

Project Title: Peas: Downy mildew control

Project Number: FV 215

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Annual Report: 1999

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Date project commenced: April 1998

Date completion due: October 2000

Key Words: vining peas, varietal susceptibility, downy mildew,  
*Peronospora viciae*, seed treatments, foliar treatments.

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## **PRACTICAL SECTION FOR GROWERS**

### **Background**

Downy mildew has been a particular problem in vining peas in recent years. Seed of all varieties is routinely treated with fungicides to reduce mildew infection, but the level of control is now variable, possibly due to the development of metalaxyl-resistant populations of the fungus. There is insufficient information on varietal resistance and no foliar applied fungicides which are currently available.

The project is aimed at evaluating the relative field resistance of current varieties, comparing the effectiveness of seed treatments and screening foliar applied chemicals for activity against downy mildew.

### **Summary of results**

In the second year of the project, eighteen commercial varieties of vining peas were evaluated in field trials and in an inoculated polythene tunnel for their relative resistance to downy mildew. Of these, Barle, Kermit and Pinnacle showed the lowest levels of infection, compared with the susceptible standard variety Avola.

A comparison of seed treatments showed that Apron Elite continued to provide good control of downy mildew early in the season.

An evaluation of possible foliar applied treatments to control secondary mildew infection gave disappointing results, with no single product providing consistently effective control.

### **Potential benefits**

Knowledge of the relative field resistance of varieties will help reduce the reliance on seed treatments as the only means of control. Foliar treatments with a different mode of action would be a useful alternative to routinely applied seed treatments. Widening the choice of seed treatments would reduce the risk of development of resistant mildew populations.

## SCIENCE SECTION

### Introduction

Downy mildew caused by *Peronospora viciae*, is a common disease of peas in many of the temperate pea growing areas of the world. Seedlings become infected, following exposure to soil-borne oospores, shortly after germination. Newly emerged plants produce mycelium on the underside of the leaf, which later becomes the source of air-borne spores which are released during periods of high humidity. Secondary foliar infection develops as a result of infection by the air-borne spores. Leaves become covered with mildew and pods are poorly developed and contain low seed numbers. The disease affects seedling survival and secondary infection reduces plant vigour and pod development, resulting in low yield and poor quality of vined peas.

Chemical control by foliar-applied fungicides has not been effective, partly because of poor leaf uptake and partly because of a lack of active chemicals. Seed treatment with phenylamide fungicides is the most successful in reducing levels of primary infected seedlings from soil-borne inoculum, but there is increasing evidence of resistance to metalaxyl in some areas of the UK and reports of resistance in New Zealand and the USA, where the chemical has also been in regular use for a number of years.

*Peronospora viciae* exists as several races and although some combining pea varieties exhibit good levels of field tolerance, vining peas generally appear to be more susceptible. However screening vining peas for field resistance has been carried out on a very limited scale.

Downy mildew was severe in 1997 and in view of the problems in control outlined above, there are a number of aspects that need further investigation in order to formulate a disease management strategy that will be sustainable for the future.

The objectives of the project are as follows:-

- a) To evaluate a range of commercially available vining pea varieties for their relative field resistance to downy mildew.
- b) To compare seed treatments for the control of downy mildew.
- c) To evaluate fungicides and foliar treatments for post emergence application to control secondary infection of downy mildew.

## Methods

### a) Varietal field resistance

Eighteen commercially available varieties of vining peas were selected to represent a range of plant types, seed size and maturity. These included most of the varieties tested in 1998 with the exception of three, and eight additional varieties were tested in 1999. Seeds of each were planted in disease observation trials sited in three commercial crops of vining peas. A further trial was carried out under a polythene tunnel at NIAB Cambridge. The varieties and their characteristics are shown in Table 1.

Table 1. Varieties and characteristics

Variety	Maturity	Leaf Type	Seed size
Avola*	first early	leafy	medium/large
Cabree*	first early	leafy	medium
Winner*	first early	leafy	medium
Jaguar*	second early	semi-leafless	medium/large
Barle*	early main crop	semi-leafless	medium/large
Brule	early main crop	semi-leafless	medium
Colana*	early main crop	leafy	medium
Favorit	early main crop	leafy	medium/small
Kermit	early main crop	semi-leafless	medium/small
Oasis	early main crop	semi-leafless	medium/large
Jewel	early main crop	leafy	petit pois
Paso	early main crop	semi-leafless	petit pois
Sancho*	early main crop	semi-leafless	medium/small
Sigra*	early main crop	semi-leafless	small
Ambassador*	main crop	leafy	medium/large
Balmoral*	main crop	leafy	medium
Pinnacle	main crop	semi-leafless	medium/small
Tyne	main crop	semi-leafless	medium

\*Also tested in 1998

### i) Field Trials

No fungicide seed treatment was applied to any of the varieties in the field trials, each plot consisted two rows of 100 seeds, 5 m in length and replicated twice. The seed was planted with an Oyjord plot seeder, at a depth of 10 cm, the soil rolled and a pre-emergence herbicide applied. The trial site details are shown in Table 2.

Table 2. Site details

Site 1. Slate House Farm, Gypsy Bridge, Boston.	Sowing date: 22.3.99
Site 2. Birds Drove Farm, Gosberton, Spalding.	Sowing date: 26.4.99
Site 3. Colony Farm, Manea, Chatteris	Sowing date: 27.4.99

Disease assessments were made on two occasions during the growing season. The first was made just after emergence at gs 104-106 and the second, during the flowering and pod development stages gs 205-206. On each occasion, the plots were examined visually and an assessment of the % of plants showing systemic infection was made. The plots were then assessed to estimate the % sporulation on the infected plants. The two figures were combined to give an average over the plot area.

## ii) Polythene tunnel

The varieties were sown under polythene at NIAB Cambridge on 17<sup>th</sup> March 1999. Four replications of 60 seeds were sown in a 60cm long row. Downy mildew inoculum had been increased by incorporation of infected pea debris the previous year into soil which had been used for downy mildew testing for several years. Disease was assessed on three occasions, at gs 103, 108 and 110 by estimating the percentage leaf area in each plot covered with sporulating downy mildew.

## b) Comparison of seed treatments

Seed of the vining pea varieties, Avola and Tristar, known to be susceptible to downy mildew was treated with a range of fungicide mixtures using a Hege laboratory seed treater. The application rates and products are shown in Table 3.

Table 3. Seed treatment details

Product	Company	Ingredients	Rate/kg
1. On Label for peas, Hy-TL	Agrichem	thiabendazole + thiram	2.0 ml
2. On label Apron Combi FS	Novartis	metalaxyl + thiabendazole + thiram	3.0 ml
3. Expt 1. Triple Pea Treatment:		fosetyl aluminium, thiabendazole + thiram, Aliette, Hy-TL, Sepiret 2020	2 g, 1.7 ml, 0.8 g
4. On Label Apron Elite	Novartis	cymoxanil, oxadixyl, carbendazim, thiram	3.0 g

Seed was drilled at the three sites used for the variety evaluation. The Avola was drilled at Gypsy Bridge and Tristar was drilled at Gosberton and Manea. The drilling was done by an Oyjord plot seeder in plots measuring 5 m x 1.5 m with 15 cm row spacing. Each treatment was replicated five times in a fully randomised block experiment. The plots were rolled immediately after drilling and a pre-emergence herbicide applied to the Gypsy Bridge and Gosberton trials and a post-emergence herbicide applied at Manea.

Seedling emergence was recorded by counting seedlings within a 0.33 m<sup>2</sup> circular quadrat at six positions in each plot. An assessment of disease seedlings was made during the early part of the growing season and again at flowering and pod development time. Disease assessments were made as detailed in section (a).

## c. Foliar treatments

Several fungicides were evaluated as spray treatments in three trials situated in commercial crops of vining peas. The field trials were situated at, Wootton Marsh Farm, North Wootton, Kings Lynn Norfolk, OS 620 255. Moat House Farm, Monkesthorne, Spilsby, Lincs OS 452 648 and Hessleskew Farm, Market Weighton, Yorkshire OS 925 406.

The treatments are shown in Table 4.

Table 4. Spray treatment details.

Product	Company	Active ingredient	rate/ha
1. Untreated		-	-
2. Aliette	Hortichem	fosetyl aluminium	1.68 kg
3. Aliette + Agral	Hortichem	fosetyl aluminium + wetting agent	1.68 kg + 100 ml
4. Invader	Cyanamid	dimethomorph + mancozeb	2.0 kg
5. On Label Bravo 500	Zeneca	chlorothalonil	2.0 l
6. Thiovit	Novartis	sulphur	10 kg

Sprays were applied to plots measuring 5 m x 2 m on two occasions (T<sub>1</sub> early vegetative stage and T<sub>2</sub> 14 days later) with an Azo plot sprayer in 200 l water/ha through 02/F110 fan nozzles at 2.5 bar provided by propane. Each treatment was replicated four times in a randomised block design.

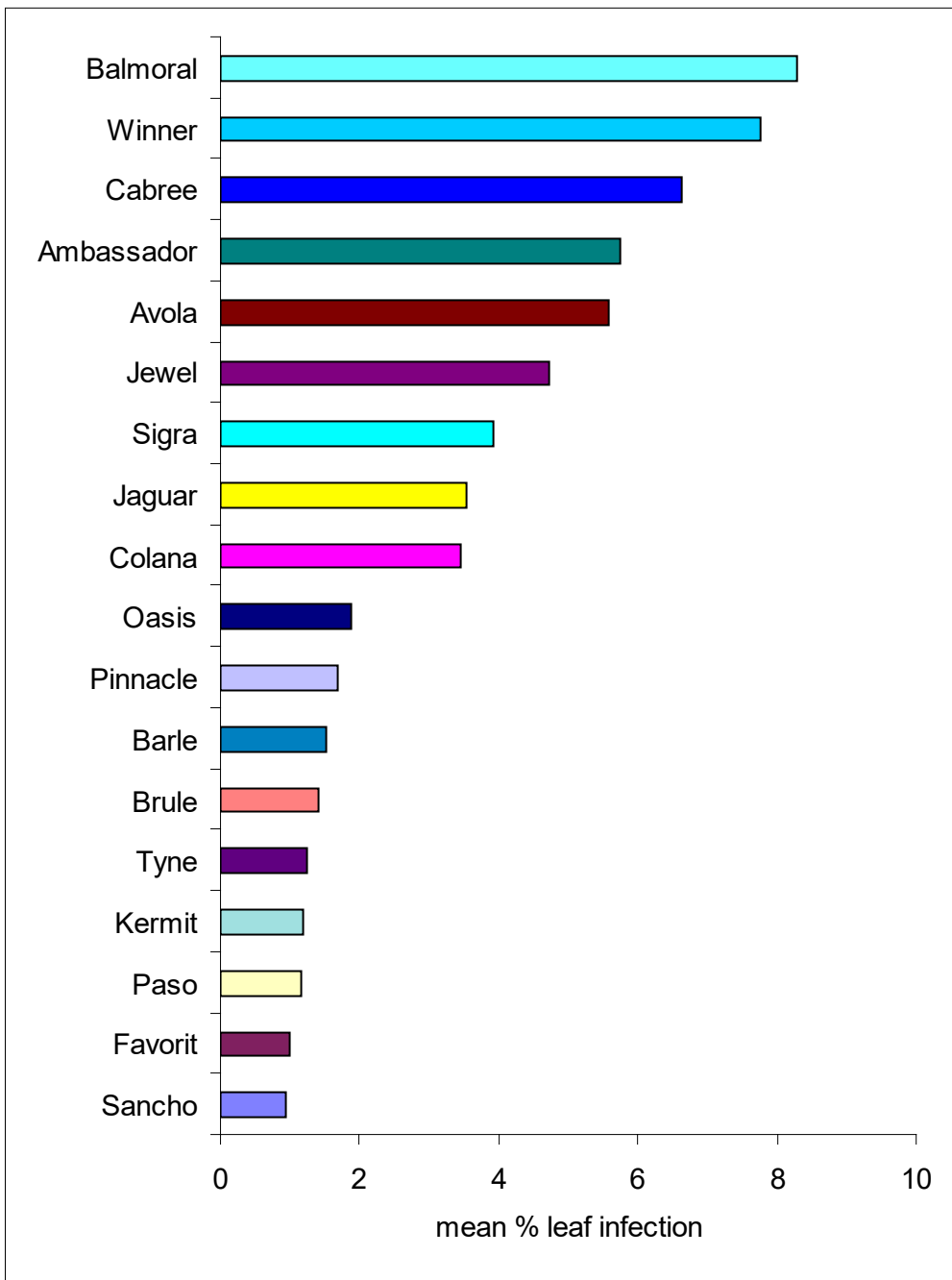
Disease assessments were made immediately before the T<sub>2</sub> timing and were based on leaf area infection of five position in each plot as described in section (a). At the pod full stage (gs 205) fifteen plants were selected from each plot and the percentage leaf and stem infection was made on the top, middle and bottom thirds of each plant. The mean values of each section were calculated.

## Results

### a) Varietal field resistance to downy mildew

The disease assessment figures from the field trials shown graphically in Figure 1 are the combined scores for each assessment date and trial site. The complete data sets are shown in Appendix 1.

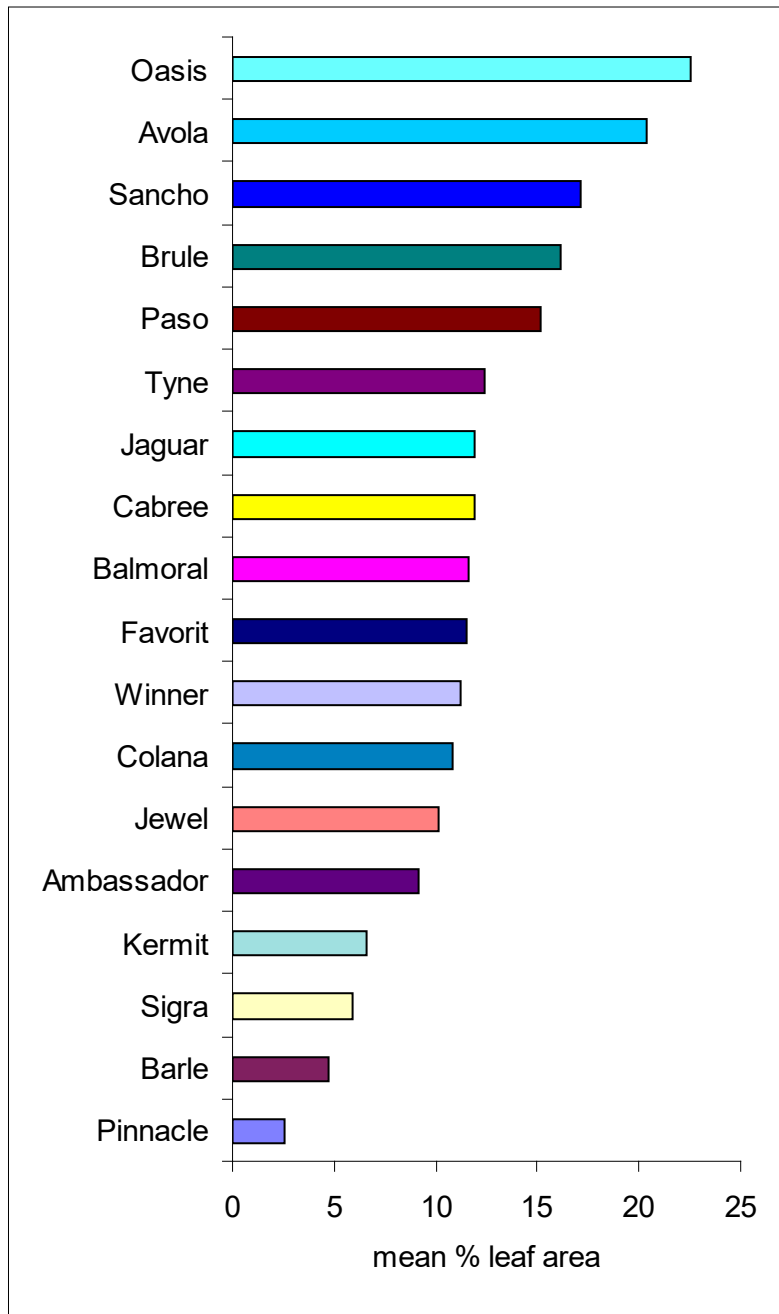
Figure 1. Disease infection levels of varieties in field trials.





The disease assessments from the polythene tunnel are shown in Figure 2 and are the means of the three assessments. The complete data set is shown in Appendix 2.

Figure 2. Disease infection levels of varieties in the polythene tunnel.



## b) Comparison of seed treatments

The results of the seed treatment trials are shown in Tables 5, 6 and 7. Diseases levels were low at Gypsy Bridge and very low at Gosberton. Although diseases assessments were made on two occasions during the season, at those sites, only one was made at Manea because of the extremely low incidence of downy mildew.

None of the seed treatments had any effect on seedling emergence, but the Apron Elite reduced mildew infection early in the season. Variable results were obtained from the Triple Pea Treatment and Apron Combi performed poorly.

**Table 5. Seed treatment trial - Gypsy Bridge 1999**

Treatment	Seedling emergence/m <sup>2</sup> (30.4.99)	% leaf infection (26.5.99)	% leaf infection (16.6.99)
Hy-TL	83.8	3.10	0.72
Apron Combi	83.1	1.70	0.75
Apron Elite	93.0	0.24	0.39
Expt. 1 Triple Pea Treatment	80.4	2.44	0.65
LSD @ p=0.05	18.6(nsd)	2.41(nsd)	1.09(nsd)
coefficient of variation %	16.4	81.3	116.0

**Table 6. Seed treatment trial - Gosberton**

Treatment	Seedling emergence/m <sup>2</sup> (18.5.99)	% leaf infection (16.6.99)	% leaf infection (16.7.99)
Hy- TL	133.2	2.18	0.12
Apron Combi	130.8	1.28	0.13
Apron Elite	131.1	0.29	0.30
Expt. 1 Triple Pea Treatment	137.0	0.26	0.07
LSD @ p=0.05	13.25(nsd)	0.91(sig)	0.25(nsd)
coefficient of variation %	7.4	71.6	112.1

**Table 7. Seed Treatment - Manea 1999**

Treatment	Seedling emergence/m <sup>2</sup> (12.5.99)	% leaf infection (30.6.99)
Hy-TL	98.9	0.18
Apron Combi	97.5	0.17
Apron Elite	97.2	0.27
Expt. 1 Triple Pea Treatment	101.1	0.26
LSD @ p=0.05	19.16(nsd)	0.18(nsd)
coefficient of variation %	14.3	65.8

### c) Foliar treatments

The data from the foliar treatment trials are shown in Tables 8, 9 and 10. Disease had developed early in the season at all of the sites, but the site at North Wootton was affected by the hot dry weather conditions during July and secondary disease development was severely restricted.

Table 8. Foliar treatments - North Wootton.

Treatment	% leaf area infected				
	whole plant (13.7.99)	top of plant (26.7.99)	middle	bottom	mean infection
1. untreated	0.08	0.60	0.88	4.80	2.10
2. Aliette	0.07	0.44	0.83	5.08	2.12
3. Aliette + Agral	0.02	0.40	1.61	6.00	2.67
4. Invader	0.06	0.53	0.58	4.28	1.80
5. Bravo 500	0.09	0.51	0.92	4.57	2.00
6. Thiovit	0.04	0.37	0.83	5.55	2.25
LSD @ p=0.05	0.09(nsd)	0.54(nsd)	0.77(nsd)	1.34 (nsd)	0.70 (nsd)
coefficient of variation %	97.7	75.6	53.7	17.6	21.5

Variety: Tristar

Treatment T<sub>1</sub> applied 24.6.99 gs 107  
 Treatment T<sub>2</sub> applied 8.7.99 gs 206

Table 9. Foliar treatments - Spilsby 1999

Treatment	% leaf area infected				
	whole plant (13.7.99)	top of plant (27.7.99)	middle	bottom	mean infection
1. untreated	1.88	1.79	2.17	1.87	1.94
2. Aliette	0.25	1.28	1.38	2.77	1.81
3. Aliette + Agral	0.35	0.65	1.73	0.97	1.12
4. Invader	0.82	1.15	1.50	2.25	1.63
5. Bravo 500	0.85	1.53	1.80	2.88	2.07
6. Thiovit	1.01	2.33	1.48	2.04	1.95
LSD @ p=0.05	1.01(sig)	1.58(nsd)	0.99(nsd)	1.91(nsd)	1.09(nsd)
coefficient of variation %	78.0	72.0	39.0	59.6	41.3

Variety: Walsingham

Treatment T<sub>1</sub> applied 25.6.99 gs 201  
 Treatment T<sub>2</sub> applied 8.7.99 gs 206

Table 10. Foliar treatments - Market Weighton 1999

Treatment	% leaf area infected				
	whole plant (6.7.99)	top of plant (27.7.99)	middle	bottom	mean infection
1. untreated	0.58	6.20	4.23	5.30	4.23
2. Aliette WDG	0.44	3.60	3.43	6.05	3.44
3. Aliette WDG + Agral	0.99	6.08	3.72	5.63	3.89
4. Invader	0.57	3.67	3.20	4.82	5.04
5. Bravo 500	1.50	2.44	3.58	5.23	4.58
6. Thiovit	0.72	3.32	3.38	5.45	5.25
LSD @ p=0.05	0.90(nsd)	4.17(nsd)	2.30(nsd)	2.57(nsd)	2.61(nsd)
coefficient of variation %	74.4	65.5	42.5	31.5	39.2(nsd)

Variety: Puget

Treatment T<sub>1</sub> applied 22.6.99 gs 201  
 Treatment T<sub>2</sub> applied 6.7.99 gs 203-4

## CONCLUSIONS

In the second year of the project, varieties of vining peas again exhibited a range of tolerance to downy mildew in both the field trials and in the inoculated polythene tunnel trial. However, there were some inconsistencies between some of the varieties in their tolerances between the field and tunnel tests and this further suggests that different populations of downy mildew 'strains' exist between the sites. However, some varieties showed a high degree of tolerance overall, namely Pinnacle, Barle and Kermit.

Disease levels in the seed treatment trials were generally low and some variable results were obtained. However, Apron Elite, continued to provide good levels of disease reduction, reinforcing the need to use alternatives to the single metalaxyl ingredient in Apron Combi.

Foliar treatments were generally disappointing. Aliette WDG with or without Agral wetter reduced infection at one site, but appeared to have little effect at the others. Other products had less effect at all sites.

## APPENDIX 1

### Varietal resistance to downy mildew - field trials 1999

Variety	% leaf area infection						Mean
	Gypsy Bridge		Gosberton		Manea		
	assmt 1 (26.5.99)	assmt 2 (16.6.99)	assmt 1 (16.6.99)	assmt 2 (16.7.99)	assmt 1 (30.6.99)	assmt 2 (19.7.99)	
Assmt date:							
Ambassador	20.3	11.2	0.5	0.25	2.15	0.25	5.75
Avola	21.0	5.0	0.75	0.38	2.0	3.13	5.58
Balmoral	34.0	10.5	1.0	1.5	1.63	1.12	8.29
Barle	2.5	3.0	0.12	0.62	0.75	2.15	1.52
Brule	6.0	0.5	0.62	0.62	0.12	0.62	1.41
Cabree	9.0	21.5	1.0	0.38	3.5	4.5	6.64
Coloma	12.0	2.5	1.5	4.12	0	0.5	3.44
Favorit	3.75	1.0	0.12	0.62	0.25	0.25	1.00
Jaguar	12.0	4.5	1.0	0.12	2.0	1.63	3.54
Jewel	11.0	12.5	0.12	0.5	4.12	0.12	4.73
Kermit	3.12	1.0	0	2.12	0.38	0.5	1.19
Oasis	5.5	2.25	0.75	0.38	1.50	1.0	1.89
Paso	0.62	1.0	0.25	3.0	2.0	0	1.15
Pinnacle	2.0	7.0	0.25	0.75	0.12	0	1.68
Sancho	2.5	1.12	1.0	0.25	0	0.75	0.94
Sigra	5.5	9.0	0.38	8.0	0	1.12	3.91
Tyne	1.12	0.12	0.12	0.62	0.5	5.0	1.25
Winner	27.75	16.63	0.62	3.25	2.38	2.75	7.77
LSD @ p=0.05							5.16(sig)
Coefficient of variation %							66.0

## APPENDIX 2

### Varietal resistance to downy mildew - polythene tunnel 1999

	% leaf area infected			
	1 <sup>st</sup> ass	2 <sup>nd</sup> ass	3 <sup>rd</sup> assmt	mean
Ambassador	3.5	8.1	16.1	9.2
Avola	9.8	11.8	39.5	20.4
Balmoral	5.5	7.2	22.0	11.6
Barle	1.2	0.9	12.1	4.7
Brule	3.4	13.2	31.8	16.1
Cabree	3.1	5.9	26.8	11.9
Coloma	2.2	5.9	24.3	10.8
Favorit	4.5	11.5	18.3	11.5
Jaguar	6.5	8.1	21.1	11.9
Jewel	5.5	6.1	18.8	10.1
Kermit	3.0	5.4	11.5	6.6
Oasis	17.5	13.8	36.3	22.5
Paso	8.2	13.0	24.3	15.2
Pinnacle	0.5	1.8	5.5	2.6
Sancho	1.2	8.4	41.8	17.1
Sigra	1.8	2.3	13.8	5.9
Tyne	5.8	4.4	27.1	12.4
Winner	3.0	7.5	23.0	11.2
LSD @ p=0.05	5.61(sig)	6.81(sig)	17.53(sig)	
Coefficient of variation %	82.4	63.1	53.2	