

# HORTICULTURE RESEARCH INTERNATIONAL

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Susceptibility of 42 apple varieties  
to pests and diseases, 1998

*Undertaken for APRC*

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## Susceptibility of 42 apple varieties to pests and diseases, 1998

### Summary

A replicated field experiment to evaluate the susceptibility of 42 apple varieties to pests and diseases was planted at Poultry Farm, Marden, in February 1998. There are four replicates and each plot consists of two adjacent trees. The varieties (M9 rootstock) are:

1. A567/19	15. Egremont Russet	29. Prima
2. A931/15	16. Falstaff	30. Princess
3. A93/16	17. Fiesta	31. Priscilla
4. Antonoulka	18. Florina	32. Red Charles Ross
5. Belle de Boscoop	19. Freedom	33. Red Elison's Orange
6. Ceeval	20. Goldrush	34. Red Fortune
7. Delorina	21. Greensleeves	35. Redfree
8. Discovery	22. Herrings Pippin	36. Regent
9. Double Red Wealthy	23. Judeline	37. Saturn
10. E11/20	24. King of the Pippins	38. Sir Prize
11. E83/4	25. Liberty	39. Vanda
12. E210/198	26. Lord Lambourne	40. Wealthy
13. Early Victoria	27. Mother	41. Winston Red Sport
14. Edward VII	28. Northern Greening	42. Wyken Pippin

Foliar sprays were not applied in 1998. Infestations of pests and diseases and the damage caused by them were assessed on 22-23 June and 1-2 October 1998. The newly planted trees broke bud late and bore little or no fruit in 1998.

The incidence of scab was very small because the levels of inoculum present initially were very low. Traces of scab were present on many of the varieties, including two believed to be resistant (Discovery and Florina) but absent on a variety known to be susceptible (Egremont Russet). No scab was recorded on the varieties Antonoulka, Egremont Russet, Freedom, Lord Lambourne, Northern Greening, Prima, Priscilla, Redfree, Saturn, Vanda and Wealthy. Conclusions about the relative susceptibility of the varieties to scab cannot be drawn safely from the results obtained in the first year of the experiment. All varieties were infected with secondary mildew to a greater or lesser extent but there were no statistically significant varietal differences in the incidence of infection. Differences in the growth rates of the trees during establishment influenced the degree of mildew infection. Several further full seasons are needed for scab and mildew to establish fully so that the differences in varietal susceptibility can be determined. Fungal leaf spotting was not recorded on any of the trees of the varieties A93/16, Early Victoria, Lord Lambourne and Wyken Pippin. Antonoulka, E210/198, Freedom, Priscilla, Red Fortune and Regent had a high incidence of leaf spotting. Sooty blotch infection was seen on fruits of the varieties A567/19, Delorina, Double Red Wealthy, Egremont Russet, Falstaff, Fiesta, Freedom, Judeline, Prima and Saturn. It was most frequent on A567/19, Delorina, Falstaff and Prima.

The most numerous insect pests were leaf hoppers and apple leaf midge. Differences in the susceptibility of varieties to leaf hoppers were apparent. Antonoulka, Edward VII, Florina, Herrings Pippin, King of the Pippins and especially

Lord Lambourne were damaged the most severely. However, there were no differences in the percentage of leaves in shoot terminals damaged by apple leaf midge. Severe rosy apple aphid infestations were recorded on one individual tree of the varieties E210/198, Freedom, King of the Pippins, Lord Lambourne and Northern Greening and on two trees of A567/19, but no infestation was recorded on the other varieties. Leaf mines caused by a number of species of leaf mining moths and damage caused by the apple leaf skeletonizer were present but distributed erratically. However, blotch leaf mines caused by larvae of the leaf mining moth *Stigmella pomella* were conspicuous on the variety Winston Red Sport.

Spider mite was recorded in very small numbers on the varieties A931/15, A93/16, Ceeval, Discovery, E83/4, Early Victoria, Edward VII, Fiesta, Goldrush, Liberty, Mother, Prima, Princess, Priscilla and Vanda at the first assessment but was absent on the other varieties and on all varieties at the second assessment. The largest numbers were recorded on Edward VII with much lower numbers on the other varieties. The rapid establishment of the orchard predatory mite *Typhlodromus pyri* regulated the pest naturally and prevented significant populations or damage from developing. There were no significant differences in the degree of infestation by apple rust mite or foliar bronzing.

## **Introduction**

There is strong and increasing market demand for organically produced apples and other fruits in the UK and this demand is currently being satisfied only partially, mainly by imports. UK organic fruit production is on a very limited scale and it is recognised widely that methods of organic apple production for UK conditions are totally inadequate.

Almost all varieties of apple grown in modern conventional top fruit production are highly susceptible to pests and diseases and intensive programmes of sprays of insecticides and fungicides are applied to avoid economic damage. However, the use and range of insecticides and fungicides is restricted severely by organic production rules. The United Kingdom Register of Organic Food Standards (UKROFS) (1997 edition) permits the use of sprays of pyrethrins, derris, quassia, potassium soap, *Bacillus thuringiensis* and granuloviruses for pest control and of copper and sulphur for disease control. These products are of only very limited efficacy against the major pests and diseases of apple. Failure to control pests and diseases effectively is the main reason why methods of organic fruit production are inadequate.

Organic apple production is only likely to be successful if apple varieties with resistance, low susceptibility or tolerance to important pests and diseases are used. Resistance, low susceptibility or tolerance to scab and mildew are particularly important as these are debilitating diseases to which the plant is susceptible throughout most of the growing season and which require programmes of sprays to control them effectively.

An important objective in the development of successful methods of organic apple production for the UK is to identify a range of dessert apple varieties of acceptable quality, including taste and appearance (for direct consumption and processed markets), with resistance to apple scab and low susceptibility to mildew. Varieties with a range of seasons and storage potentials, including some with medium to long-term storage potential, are needed. The aim should be to enable the market to be supplied with apples produced organically in the UK for at least 6 months of the

year; yields and quality should be broadly similar to those achieved in conventional production.

A replicated field experiment planned to last at least three years was planted in March 1998 to determine the susceptibility of 42 apple varieties to pests and diseases. The varieties were chosen by Dr D. Pennell, Brogdale Horticultural Trust, as being potentially suitable for organic production using a range of criteria, though information about their susceptibility to pests and diseases was limited.

The results obtained in the first season are reported in this paper.

## **Methods and materials**

The experiment was planted on 16 February 1998 with two- year- old nursery trees supplied by the Brogdale Horticultural Trust. It consists of 8 rows of 42 trees. The rows are spaced 10 feet (= 3.05 m) apart with a spacing of 5 feet (= 1.52 m) between trees in the row. The design of the experiment is a randomised block with four replicates. Each plot consists of two adjacent trees in a row. Hence each row contains 21 plots. No foliar sprays of plant protection products or nutrients have been applied to the trees which were mulched with straw in June 1998.

The incidence of pests and diseases and the damage caused by them on each tree were assessed on 22-23 June and 1-2 October 1998. The methods of assessment were tailored to the range and levels of pests and diseases present. The assessment methods used are shown in Table 1. Data were collated and analysed statistically by ANOVA where appropriate.

### **Table 1. Assessment methods for pests and diseases**

<b>Pest/disease</b>	<b>Assessment method per tree</b>
<i>First assessment (22-23 June 1998)</i>	
Apple leaf midge	Nos. of infested leaves in terminal of each of 2 shoots recorded
Rust mite	Nos. of mites on each of 2 leaves scored into categories:- 0 = 0, 1 = ≤ 5, 2 = 6-25, 3=26-100, 4 = >100 mites per leaf
Spider mite	Nos. mites on each of 2 leaves recorded
Leaf hopper	Leaf speckling damage scored:- 0 = 0, 1 = trace, 2 = slight, 3 = moderate, 4 = severe
Mildew	Nos. out of 5 youngest leaves infected in one shoot recorded
Scab	Presence of scab on one shoot and on whole tree recorded
Other diseases	Presence or absence on tree recorded
<i>Second assessment (1-2 October 1998)</i>	
Apple leaf midge	Nos. infested leaves in terminal of each of 2 shoots recorded
Mite bronzing	Leaf bronzing damage scored:- 0 = none, 1 = trace, 2 = slight, 3 = moderate, 4 = severe
Leaf hopper	Score leaf speckling damage:- 0 = 0, 1 = trace, 2 = slight, 3 = moderate, 4 = severe
Other pests	Presence or absence on tree recorded
Mildew	Nos. out of 5 youngest leaves infected in one shoot recorded
Scab	Presence of scab on one shoot and on whole tree recorded.
Other diseases	Record presence or absence on tree

## **Results and discussion**

*Scab:* The 1998 season was very favourable for scab infection. However, the newly planted trees were sprayed with fungicides in the nursery and thus had only very low levels of infection initially. They broke bud late, in May, after the main early scab infection periods and, thus, the opportunity for development of scab during the season was curtailed. Levels of scab were low or zero, even on variety Egremont Russet which is known to be susceptible to scab. For this reason, results are presented as the numbers of trees out of 8 on which scab was present (Table 2). Scab was not recorded on the varieties Antonoulka, Egremont Russet, Freedom, Lord Lambourne, Northern Greening, Prima, Priscilla, Redfree, Saturn, Vanda or Wealthy. Traces of scab were present on two varieties known to be resistant or partially resistant to scab viz. Discovery and Florina. Conclusions about the relative susceptibility of the varieties to scab cannot be drawn safely from these first years' results as the incidence of scab was too erratic. Several further full seasons are needed for the disease to establish fully so that the differences in varietal susceptibility can be determined.

*Mildew:* All varieties were infected with secondary mildew to a greater or lesser extent (Table 2). Analysis of variance revealed no statistically significant differences in the percentage of leaves in shoot terminals infected. The amount and vigour of shoot growth varied greatly from tree to tree due to the variability in the growth of trees during establishment. This influenced the degree of mildew infection, making it difficult to identify differences in varietal susceptibility to mildew. Several further full seasons are needed for the disease to establish fully and differences in varietal susceptibility to be determined. It is possible that the method of assessment might be

improved to take into account the intensity of infection as well as its incidence. The susceptibility of a wide range of apple cultivars in the Brogdale collection to mildew was reported by Alston (1969). Most of the varieties in the current experiment were not present in his evaluation. However, Alston (1969) scored the varieties Mother and Charles Ross as having a 'reasonable level' of field resistance. Belle de Boscoop, Edward VII, Elison's Orange, Lord Lambourne and Wealthy were scored as being more susceptible.

*Leaf spots.* Fungal leaf spotting was present on the foliage of most varieties, though the fungal pathogens responsible have not been identified as the fungi do not sporulate readily. Leaf spotting was not recorded on any of the trees of the varieties A93/16, Early Victoria, Lord Lambourne and Wyken Pippin. Varieties with a higher incidence of leaf spotting (present on 5 or more out of 8 trees) were Antonoulka, E210/198, Freedom, Priscilla, Red Fortune and Regent.

*Sooty blotch.* Sooty blotch infection was seen on fruits of the varieties A567/19, Delorina, Double Red Wealthy, Egremont Russet, Falstaff, Fiesta, Freedom, Judeline, Prima and Saturn. It was most frequent on A567/19, Delorina, Falstaff and Prima.

*Leaf hopper:* Leafhoppers (*Edwardsiana* spp.) were abundant and caused characteristic leaf speckling to a greater or lesser extent on all varieties (Table 2). Analysis of variance of the leafhopper damage scores was not appropriate because the damage categories were too few and did not represent damage in regularly increasing amounts. However, the scoring did indicate which trees were affected more severely by leafhoppers. Most or all trees of several varieties had moderate or severe leafhopper damage. Varieties with 5 or more trees out of 8 in the moderate (score 3) or severe (score 4) damage categories at the first and/or the second assessment were: Antonoulka, Edward VII, Florina, Herrings Pippin, King of the Pippins and Lord Lambourne. The latter variety was particularly badly affected.

*Rust mite:* Analysis of variance did not revealed statistically significant differences in the mean scores of the numbers of apple rust mite present at the first assessment, or the severity of leaf bronzing at the second assessment (Table 2). Varieties with a high mean score ( $\geq 2.5$ ) for the numbers of rust mite present at the first assessment (i.e. Edward VII, Herrings Pippin, Princess) did not necessarily have higher than average ( $> 1.4$ ) bronzing scores at the second assessment. The orchard predatory mite *Typhlodromus pyri* may have established more rapidly where the numbers of rust mite were higher earlier in the season and regulated rust mite earlier to prevent bronzing in the latter part of the season.

*Fruit tree red spider mite.* Very small numbers of spider mite were recorded on the varieties A931/15, A93/16, Ceeval, Discovery, E83/4, Early Victoria, Edward VII, Fiesta, Goldrush, Liberty, Mother, Prima, Princess, Priscilla and Vanda at the first assessment. However, the mite was absent on the other varieties and on all the varieties at the second assessment. The greatest numbers (3.1/leaf) were recorded on Edward VII with much lower ( $< 1.1$ /leaf) on the other varieties. The rapid establishment of the orchard predatory mite *Typhlodromus pyri* regulated the pest naturally and prevented significant populations and damage developing.

*Leaf midge*: All varieties were susceptible to apple leaf midge. There were no statistically significant differences in the numbers of terminal leaves infested. Variations appeared to be due largely to the differences in the availability of young leaves for the midge to infest.

*Other pests*: Severe rosy apple aphid, *Dysaphis plantaginea*, infestations were recorded on one individual tree of the varieties E210/198, Freedom, King of the Pippins, Lord Lambourne and Northern Greening and on two trees of A567/19. Green apple aphid was recorded on one tree of the variety Discovery. Leaf mines caused by the apple leaf miner, *Lyonetia clerkella*, were present on all varieties except Regent and King of the Pippins. Their absence probably reflects the erratic distribution of the pest rather other factors such as varietal resistance. Leaf mines caused by *Phyllonorycter blancardella* and characteristic damage caused by the apple leaf skeletoniser, *Euromula pariana*, were common but erratic. Their abundance was not associated with particular varieties. However, blotch leaf mines caused by larvae of the leaf mining moth *Stigmella pomella* were consistently numerous on the variety Winston Red Sport.

### **General conclusions**

Low susceptibility to the diseases scab and mildew are key attributes for apple varieties suitable for organic production. It is probable that significant differences in susceptibility to diseases exist amongst the 42 varieties being evaluated and these differences are likely to become increasingly apparent in future years of the trial. Differences in the susceptibility of the varieties to certain pest species are becoming apparent and it is likely that further important information will be gathered in future years of the experiment.

### **Acknowledgements**

We are grateful to Dr David Pennell, Brogdale Horticultural Trust who initiated the experiment, chose and propagated most of the varieties included. We also thank Peter Hall, Target Farm, Marden, for his enthusiastic support, including provision of the site for the trial, planting and horticultural maintenance.

### **Reference**

Alston, F. H. (1969). Response of apple cultivars to mildew, *Podosphaera leucotricha*. *Report of East Malling Research Station for 1968*, 133-135.



**Table 2. Levels of scab, mildew, leafhopper damage, rust mite and damage and leaf midge damage**

Variety	Leaf scab (Nos. trees out of 8 with scab present)		Mildew (mean nos. leaves infected/5)		Leaf hopper (mean damage score)		Rust mite		Leaf midge (mean nos. of leaves infested in 2 shoot terminals)	
	22-23 June	1-2 Oct	22-23 June	1-2 Oct	22-23 June	1-2 Oct	Nos. mites Score	Bronzing score	22-23 June	1-2 Oct
A567/19	2	1	3.8	2.5	1.5	2.4	0.9	1.1	0	8.4
A931/15	2	0	2.6	1.5	1.9	1.9	1.9	1.3	2.4	9.4
A93/16	0	1	2.6	3.5	1.5	2.4	2.3	1.1	1.0	8.5
Antonoulka	0	0	3.4	2.8	1.9	2.6	1.5	1.0	2.3	8.1
Belle de Boscoop	2	2	2.6	0.3	2.0	1.8	1.8	1.5	0.9	9.4
Ceeval	2	0	3.8	1.8	1.3	1.8	1.5	1.5	0.4	9.4
Delorina	1	3	4.1	4.0	0.9	1.8	1.3	0.6	1.1	7.6
Discovery	1	2	2.6	2.3	1.5	2.1	1.0	2.0	0.4	9.8
Double Red Wealthy	1	0	4.5	3.3	1.4	1.9	1.0	1.9	0.6	5.5
E11/20	0	2	2.9	2.1	1.7	2.0	0.8	1.9	0.3	9.4
E83/4	1	0	3.4	3.1	2.3	2.1	2.0	1.6	0.5	10.0
E210/198	3	4	3.1	1.5	1.5	2.0	0.8	1.6	1.6	9.5
Early Victoria	0	1	3.9	4.0	1.1	2.3	0.3	1.1	0.6	10.0
Edward VII	1	1	3.8	3.6	1.5	2.9	2.7	1.5	0.8	9.3
Egremont Russet	0	0	2.5	1.3	1.8	2.3	1.4	1.4	0.6	9.3
Falstaff	0	1	2.7	0.6	1.1	1.9	1.3	1.3	0	10.1
Fiesta	2	4	3.5	2.1	2.5	2.5	1.8	1.5	1.0	9.9
Florina	1	1	2.3	1.9	1.4	2.9	1.3	1.0	2.0	9.9
Freedom	0	0	1.4	1.9	2.1	2.1	1.7	1.3	0.1	9.8

Variety	Leaf scab (Nos. trees out of 8 with scab present)		Mildew (mean nos. leaves infected/5)		Leaf hopper (mean damage score)		Rust mite		Leaf midge (mean nos. of leaves infested in 2 shoot terminals)	
	22-23 June	1-2 Oct	22-23 June	1-2 Oct	22-23 June	1-2 Oct	Nos. mites Score	Bronzing score	22-23 June	1-2 Oct
Goldrush	0	2	2.8	1.0	1.9	2.5	1.7	1.1	1.4	9.9
Greensleeves	0	1	3.4	1.8	1.6	1.5	1.3	1.4	0	10.0
Herrings Pippin	0	1	3.6	3.0	2.9	2.9	3.1	0.8	1.8	8.6
Judeline	1	2	3.8	2.9	1.4	2.3	1.7	1.3	0.3	9.6
King of the Pippins	1	2	2.9	3.4	2.6	2.6	2.0	1.0	0.4	9.8
Liberty	0	1	4.1	4.0	1.4	2.3	1.6	1.6	0.5	9.9
Lord Lambourne	0	0	2.3	2.1	2.9	3.4	2.3	1.6	0.5	9.8
Mother	0	1	3.4	1.4	1.1	1.3	0.7	1.0	0.5	9.6
Northern Greening	0	0	4.0	3.0	1.6	1.8	1.7	1.6	1.1	8.4
Prima	0	0	3.8	2.6	1.8	2.8	2.2	2.0	1.1	9.4
Princess	2	3	3.3	4.4	1.1	2.3	2.5	1.9	1.1	9.5
Priscilla	0	0	4.3	3.3	1.6	2.5	0.7	1.3	1.4	9.3
Red Charles Ross	1	1	4.3	1.5	1.6	2.8	1.8	1.8	0.5	9.9
Red Ellison's Orange	1	0	3.3	2.3	1.6	2.3	1.3	1.3	1.0	7.8
Red Fortune	0	2	2.8	0.8	1.6	2.4	2.0	1.0	0.9	9.5
Redfree	0	0	3.4	2.0	1.4	1.9	1.7	1.9	1.3	8.6
Regent	1	2	3.9	2.0	1.1	1.8	2.1	1.4	0.8	9.8
Saturn	0	0	4.1	3.0	1.5	2.3	1.7	1.5	0.3	8.0
Sir Prize	0	3	3.1	3.1	1.8	2.4	1.6	0.8	0.9	9.5
Vanda	0	0	3.3	2.5	1.5	1.6	0.1	0.6	1.9	10.0
Wealthy	0	0	3.3	0	2.0	1.8	1.0	1.4	0	7.9
Winston Red Sport	2	3	4.3	3.0	2.0	2.4	1.9	1.9	0.3	9.6
Wyken Pippin	1	2	3.3	1.4	1.6	1.6	1.5	0.9	0	10.0
SED (123 df)	-	-	1.01	1.17	-	-	0.86	0.63	0.77	1.05

