF R		DF R	A* DFR	DF R
12. block incorporation	A								
13. block incorporation + Aliette -/1 spray*	A							A*	
14. block incorporation + Aliette as in 7 1 spray*/1 spray*	A			A*				A*	

+ during propagation/after planting \* overhead irrigation

(S) Seed sown: 31 May

(P) Planted out: 29 June

Harvested: 25 July

A - Aliette

F - Favour 600FW

D - Dithiocarbamate

R- Rovral WP

Note: Repeat Aliette treatment 21 days post-planting was not applied due to the short cropping period in this trial



## Results: Phytotoxicity trials with Aliette

### Trial 1. February-May 1989

The crop was grown throughout under cool conditions. At no stage was there any evidence of damage to the plants by the treatments applied.

Downy mildew did not occur and Botrytis bottom rot, though common, caused little damage (see table 5).

There were no significant differences in the mean weight per lettuce head associated with the various treatments (see Table 5).

There was no evidence in this trial of phytotoxicity from any of the Aliette treatments on their own or in integrated programmes with three other fungicides.

### Trial 2. May-June 1989

The weather during propagation was warm at first but then mainly dull and cool. After planting out the weather was cool and then by mid-June was hot and sunny.

On 13 June a marked difference in the appearance of some plots was noticed and a more detailed assessment on 15th June showed that phytotoxicity symptoms were confined to plants in treatment 9 (Aliette + dithiocarbamate programme) and treatment 11 (Aliette + dithiocarbamate + Favour + Rovral programme). The symptoms were an overall slight yellowing of the plants and a stunting of some plants though with much within-plot variability.

Downy mildew did not occur and Botrytis bottom rot was common but only slightly damaging, with least damage in the plots to which the dithiocarbamate programme had been applied, treatments 9 and 11 (see Table 6).

There were no significant differences between the yields associated with the various treatments (Table 6).

Although phytotoxicity symptoms were detected in some treatments they had no apparent effect on secondary disease or on yield.

### Trial 3. July-September 1989

The weather during the trial period was mainly warm and with hot spells in the last two weeks.

On the 1 August, during the propagation stage, some obvious stunting of plants was noticed, associated with treatments 9 and 11 (the two treatments which included dithiocarbamate programmes). At this time 5 sprays had been applied over an 11-day period. Whilst healthy plants had 4-5 true leaves, affected plants had 2-3 true leaves, some leaves were distorted and some plants were wilting. The symptoms were mainly confined to plants in trays which were not shaded; plants in shaded areas appeared normal.

No downy mildew occurred in the trial. The incidence and severity of Botrytis bottom rot at harvest were similar to those recorded in Trial 2 and again there was least disease in the treatments which included the dithiocarbamate programmes though the levels (as in Trial 2) did not differ significantly from those in some other treatments (Table 7). Although there were significant differences between the yields associated with some treatments (Table 7) no firm conclusions could be drawn. Two of the lowest yields were associated with the two dithiocarbamate treatments (9 and 11) but these were similar to the yield of the untreated, suggesting that the earlier observed damage to plants did not result in reduced yield. There was no evidence of reduced yield due to the use of any of the Aliette treatments. The use of overhead irrigation to wash the Aliette deposit from the leaves had mixed results. When a spray was applied only during propagation (treatments 2 and 3) and when two post planting sprays were applied (treatments 6 and 7) the irrigation treatments were associated with lower yields. When one spray was applied post planting, irrigation had the opposite effect.

### Trial 5. May - July 1990

The weather during the trial period was mainly very warm and sunny. The crop matured rapidly so that the planned second post planting Aliette spray (in treatments 6, 7, 8, 9, 10, 11, 13 and 14) could not be applied because the harvest interval of 14 days could not be satisfied.

No downy mildew occurred in the trial and the incidence and severity of Botrytis bottom rot was low with no significant differences between treatments (Table 8).

Lettuce heads were weighed untrimmed and again after trimming to make them suitable for market. There was relatively little waste from trimming reflecting the low disease, and in both weighings there were no significant differences between treatments (Table 8).

As in the previous trials there was no evidence of phytotoxicity associated with the use of Aliette.

Table 5 : Aliette Phytotoxicity Trial 1, February - May 1989  
 Assessments of Botrytis bottom rot and the yield of untrimmed  
 heads of lettuce at harvest, 12 May.

Treatments+	Botrytis bottom rot		Yield (g/head)
	% plants affected	disease index	
1. Untreated	16.6	5.6	292.5
2. 1 spray/-	14.6	4.9	295.8
3. 1 spray*/-	10.4	3.5	281.3
4. 1 spray/1 spray	11.5	3.8	252.3
5. 1 spray*/1 spray*	6.3	1.8	235.4
6. 1 spray/2 sprays	8.3	2.5	253.3
7. 1 spray*/2 sprays*	15.6	5.2	292.9
8. As 7 + Favour 2 sprays/2 sprays	12.5	4.2	275.0
9. as 7 + dithiocarbamates every 2-3 days/2 sprays	15.6	5.2	285.4
10. As 7 + Rovral 2 sprays/2 sprays	4.1	1.4	287.5
11. As 7 + Favour+Dithio+Rovral as in 8 - 10	1.1	0.4	242.9
12. block incorporation	9.4	3.2	261.7
13. block incorporation + Aliette -/2 sprays*	5.2	1.8	268.8
14. block incorporation + Aliette as in 7 1 spray*/2 sprays*	12.5	4.2	328.3
SED	6.308	2.086	28.583
DF	39	39	39
CV %	86.86	87.19	14.70
	NSD	NSD	NSD

+ during propagation/after planting

\* overhead irrigation

Table 6 : Aliette Phytotoxicity Trial 2, May - June 1989

Assessments of phytotoxicity on 15 May and of Botrytis bottom rot and the yield of untrimmed heads of lettuce at harvest, 28 May.

Treatments+	Phytotoxicity (0-10)	Botrytis bottom rot % plants affected	Botrytis bottom rot disease index	Yield (g/head)
1. Untreated	0	44.8 cde	14.9 cde	364.6
2. 1 spray/-	0	42.7 bcd	14.2 bcd	287.5
3. 1 spray*/-	0	69.8 e	23.3 e	353.3
4. 1 spray/1 spray	0	57.3 de	19.2 de	297.2
5. 1 spray*/1 spray*	0	29.2 abc	9.7 abc	315.8
6. 1 spray/2 sprays	0	40.6 bcd	13.5 bcd	306.3
7. 1 spray*/2 sprays*	0	49.0 cde	16.3 cde	300.0
8. As 7 + Favour 2 sprays/2 sprays	0	51.1 cde	17.0 cde	314.6
9. as 7 + dithiocarbamates every 2-3 days/2 sprays	4.3	12.5 a	4.1 a	314.6
10. As 7 + Rovral 2 sprays/2 sprays	0	26.1 abc	8.7 abc	318.8
11. As 7 + Favour+Dithio+Rovral as in 8 - 10	5.5	16.7 ab	5.5 ab	292.9
12. block incorporation	0	36.5 abcd	12.2 abcd	331.6
13. block incorporation + Aliette -/2 sprays*	0	38.6 abcd	13.9 bcd	317.9
14. block incorporation + Aliette as in 7 1 spray*/2 sprays*	0	26.0 abc	8.7 abc	320.8
SED	0.600	11.178	3.753	22.458
DF	39	39	39	39
CV %	121.9	40.94	41.04	22.458
				NSD

+ during propagation/after planting

\* overhead irrigation

Figures with the same letter in the suffix within each column do not differ significantly (P=0.05).  
Duncans Multiple Range Test.

Table 7 : Aliette Phytotoxicity Trial 3, July - September 1989  
 Assessments of Botrytis bottom rot and the yield of untrimmed  
 heads of lettuce at harvest, 6 September.

Treatments+	Botrytis bottom rot		Yield (g/head)
	% plants affected	disease index	
1. Untreated	32.3 abcd	11.1 abcd	270.8 abc
2. 1 spray/-	58.3 d	21.2 cd	300.0 cd
3. 1 spray*/-	53.1 cd	17.7 cd	262.5 ab
4. 1 spray/1 spray	32.3 abcd	12.5 abcd	262.5 ab
5. 1 spray*/1 spray*	58.3 d	22.9 d	300.0 cd
6. 1 spray/2 sprays	33.3 abcd	11.8 abcd	300.0 cd
7. 1 spray*/2 sprays*	61.5 d	23.3 d	266.7 ab
8. As 7 + Favour 2 sprays/2 sprays	46.9 bcd	15.6 bcd	270.8 abcd
9. as 7 + dithiocarbamates every 2-3 days/2 sprays	12.5 ab	4.2 ab	275.0 abcd
10. As 7 + Rovral 2 sprays/2 sprays	20.8 abc	6.9 abc	283.3 abcd
11. As 7 + Favour+Dithio+Rovral as in 8 - 10	0 a	0 a	258.3 a
12. block incorporation	36.5 abcd	14.2 bcd	300.0 cd
13. block incorporation + Aliette -/2 sprays*	39.6 bcd	15.6 bcd	304.2 d
14. block incorporation + Aliette as in 7 1 spray*/2 sprays*	56.3 cd	20.1 cd	291.7 bcd
SED	15.535	5.645	13.208
DF	39	39	39
CV %	56.79	56.74	6.64

+ during propagation/after planting

\* overhead irrigation

Figures with the same letter in the suffix within each column do not differ significantly (P= 0.05).  
 Duncans Multiple Range Test.

Table 8 : Aliette Phytotoxicity Trial 5, May - July 1990  
 Assessments of Botrytis bottom rot and the yield of untrimmed  
 and trimmed heads of lettuce at harvest, 25 July.

Treatments+	Botrytis bottom rot		Yield (g/head)	
	% plants affected	disease index	untrimmed	trimmed
1. Untreated	27.5	9.2	215.0	184.0
2. 1 spray/-	20.0	8.3	246.0	220.0
3. 1 spray*/-	17.5	6.7	209.0	188.0
4. 1 spray/1 spray	27.5	10.0	236.0	212.0
5. 1 spray*/1 spray*	25.0	10.9	223.0	207.0
6. 1 spray/2 sprays	25.0	9.2	215.0	197.0
7. 1 spray*/2 sprays*	17.5	6.7	210.0	194.0
8. As 7 + Favour 2 sprays/2 sprays	37.5	13.3	238.0	211.0
9. as 7 + dithiocarbamates every 2-3 days/2 sprays	7.5	2.5	223.0	209.0
10. As 7 + Rovral 2 sprays/2 sprays	12.5	4.2	243.0	222.0
11. As 7 + Favour+Dithio+Rovral as in 8 - 10	5.0	1.7	211.0	193.0
12. block incorporation	22.5	7.5	279.0	244.0
13. block incorporation + Aliette -/2 sprays*	12.5	5.0	238.0	205.0
14. block incorporation + Aliette as in 7 1 spray*/2 sprays*	20.0	7.5	216.0	199.0
SED	9.453	3.658	31.3	26.2
DF	39	39	39	39
CV %	67.44	70.66	19.39	18.05
	NSD	NSD	NSD	NSD

+ during propagation/after planting

\* overhead irrigation

## Discussion

Four trials investigated the possible phytotoxic effects of Aliette applied according to recommendations developed in Holland and given "Off-Label" Approval for use in the U.K. Aliette was also used in simpler programmes, as a block incorporation and in combination with other fungicides which are used on lettuce crops.

The trials were carried out under a variety of weather conditions in two different seasons.

There is no evidence from the trials that any of the Aliette programmes were phytotoxic either in respect of observed damage to plant tissues or having an adverse effect on yield.

The only signs of phytotoxicity were in Trials 2 and 3 in the two treatments (9 and 11) which included the dithiocarbamate programme. Since this programme was not used on its own, it is not clear whether the damage to plants was caused exclusively by the dithiocarbamate mixture or by its use in combination with the "Off-Label" Approval recommendations for Aliette. In any case the damage did not appear to be permanent and it did not result in a reduced head weight.



## II. The efficacy of fungicides for the control of downy mildew

### Treatments

1. Untreated
2. Zineb programme  
Propagation: Hortag Zineb Dust, apply lightly (quarter rate) from emergence every 2-3 days.  
Post-planting: Hortag Zineb WP, apply (full rate) as a spray shortly after planting and repeat 14 days later.
3. Favour 600FW  
Propagation: apply a spray at 100% emergence and at 3-4 true leaf stage.  
Post-planting: apply a spray 2-3 days after planting out and repeat 14 days later.
4. Aliette  
Propagation: incorporate in blocking compost immediately prior to seeding.  
Post-planting: no other treatment.
5. Aliette  
Propagation: apply a spray at 2-3 true leaf stage; immediately apply overhead irrigation.  
Post-planting: no other treatment.
6. Aliette  
Propagation: apply a spray at 2-3 true leaf stage; immediately apply overhead irrigation.  
Post-planting: apply a spray 7 days after planting; overhead irrigation 1 hour after the application.
7. Aliette  
Propagation: apply a spray at 2-3 true leaf stage; immediately apply overhead irrigation.  
Post-planting: apply a spray 7 and 21 days after planting; overhead irrigation 1 hour after each application.

8. Aliette

Propagation: apply a spray at 2-3 true leaf stage; no overhead irrigation.  
Post-planting: apply a spray 7 and 21 days after planting; no overhead irrigation.

9. Filex

Propagation: apply a drench immediately after seeding.  
Post-planting: apply a spray 2-3 days after planting and repeat twice at 14 day intervals (low rate).

10. Filex

Propagation: apply a drench immediately after seeding.  
Post-planting: apply a spray 2-3 days after planting and repeat twice at 14 day intervals (high rate).

11. Filex

Propagation: no treatment.  
Post-planting: apply a spray 2-3 days after planting and repeat twice at 14 day intervals (high rate).

12. Doz 071 WDG

Propagation: apply a spray to blocks at 100% emergence and repeat at 3-4 leaf stage.  
Post-planting: apply a spray 2-3 days after planting and repeat twice at 14-day intervals.

Overhead irrigation of ca 2mm was applied to some plots treated with Aliette to reduce or remove the fungicide deposit from the leaves, as specified in the specific Off-Label Approval.

A list of fungicides and the rates of use is included previously in the Materials and Methods section.

Diary

The actual dates when treatments were applied in each of the 2 trials are presented in Tables 9 and 10.

Table 9 : Efficacy of fungicides, Trial 4, August - October 1989  
Diary of applications of treatments

Treatments+	Propagation										Post-Planting					
	August					September					October					
	15 (S)	16	21	22	23	25	29	1	4	5	7 (P)	11	14	21	5	13
1. untreated																
2. zineb dust/ 2 sprays				Z			Z	Z		Z		Z		Z		
3. Favour 2 sprays/2 sprays				Fa					Fa		Fa		Fa			
4. Aliette block/-	A															
5. Aliette 1 spray */-									A*							
6. Aliette 1 spray */1 spray *									A*				A*			
7. Aliette 1 spray */2 sprays *									A*				A*		A*	
8. Aliette 1 spray /2 sprays									A				A		A	
9. Filex drench / 3 sprays @ 1.5 l/ha		Fi										Fi	Fi		Fi	
10. Filex drench / 3 sprays @ 2.0 l/ha		Fi										Fi	Fi		Fi	
11. Filex - / 3 sprays @ 2.0 l/ha												Fi	Fi		Fi	
12. Doz 071 2 sprays/2 sprays							D		D				D		D	

(S) Seed sown: 15 August  
(P) Planted out: 7 September  
H Harvested: 19 October

+ During propagation/after planting  
\* = overhead irrigation during post-planting period

Table 10 : Efficacy of fungicides, Trial 6, August - October 1990  
Diary of applications of treatments

Treatments+	Propagation					Post-planting						
	August					September			October			
	21 (S)	30	31	3	6	10	12	14	19	26	3	10
1. untreated												
2. zineb dust/ 2 sprays		Z		Z	Z	Z		Z		Z		
3. Favour 2 sprays/2 sprays				Fa		Fa		Fa		Fa		
4. Aliette block/-	A											
5. Aliette 1 spray*/-					A*							
6. Aliette 1 spray */1 spray *					A*			A*				
7. Aliette 1 spray */2 sprays *					A*			A*		A*		
8. Aliette 1 spray /2 sprays					A			A		A		
9. Filex drench / 3 sprays @ 1.5 l/ha	Fi							Fi		Fi		Fi
10. Filex drench / 3 sprays @ 2.0 l/ha	Fi							Fi		Fi		Fi
11. Filex - / 3 sprays @ 2.0l/ha								Fi		Fi		Fi
12. Doz 071 2 sprays/3 sprays				D		D		D		D		D

(S) Seed sown: 21 August  
(P) Planted out: 12 September  
H Harvested: 31 October

+ During propagation/after planting  
\* = overhead irrigation during post-planting period

## Results: Efficacy trials

1989

There was a satisfactory spread of downy mildew following artificial inoculation during propagation and when disease assessments were made 12 days after planting out nearly all the plants in the untreated plots were severely affected by the disease. At this time the fungicide treatments had been applied as required during propagation but only one of the post-planting treatments had been applied.

At the assessment 12 days after planting out (Table 11), plants treated with zineb, Aliette (block incorporation) and Doz 071 (Treatments 2, 4 and 12 respectively) remained disease-free. Very low levels of downy mildew, not significantly different from those in the disease-free treatments, were recorded on plants treated with Favour, (Treatment 3), Aliette applied with no overhead irrigation (Treatment 8) and Filex (Treatment 9). All other treatments had significantly more disease (including Aliette applied according to the current specific "Off-Label" Approval, Treatment 7), especially the Aliette treatment (5) which did not have a post-planting spray and the Filex treatment (11) which did not include a drench during propagation.

It is interesting to note that the omission of the irrigation (Treatment 8) from the use of Aliette according to the current "Off-Label" Approval (Treatment 7) was associated with a significantly better control of downy mildew without any apparent signs of phytotoxicity.

There is no apparent explanation for the different levels of disease recorded in the two similar Filex treatments 9 and 10 where the lower rate of use in treatment 9 (1.5 l/ha compared with 2.0 l/ha in treatment 10) gave the better control.

A change to brighter, warmer weather in the later stages of the trial checked the spread and development of the downy mildew so that at the time assessments were made on 19 October, at harvest, relatively less disease was recorded (see Table 12).

No disease was recorded on the plants treated with the Favour programme and there were low levels of disease on plants treated with the zineb, Filex and Doz 071 programmes respectively, but none of these were significantly different from the untreated or most of the other treatments. The most severe disease was associated with plants treated with Aliette in the block only, indicating that the effective early control had not been maintained.

Many plants in the trial became affected by a bottom rot, caused mainly by Botrytis cinerea, prior to harvest and assessments of this disease were included (Table 12). There was least disease in plots treated with the Favour programme though these did not differ significantly from those treated with the zineb, the two Filex and the Doz 071 programmes and the Aliette block incorporation respectively. However, all treatments except the best (Favour) and the worst (Aliette, propagation spray only) did not differ significantly from the untreated. Most disease occurred in plants treated with Aliette sprays except in the treatment (Treatment 8) where irrigation was not applied after spraying.

The highest yield was associated with the Aliette block incorporation treatment though this was not significantly different from yields associated with the zineb, Favour, two Aliette treatments (6 & 8), Filex (9) and Doz 071 programmes respectively (Table 13). All these treatments yielded significantly more than the untreated. Of the two Filex treatments, 9 & 10, the former using the 1.5 l/ha rate, which gave the more effective control of downy mildew at the 19 September assessment, was also associated with a significantly higher yield.

There was an apparent relationship between the severity of the two diseases recorded, downy mildew and Botrytis bottom rot, and also between these diseases separately and yield. This was investigated further by calculating the respective linear correlation coefficients ( $r$ ). There was a very good negative relationship

between downy mildew and yield ( $r = - 0.727$ ) and a less good, though significant, negative relationship between Botrytis bottom rot and yield ( $r = - 0.325$ ). There was also a good relationship between the severity of downy mildew and bottom rot ( $r = - 0.592$ ). This may be causal since the fungicides used (with the exception of Favour which contains thiram) are not known to have a significant effect on the control of Botrytis bottom rot.

1990

In contrast to the 1989 season, the weather during the early stages of the trial in autumn 1990 was bright and warm and attempts to establish infection with downy mildew artificially during propagation were unsuccessful. However, a change in the weather immediately after planting (12 September) created conditions almost ideal for infection. Repeat inoculation with B. lactucae was successful and severe disease (as assessed on the untreated plots) was maintained until harvest at the end of October.

An interim assessment of downy mildew 19 days after planting out showed an excellent control of the disease with the Favour and Doz 071 programmes respectively (Table 14) which persisted until harvest (see later assessments in Tables 14 & 15). The zineb and the Aliette (no irrigation) programmes (Treatments 2 & 8 respectively) gave a good control up to 19 days after planting out but the control did not persist. The remaining Aliette programmes (Treatments 5-7), but not the block incorporation (Treatment 14), gave some control at the earliest assessment but again this did not persist through to harvest on 31 October. The Filex treatments when assessed 19 days after planting out gave a poor control, mainly not significantly different from the untreated, but later there was an improvement in control relative to the other treatments and at harvest one of the programmes (9, 1.5 l/ha rate) had significantly less disease than the untreated.

Immediately before harvest an overall assessment of the plots was later confirmed by the more detailed downy mildew assessments at harvest (Table 15). The outstanding plots were those treated with Doz 071 whilst plots treated with Favour and Filex (Treatment 9) were better than most others.

The yield data (Table 16) shows that the fungicides which gave the best disease control (Favour and Doz 071) also gave the highest yields, significantly higher than the untreated and most of the other treatments for both trimmed and untrimmed lettuce heads. Zineb which gave a good early control of downy mildew was also associated with weights significantly greater than those of the untreated in the untrimmed crop but not in the trimmed crop. The Aliette treatments which were not effective in disease control were associated with yields not significantly different from the untreated. The Filex treatments which showed a relatively better disease control later in the season were associated with yields of untrimmed lettuce which in two of the three programmes were significantly higher than the untreated. However, in the trimmed crop the yields were not significantly different from the untreated.

As in the 1989 trials there appeared to be a good relationship between the severity of the two diseases and yield. There was a very good negative relationship between downy mildew and yield ( $r = - 0.873$  (untrimmed);  $r = - 0.890$  (trimmed)). Similarly there was a highly significant, negative relationship between Botrytis bottom rot and yield ( $r = - 0.898$  (untrimmed);  $r = - 0.944$  (trimmed)). Finally there was a very good correlation between the severity of downy mildew and the incidence of bottom rot ( $r = - 0.937$ ).



Table 11 : Efficacy of fungicides, Trial 4, August - October 1989

Interim assessments of downy mildew in the growing crop 12 days after planting out 19 September.

Treatments+	Downy mildew		
	% plants infected	Disease index	
1. untreated	97.50 d	84.99 c	
2. zineb dust/ 2 sprays	0 a	0 a	
3. Favour 2 sprays/2 sprays	2.50 a	0.83 a	
4. Aliette block/ -	0 a	0 a	
5. Aliette 1 spray*/ -	90.00 d	66.66 c	
6. Aliette 1 spray */1 spray *	62.50 c	34.99 b	
7. Aliette 1 spray */2 sprays *	77.50 d	42.50 b	
8. Aliette 1 spray /2 sprays	27.50 b	9.17 a	
9. Filex drench /3 sprays @ 1.5 l/ha	15.00 ab	6.67 a	
10. Filex drench /3 sprays @ 2.0 l/ha	47.00 bc	26.25 b	
11. Filex - / 3 sprays @ 2.0 l/ha	92.50 d	77.50 c	
12. Doz 071 2 sprays/2 sprays	0 a	0 a	
	SED	10.742	9.198
	DF	33	33
	CV%	35.60	44.18

+ During propagation/after planting \* = overhead irrigation during post-planting period

In treatments 2, 3, 7, 8, 9, 10, 11 & 12 only 1 post-planting spray treatment had been applied when assessments were made.

Figures with the same letter in the suffix within each column do not differ significantly (P=0.05).

Duncans Multiple Range Test.

Table 12 : Efficacy of fungicides, Trial 4, August - October 1989  
 Assessment of downy mildew and Botrytis bottom rot at harvest, 19 October

Treatments+	Downy mildew		Botrytis bottom rot		
	% plants infected	disease index	% plants infected	disease index	
1. untreated	26.1	9.4 a	74.0 bcde	35.1 bcde	
2. zineb dust/ 2 sprays	3.3	1.1 a	60.4 abcd	24.0 abc	
3. Favour 2 sprays/2 sprays	0	0 a	31.3 a	11.5 a	
4. Aliette block/-	49.0	33.7 b	51.1 abc	20.8 ab	
5. Aliette 1 spray*/-	34.4	16.0 ab	96.9 e	59.0 f	
6. Aliette 1 spray */1 spray *	24.9	10.1 a	91.7 de	53.5 ef	
7. Aliette 1 spray */2 sprays *	27.1	12.2 a	82.3 cde	50.3 def	
8. Aliette 1 spray /2 sprays	31.3	10.8 a	70.9 bcde	32.6 bcd	
9. Filex drench / 3 sprays @ 1.5 l/ha	34.4	12.3 ab	54.2 abc	21.9 abc	
10. Filex drench / 3 sprays @ 2.0 l/ha	12.5	4.9	50.0 ab	22.6 abc	
11. Filex - / 3 sprays @ 2.0 l/ha	25.0	10.4 a	71.9 bcde	41.0 cdef	
12. Doz 071 2 sprays/2 sprays	12.6	5.6 a	46.9 ab	16.7 ab	
	SED	15.472	8.966	13.548	8.369
	DF	33	33	33	33
	CV%	93.01	116.56	29.43	36.52
	NSD				

+ During propagation/after planting.

\* = overhead irrigation

Figures with the same letter in the suffix within each column do not differ significantly (P=0.05).

Duncans Multiple Range Test

Table 13 : Efficacy of fungicides, Trial 4, August - October 1989  
Yield of untrimmed heads of lettuce at harvest, 19 October

Treatments+	Yield (g/head)
1. untreated	163.8 a
2. zineb dust/ 2 sprays	218.8 d
3. Favour 2 sprays/2 sprays	213.8 cd
4. Aliette block/-	220.8 d
5. Aliette 1 spray*/-	172.1 a
6. Aliette 1 spray */1 spray *	204.2 bcd
7. Aliette 1 spray */2 sprays *	186.7 abc
8. Aliette 1 spray /2 sprays	212.5 cd
9. Filex drench / 3 sprays @ 1.5 l/ha	212.5 cd
10. Filex drench / 3 sprays @ 2.0 l/ha	179.2 ab
11. Filex - / 3 sprays @ 2.0 l/ha	180.4 ab
12. Doz 071 2 sprays/2 sprays	213.8 cd
SED	13.333
DF	33
CV%	9.5

+ During propagation/after planting.

\* = overhead irrigation

Figures with the same letter in the suffix within each column do not differ significantly (P=0.05).  
Duncans Multiple Range Test.

Table 14 : Efficacy of fungicides, Trial 6, August - October 1990

Interim assessments of downy mildew in the growing crop 19 and 42 days after planting out, 1 and 24 October respectively ++

Treatments+	1 October		24 October	
	% plants infected	disease index	% plants infected	disease index
1. untreated	93.8 g	86.8 f	72.5 def	47.5 cd
2. zineb dust/ 2 sprays	29.7 abc	18.8 ab	55.5 de	28.5 abcd
3. Favour 2 sprays/2 sprays	1.6 a	1.0 a	10.0 ab	3.3 a
4. Aliette block/-	92.2 g	78.0 ef	65.0 cdef	36.0 bcd
5. Aliette 1 spray*/-	56.3 cdef	49.0 cd	90.0 ef	54.0 d
6. Aliette 1 spray */1 spray *	56.3 cdef	34.3 abcd	82.5 def	50.0 d
7. Aliette 1 spray */2 sprays *	48.5 cde	43.3 bcd	82.5 def	58.3 d
8. Aliette 1 spray /2 sprays	32.8 bcd	24.8 abc	100.0 f	59.0 d
9. Filex drench / 4 sprays @ 1.5 l/ha	78.2 efg	62.5 def	25.0 abc	10.0 ab
10. Filex drench / 4 sprays @ 2.0 l/ha	64.1 defg	50.0 cde	42.5 abcd	17.5 abc
11. Filex - / 4 sprays @ 2.0 l/ha	81.3 fg	62.3 def	50.0 bcde	17.5 abc
12. Doz 071 2 sprays/2 sprays	6.3 ab	5.3 a	2.5 a	0.8 a
SED	13.737	12.538	17.99	13.263
DF	33	33	33	33
CV%	36.38	41.25	45.07	58.88

+ During propagation/after planting. \* = overhead irrigation

++ At the time of assessment on 1 October two sprays of Zineb, Favour, Filex and Doz 071 and one spray Aliette had been applied post-planting

Figures with the same letter in the suffix within each column do not differ significantly (P=0.05). Duncans Multiple Range Test.

Table 15 : Efficacy of fungicides, Trial 6, August - October 1990  
 Assessments of downy mildew and Botrytis bottom rot at harvest 31 October.

Treatments+	Downy mildew			Botrytis bottom rot index	
	overall plot score (0-3)	% plants affected	disease index		
1. untreated	1.3 bc	87.5 abc	43.0 de	62.5	
2. zineb dust/ 2 sprays	1.3 bc	62.5 bc	30.0 bcde	53.3	
3. Favour 2 sprays/2 sprays	0.5 ab	25.0 ab	5.0 ab	39.1	
4. Aliette block/-	1.5 bc	67.5 c	28.5 bcde	55.8	
5. Aliette 1 spray*/-	2.3 c	95.0 c	46.5 e	71.6	
6. Aliette 1 spray */1 spray *	1.8 c	90.0 c	35.0 cde	64.9	
7. Aliette 1 spray */2 sprays *	1.8 c	75.0 c	37.5 de	62.5	
8. Aliette 1 spray /2 sprays	2.3 bc	92.5 c	45.0 de	67.5	
9. Filex drench / 4 sprays @ 1.5 l/ha	0.5 ab	27.5 ab	10.5 abc	51.7	
10. Filex drench / 4 sprays @ 2.0 l/ha	1.3 bc	90.0 c	23.0 abcde	59.1	
11. Filex - / 4 sprays @ 2.0 l/ha	1.3 bc	77.5 c	18.5 abcd	54.1	
12. Doz 071 2 sprays/2 sprays	0 a	0 a	0 a	37.5	
	SED	0.463	17.712	11.213	11.840
	DF	33	33	33	33
	CV%	50.58	38.04	58.96	29.58

+ During propagation/after planting. \* = overhead irrigation

Figures with the same letter in the suffix within each column do not differ significantly (P=0.05).  
 Duncans Multiple Range Test.

Table 16 : Efficacy of fungicides, Trial 6, August - October 1990  
Yield of untrimmed and trimmed heads of lettuce at harvest, 31 October

Treatments+	Yield, untrimmed (g/head)	Yield, trimmed (g/head)
1. untreated	162.0 a	84.0 ab
2. zineb dust/ 2 sprays	203.0 cd	100.0 ab
3. Favour 2 sprays/2 sprays	232.0 e	166.0 c
4. Aliette block/-	176.0 abc	102.0 ab
5. Aliette 1 spray*/-	168.0 ab	63.0 a
6. Aliette 1 spray */1 spray *	175.0 abc	96.0 ab
7. Aliette 1 spray */2 sprays *	168.0 ab	88.0 ab
8. Aliette 1 spray /2 sprays	172.0 ab	84.0 ab
9. Filex drench / 3 sprays @ 1.5 l/ha	195.0 bcd	115.0 b
10. Filex drench / 3 sprays @ 2.0 l/ha	196.0 bcd	99.0 ab
11. Filex - / 3 sprays @ 2.0 l/ha	185.0 abc	92.0 ab
12. Doz 071 2 sprays/3 sprays	219.0 de	159.0 c
SED	5.167	7.958
DF	33	33
CV%	9.34	26.02

+ During propagation/after planting. \* = overhead irrigation

Figures with the same letter in the suffix within each column do not differ significantly (P=0.05),  
Duncans Multiple Range Test.

## Discussion

In both years the downy mildew fungus was successfully introduced into the lettuce crops through the artificially infected infector plants but the nature of the subsequent epidemic was determined by the prevailing outside weather conditions. In 1989 the disease was severe during the propagation stages and for the first few weeks after planting out but then in the late stages of the crop it virtually disappeared. The disease indices at 12 days after planting out and at harvest (42 days post-planting) were 85.0 and 9.4 respectively on the untreated plots. In 1990 the disease was not established until after planting out but then was severe until harvest; the disease indices at 19, and 42 days after planting out and at harvest (49 days post-planting) were 85.8, 47.5 and 43.0 respectively.

The zineb programme controlled the severe disease in propagation and in the early post-planting stages in 1989. However, in the severe later epidemic in 1990 the programme did not give a satisfactory control. According to the current restrictions, dithiocarbamate fungicides may be applied twice within 2 weeks of planting but not at all thereafter. The only exception is where thiram is used in the winter when three applications may be applied within three weeks of planting out. In 1990 this meant that no zineb sprays were applied during the final 3 weeks of the crop. Under these conditions the zineb programme was not sufficiently effective and/or persistent to control disease in the latter stages of the crop.

Aliette, used according to the Specific "Off-Label" Approval (Treatment 7), did not show any apparent evidence of phytotoxicity. With a 3-week harvest interval it could provide late season crop protection. However, in the trials reported here it failed to give a satisfactory control of downy mildew in both years. Overhead irrigation was applied to wash deposits of fungicide from the leaves, in accordance with the "Off-Label" Approval, apparently to reduce phytotoxicity. When the irrigation was omitted (Treatment 8) there was some evidence from the 1989 trial of a better disease control and still no evidence of phytotoxicity. Of some concern, however, was the increased incidence of Botrytis bottom rot following treatment with Aliette in 1989 (Tables 11 & 12). This may simply have been a reflection of the increased incidence of downy mildew in these plots. Alternatively though, it may provide an indication of damage to the stem base as a result of phytotoxicity, albeit not apparent in the growing crop. This aspect requires further investigation.

Block incorporation of Aliette provided an excellent control of downy mildew in the propagation stages in 1989 but the effect did not persist after planting out in either 1989 or 1990.

The products containing phenylamide fungicides, Favour 600FW (metalaxyl+thiram) and the experimental Doz 071 (oxadixyl+cymoxanil), gave excellent control of downy mildew throughout both seasons. The inclusion of the dithiocarbamate thiram in Favour 600FW prevented its use later than two weeks after planting in these autumn crops, but the control achieved was not significantly different from that of Doz 071 which was applied on one extra occasion nearer to harvest.

The treatments which included Filex gave uneven though promising results. In the early season epidemic in 1989 the treatments which included a drench at seeding gave significant disease control at the interim assessment though not at harvest. In 1990 early disease assessments indicated poor control from all Filex treatments (Table 14) but later there was less disease in these treatments than in the untreated (Tables 14 & 15) particularly with Filex in Treatment 9.

In 1989 there was evidence of less Botrytis bottom rot at harvest in those treatments which gave the best control of downy mildew. The least bottom rot was in plots treated with Favour where the inclusion of thiram may have had some direct effect on the disease. None of the other fungicides are known to control bottom rot. There was a similar if less marked pattern in 1990.

Treatments were mainly associated with yields higher than the untreated but yields significantly higher than the untreated were associated only with those treatments giving significant disease control at some stage in the growth of the crop.



## CONCLUSIONS

The first objective of the project was to obtain information on the possible phytotoxicity of Aliette when used on protected lettuce. Aliette had been given a UK Specific "Off-Label" Approval to be used according to the recommendations made in Holland which took into account the risk of phytotoxicity especially in the later stages of the crop.

The product was used in several different programmes in six trials over a two-year period under a variety of seasonal conditions. In some treatments overhead irrigation washed deposits of the fungicide from the leaves, as is required by the "Off-Label" Approval, and in others the leaves were left unwashed. On no occasion was there any apparent evidence of damage to plants or adverse effects on yield which could be attributed directly to the use of Aliette. In one trial (Efficacy of fungicides, Trial 4, 1989), more Botrytis bottom rot was recorded in some Aliette treatments, a feature noticed in previous trials outside this project. However, there were no signs of damage by the fungicide which might have initiated the increased levels of bottom rot and a more probable explanation is the severity of earlier attacks of downy mildew on plants in these treatments.

The only phytotoxicity recorded was related to the use of dithiocarbamates (in Trials 2 and 3) and it is not possible, in these trials, to distinguish the effect of the dithiocarbamates along from their effects in the integrated programme with Aliette.

The results show that the risk of crop damage from the use of Aliette is low. However, as with all "Off-Label" uses, responsibility for its use ultimately lies with the individual grower.

The second objective of the project was to examine the efficacy of several fungicides. Downy mildew was introduced and maintained in the trial areas through infector plants. This, together with the presence of untreated controls, provided a stern test for the candidate fungicides.

Although the trials demonstrated an apparent low risk of phytotoxicity from the use of Aliette, they also showed that sprays applied according to the Specific "Off-Label" Approval did not provide a satisfactory control of downy mildew, at least not when disease pressure was high. Block incorporation of Aliette gave an

excellent control in the propagation stages in one trial. However in neither trial was control maintained in the later stages, after planting out.

The zineb programme controlled severe disease in the propagation stages but not the late severe attack. Presumably this was due to the later growth being left unprotected because of the restriction of the use of this fungicide to within two weeks of planting out.

Treatments which included Filex gave uneven results but promising enough to merit further attention. Samples were taken by Fisons Horticulture plc for residue analysis of the active ingredient, propamocarb hydrochloride. It is hoped that the data from these trials will encourage the Company to include downy mildew of lettuce in their label recommendation. If this is not forthcoming consideration should be given to an application for a specific "Off-Label" Approval for Filex for downy mildew control on protected lettuce.

Favour 600FW and the experimental Doz 071WDG gave excellent control of downy mildew. Doz 071 contains oxadixyl + cymoxanil. Oxadixyl has the same mode of action as metalaxyl (in Favour 600FW), i.e. they are both phenylamides, and is, therefore, unlikely to be effective against metalaxyl-resistant strains of the downy mildew fungus, Bremia lactucae. The cymoxanil component, however, is likely to offer some protection against metalaxyl-resistant strains. This product could perhaps provide control of both metalaxyl-sensitive and resistant strains of B. lactucae. There are now similar related products on the market for the control of potato blight e.g. Trustan (Du Pont (UK) Ltd.) which contains a dithiocarbamate component in addition to both oxadixyl and cymoxanil. This, and other similar products, could provide systemic and eradicant activity against both metalaxyl-sensitive and resistant strains of B. lactucae and clearly warrant further evaluation.

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## STORAGE OF DATA

The raw data from this trial series will be retained for a minimum period of 5 years in the Department of Entomology & Plant Pathology at ADAS, Leeds.

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