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Project leader: Mr Jerry V. Cross
Horticulture Research International
East Malling
West Malling
Kent
ME19 6BJ

Key workers: Jerry Cross, Angela Berrie (HRI-East Malling)

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Grower Summary

Headline

The relative susceptibility of over 70 apple varieties to the most important pests and diseases has been quantified; 42 varieties over 5 years and 29 varieties over 2 years, in the unsprayed or minimal spray situation.

Varieties amongst the 70 that are moderately or highly susceptible to scab, mildew or leaf spot (which was found to cause infection on fruits on some varieties) are not an appropriate choice for organic apple production.

Many varieties were found to be of low susceptibility to scab, of low or moderate susceptibility to mildew and not to suffer severe infection of fruit by leaf spot. Any of these might be appropriate for organic apple production providing they meet market requirements for quality.

Background and deliverables

The objective of this project was to evaluate the susceptibility of 70 apple varieties to pests and diseases to identify those of low susceptibility to help choice of varieties suitable for organic apple production. These varieties were chosen for evaluation because they were claimed or believed to be disease resistant.

Summary of the project and main conclusions

In the first 2 years of this project (2001-2002), assessments were undertaken on a purpose-planted replicated trial of 42 varieties at Poultry farm, Marden, Kent continuing work done in a previous 3 year project. As exhaustive information had been gained on the original 42 varieties, it was decided to make assessments on 29 other varieties in two existing variety trials at HRI East Malling, plot TL159 containing 23 varieties and plot VF214 containing 6 varieties, in 2003. Fortuitously, pest and disease assessments had been made in TL159 in July-August 2000 and the results of these are included in this report.

Scab: Results have indicated the following classification of scab susceptibility:

Selections & Varieties of low or very low susceptibility to scab:

A567/19, A931/15, A93/16, Antonoulka, COOP37-2, DL11, DL13, DL 33, Dantes Delorina, Discovery, Dublet, E11/20 (released as Park Farm Pippin), Early Victoria, Edward VII, Florina, Freedom, Goldrush, Judeline, Julia, King of the Pippins, Lord Lambourne, Melodie, Mother, Nabella, Otava, Prima, Princess, Priscilla, Rajka, Realka, Reanda, Red Fortune, Redfree, Reglindis, Reka, Relinda, Resista, Retina, Rosana, Rubinola, Saturn, Selena, Sir Prize, Topas, Vanda, Vesna, Viktoria (Airof and Rotjki clones), Wyken Pippin.

Selections & Varieties of high susceptibility to scab:

Angold, Delor, Denar, E210/198, Egremont Russet, Fiesta, Greensleeves, Northern Greening, Regent, Winston Red Sport.

Conclusion/recommendation:

Scab is the most important disease and one of the main limiting factors in organic apple production. Choosing varieties of very low or low susceptibility to scab and avoiding susceptible varieties is important to successful production without heavy reliance on copper and sulphur sprays. The varieties of low or very low susceptibility to scab are suitable for organic production from this point of view. The varieties of high susceptibility are unsuitable.

Mildew: The following classification of mildew susceptibility has been derived:

Selections & Varieties of high susceptibility to mildew:

A567/19, Ceeval, Delorina, E83/4, Freedom, Goldrush, Julia, King of Pippins, Northern Greening, Princess, Priscilla, Sir Prize, Vanda, Vesna and Wyken Pippin.

Selections & Varieties of low or very low susceptibility to mildew:

Denar, DL121, DL13, Discovery, E11/20 (now Park Farm Pippin), Early Victoria, Edward VII, Falstaff, Florina, Greensleeves, Herrings Pippin, Judeline, Lord Lambourne, Prima, Rajka, Red Ellison, Red Fortune, Redfree, Relinda, Saturn, Viktoria (Airot and Rotjki clones), Wealthy.

Conclusion/recommendation:

Mildew is an important disease in organic apple production, though control can be achieved in areas of low to moderate risk by removal of primaries coupled with sulphur spray programmes. Avoiding varieties of high susceptibility to mildew is important to successful production. The varieties of high susceptibility should be avoided if possible.

Leaf spot: Fungal leaf spots (apparently caused by *Phoma* sp.) are minor diseases in conventional apple production as they are controlled by fungicide sprays for scab and mildew. In organic apple production they are more important because they are not controlled adequately by sulphur or copper sprays applied for scab or mildew control. The varieties E11/20 (now Park Farm Pippin), Early Victoria, Falstaff, Julia, Northern Greening, Retina, Selena, Vesna and Winston Red Sport had a high incidence of leaf spot. Julia, Mother, Northern Greening, Retina, Selena, Vesna and Winston Red Sport have proved consistently susceptible to leaf spot. Infection was found also on the fruits at high levels on the varieties Early Victoria, Falstaff and Vesna, a potential problem with organic production of these varieties.

Rosy apple aphid: Varieties of high susceptibility to rosy apple aphid are Boscoop, Discovery, Egremont Russet, Greensleeves, Northern Greening and Vanda. No rosy apple aphid has been found on Goldrush in any of five years. This does not mean it is necessarily completely resistant as infestation by the pest is sporadic and patchy. It might have escaped infestation partly (or wholly) through random chance.

Crop load: Over the four year cropping period of 42 of the varieties assessed, Judeline and Prima had by far the highest total crop load, bearing a total of well over 200 apples per tree. Falstaff, Greensleeves and Priscilla have also cropped well with a total of over 150 fruits per tree. Antonoulka, Edward VII, Mother and Northern Greening have cropped poorly, bearing a total of less than 50 fruits per tree over the 4 year cropping period.

Financial benefits

Choice of resistant varieties is crucial for successful organic production in the UK. The benefits of correct choice of variety are manifold. In simple terms, susceptible varieties grown organically might require over 100 kg of sulphur and 15 litres of 50% w/w copper oxychloride to be applied per ha per annum to maintain often only partial disease control, costing £130/ha per annum. However, this is a gross underestimate of the possible benefits of resistant varieties. In the organic apple Horticulture LINK project over 4 years, better control of pests and diseases in experimental apple plots in one orchard resulted in gross average financial outputs of ~ £16, 000 per ha per annum compared to average outputs of < £5,000 per ha per annum in untreated plots.

Action points for growers

- Growers and advisors should use the information on pest and disease susceptibility to guide choice of variety for organic apple production

Science Section

Introduction and objectives

The aim of the work reported here was to determine the susceptibility of 29 apple varieties to pests and diseases in order to identify varieties that are resistant and potentially suitable for organic apple production in the UK. In the first 5 years of the project, assessments were done on a purpose-planted replicated trial of 42 varieties at Poultry farm, Marden, Kent. The results of the first 5 years assessments are reported by Cross & Berrie (2000, 2002 and 2003) and are not included here to avoid repetition. As exhaustive information had been gained on the original 42 varieties, it was decided to make assessments on 29 other varieties in two existing variety trials at HRI East Malling, plot TL159 containing 23 varieties and plot VF214 containing 6 varieties, in 2003. Fortunately, pest and disease assessments had been made in TL159 in July-August 2000 and the results of these are included in this report.

Methods

The experimental plot TL159 at Rocks farm, East Malling contained four replicate single tree plots of each of 23 apple cultivars on M9 rootstocks. The row spacing is 4.0 m and the trees are spaced 1.7 m apart in the rows. No foliar sprays have been applied. The experimental plot VF214 at East Malling (a short distance to the East of the parish church) contains 3 replicate 4 tree plots of 6 other varieties. The plots had received occasional sprays of sulphur as part of its organic management. The incidence of pests and diseases on each plot was scored in July/August 2000 and 2003 by J V Cross (Entomologist) and A M Berrie (Plant Pathologist).

Secondary mildew, leaf scab, fruitlet scab, leaf spot on leaves and fruitlets and rosy apple aphid infestation were scored on a 0-5 severity scale (0 = none and 5 = severely infested/infected). The primary mildew infections and the number of fruits on each tree were counted. For the late season assessment, in order to gain data on late season leaf infection by scab and pests, a sample of 25 leaves was taken from each variety in early October 2003. The severity of scab and leaf spot on each leaf was scored on a 0-5 scale. The percentages of leaves infested with each of the main species of leafminer that occur on apple were also assessed on the following scale: 0=0, 1=1-20, 2=21-40, 3=41-60, 4=61-80, 5=81-100. The mean counts and scores for each variety were calculated for each assessment date and the relative susceptibility of the varieties to scab and mildew and to aphids was categorised.

Results and Discussion

The mean scores and counts are given in Table 1 (summer 2000 assessment on 23 varieties in plot TL159) and Table 2 (summer 2003 assessment on 23 varieties in plot TL159), Table 3 (summer 2003 assessment on 6 varieties in plot VF214) and Table 4 (pre-leaf fall leaf assessments on varieties in plot TL159).

Scab

Most of the 29 varieties appear to be at least moderately resistant to scab. The varieties Angold, Delor, Denar, Dublet, Nabella and Selena were more susceptible and Topaz slightly susceptible to scab. Infection occurred on the leaves and fruits of all varieties except Topaz where only leaf infection was recorded at a low level in 2000. Denar, Dublet, Nabella, Reanda, Relinda Rubinola and Vanda had low levels of scab infection on leaves in early October 2003 prior to leaf fall. It could be that the scab resistance of Reanda, Relinda, Rubinola breaks down when leaves are mature at the end of the season

Mildew

All the varieties were infected by mildew to a greater or lesser extent. Angold, Dantes, Topaz, Vanda and Vesna had the highest levels of infection consistently in the two assessment years.

Leaf spot

Julia, Retina and Vesna had comparatively high levels of leaf spot infection on the leaves in both summer assessments in 2000 and 2003 and in the autumn assessment in 2003. Vesna had the highest levels of infection on the fruits.

Rosy apple aphid

All the varieties were infested with rosy apple aphid in 2000, a bad year for the pest. The patchy nature of this pest makes it difficult to draw conclusions about the relative susceptibility of varieties from just 2 years data.

Other pests and diseases

The low levels and erratic distributions of other pests and diseases mean it is difficult to draw firm conclusions about the relative susceptibility of the different varieties to them.

Conclusions

Scab: Most of the 29 varieties appear to be at least moderately resistant to scab. The varieties Angold, Delor, Denar, Dublet, Nabella and Selena were more susceptible and Topaz slightly susceptible to scab. Infection occurred on the leaves and fruits of all these varieties except Topaz where only leaf infection was recorded at a low level in 2000. Denar, Dublet, Nabella, Reanda, Relinda Rubinola and Vanda had low levels of scab infection on leaves in early October 2003 prior to leaf fall. It could be that the scab resistance of Reanda, Relinda Rubinola breaks down when leaves are mature at the end of the season.

Mildew: All the varieties were infected by mildew to a greater or lesser extent. Angold, Dantes, Topaz, Vanda and Vesna had the highest levels of infection consistently in the two assessment years.

Leaf spot: Julia, Retina and Vesna had comparatively high levels of leaf spot infection on the leaves in both summer assessments in 2000 and 2003 and in the autumn assessment in 2003. Vesna had the highest levels of infection on the fruits.

Rosy apple aphid: All the varieties were infested with rosy apple aphid in 2000, a bad year for the pest. The patchy nature of this pest makes it difficult to draw conclusions about the relative susceptibility of varieties from the 2 years data.

Summary Table - Susceptibility of 29 apple varieties to scab, mildew and leaf spot. Varieties with moderate (M) or high (H) susceptibility to leaf spot scores had leaf spot infection on fruits as well as leaves

| Apple variety | Scab | Mildew | Leaf spot | Apple variety | Scab | Mildew | Leaf spot | Apple variety | Scab | Mildew | Leaf spot |
|---------------|------|--------|-----------|---------------|------|--------|-----------|---------------|------|--------|-----------|
| Angold | H | H | L | Melodie | 0 | M | L | Retina | 0 | M | H |
| COOP37-2 | 0 | M | L | Nabella | L | M | L | Rosana | 0 | H | L |
| Dantes | 0 | M | L | Otava | 0 | M | L | Rubinola | L | M | L |
| Delor | H | M | L | Rajka | 0 | L | L | Selena | M | M | H |
| Denar | H | L | L | Realka | 0 | M | L | Topas | L | M | L |
| DL 33 | 0 | M | L | Reanda | L | M | L | Vanda | 0 | H | L |
| DL11 | 0 | L | L | Reglindis | 0 | M | L | Vesna | 0 | H | H |
| DL13 | 0 | L | L | Reka | 0 | M | L | Vikt Airo | 0 | L | L |
| Dublet | 0 | M | L | Relinda | L | L | L | Vikt Rotjki | 0 | 1 | L |
| Julia | 0 | H | H | Resista | 0 | M | 1 | | | | |

H = high susceptibility, M = moderate susceptibility; L = low susceptibility; 0 = infection not detected

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Table 1. Mean disease and pest scores in plot TL159 in July/August 2000. Leaf spot and sooty blotch assessments on fruits were done on 5 October 2000.

| Variety | Leaf scab | Fruit scab | Leaf mildew | Fruit mildew | Leaf spot on leaf | Leaf spot on fruit | Canker | Sooty blotch | Rosy apple aphid | Green apple aphid | Leaf midge | Leaf minor |
|-----------|-----------|------------|-------------|--------------|-------------------|--------------------|--------|--------------|------------------|-------------------|------------|------------|
| Angold | 0.7 | 0.3 | 3.7 | 0.3 | 0.3 | 0 | 0 | 1 | 2 | 0 | 2.3 | 1 |
| Dantes | 0 | 0 | 2.25 | 0 | 0.25 | 0 | 0 | 0.25 | 2.75 | 1.75 | 2.25 | 0.75 |
| Delor | 3 | 3 | 2 | 0 | 0.75 | 0 | 0 | 0.25 | 3 | 0.25 | 2.25 | 0.75 |
| Denar | 3 | 3 | 1 | 0 | 0.5 | 0.5 | 0 | 0.5 | 2.75 | 1.75 | 2 | 1 |
| Dublet | 2.75 | 2.5 | 2.25 | 0 | 0.5 | 0.25 | 0 | 0.25 | 2.5 | 1.5 | 1.75 | 0.5 |
| Julia | 0 | * | 3 | 0 | 2.3 | * | 0 | * | 2.7 | 0.7 | 2.0 | 0.7 |
| Melodie | 0 | 0 | 2.75 | 0 | 0.25 | 0.67 | 0 | 0.33 | 1.5 | 0 | 2.5 | 0.75 |
| Nabella | 2.5 | 2.5 | 1.25 | 0 | 0.5 | 0.25 | 0 | 0 | 3.0 | 2.25 | 2.5 | 1.0 |
| Otava | 0 | 0 | 2.5 | 0 | 0 | 0 | 1 | 0.25 | 2.5 | 0 | 2 | 0.5 |
| Rajka | 0 | 0 | 1 | 0 | 0.7 | 0.67 | 0 | 1 | 3 | 1 | 2 | 0.3 |
| Realka | 0 | 0 | 2 | 0 | 0.75 | 0 | 1 | 0 | 1.5 | 1 | 2 | 0.5 |
| Reanda | 0 | 0 | 2.5 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 0.75 |
| Reglindis | 0 | 0 | 2.25 | 0 | 0.5 | 0 | 0 | 0 | 2.25 | 0 | 2.25 | 0.75 |
| Reka | 0 | 0 | 1.5 | 0 | 0.25 | 0 | 2 | 0 | 3 | 2 | 2.75 | 1 |
| Relinda | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1.25 | 0.75 |
| Resista | 0 | 0 | 2.75 | 0 | 0.5 | 0 | 0 | 1 | 2.0 | 0 | 2.5 | 1 |
| Retina | 0 | 0 | 1.5 | 0 | 2.5 | 0 | 0 | 0 | 3 | 0.75 | 1.5 | 1 |
| Rosana | 0 | 0 | 3 | 0 | 0.25 | 0 | 0 | 1.25 | 2.5 | 1.75 | 2 | 0.75 |
| Rubinola | 0 | 0 | 1.75 | 0 | 0.5 | 0 | 0 | 0.25 | 2.25 | 0 | 2 | 0.75 |
| Selena | 0.25 | 0.75 | 1.5 | 0.25 | 1 | 0.75 | 0 | 1 | 1.75 | 0 | 2.25 | 0.5 |
| Topas | 0.25 | 0 | 2.25 | 0 | 0.25 | 0.5 | 1 | 0.75 | 2.25 | 0 | 1.5 | 1 |
| Vanda | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 2.25 | 0 | 1.5 | 0.75 |
| Vesna | 0 | 0 | 3 | 0 | 1 | 2.5 | 3 | 1.25 | 2.25 | 1 | 1.25 | 1.25 |

Table 2. Mean disease and pest scores in plot TL159 on 17 July 2003

| Variety | Leaf scab | Fruit scab | Primary mildew | Secondary mildew | Leaf spot on leaf | Leaf spot on fruit | Canker | Rosy apple aphid | Green apple aphid |
|-----------|-----------|------------|----------------|------------------|-------------------|--------------------|--------|------------------|-------------------|
| Angold | 0 | 0 | 11 | 5 | 1 | 0 | 0.67 | 0 | 0 |
| Dantes | 0 | 0 | 10.75 | 3.5 | 1.25 | 0 | 0 | 0 | 1 |
| Delor | 0.5 | 0 | 2 | 2.75 | 1.25 | 0 | 0 | 1.5 | 3.25 |
| Denar | 0.5 | 0.25 | 0.75 | 2.5 | 0.75 | 0.25 | 0.25 | 0 | 1.75 |
| Dublet | 0 | 0.75 | 0 | 3 | 0.5 | 0 | 0 | 1.75 | 1.5 |
| Julia | 0 | 0 | 2 | 4 | 2.33 | 0 | 1.33 | 1 | 0.67 |
| Melodie | 0 | 0 | 0 | 3 | 1 | 0.75 | 0.25 | 1 | 2 |
| Nabella | 0 | 0.25 | 0.75 | 1 | 0 | 0.25 | 0.75 | 0.25 | 2.5 |
| Otava | 0 | 0 | 2.67 | 3.33 | 1 | 0 | 0.67 | 0 | 2.67 |
| Rajka | 0 | 0 | 1 | 2.33 | 0.33 | 0 | 2.33 | 0.67 | 4.33 |
| Realka | 0 | 0 | 0.5 | 2.25 | 1.5 | 0.25 | 1.75 | 0 | 1.75 |
| Reanda | 0 | 0 | 5.5 | 3.88 | 1 | 0.25 | 0.25 | 0.5 | 2.25 |
| Reglindis | 0 | 0 | 0.5 | 2.25 | 0.75 | 0.25 | 0.5 | 0.5 | 0 |
| Reka | 0 | 0 | 0 | 1.75 | 0.5 | 0 | 0.5 | 0.75 | 2.5 |
| Relinda | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 0.75 | 1 |
| Resista | 0 | 0 | 0.25 | 3.75 | 1 | 0 | 0.75 | 0.5 | 1.75 |
| Retina | 0 | 0 | 2.25 | 2.75 | 3.25 | 0.5 | 0.75 | 0.5 | 0.75 |
| Rosana | 0 | 0 | 1.25 | 3 | 0.75 | 0 | 0.25 | 1.5 | 2 |
| Rubinola | 0 | 0 | 0 | 2 | 1.25 | 1.25 | 0.5 | 0 | 1.75 |
| Selena | 0 | 0 | 1.5 | 2 | 3 | 0.25 | 0.25 | 0 | 2 |
| Topas | 0 | 0 | 4.25 | 3.25 | 1 | 0 | 2.25 | 0.75 | 1 |
| Vanda | 0 | 0 | 3.67 | 3.67 | 0.67 | 0.33 | 1 | 0 | 1.67 |
| Vesna | 0 | 0 | 2.5 | 3 | 3 | 2 | 0.5 | 0 | 0 |

Table 3. Mean disease and pest scores on varieties in plot VF214, East Malling 17 July 2003

| Variety | Leaf scab | Fruit scab | Primary mildew | Secondary mildew | Leaf spot on leaf | Leaf spot on fruit | Canker | Rosy apple aphid | Green apple aphid |
|-----------------|-----------|------------|----------------|------------------|-------------------|--------------------|--------|------------------|-------------------|
| COOP 37-2 | 0 | 0 | 0 | 1.5 | 0 | 0 | 0 | 0.3 | 0 |
| DL11 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| DL13 | 0 | 0 | 0 | 0.7 | 0 | 0 | 0 | 0 | 0 |
| DL 33 | 0 | 0 | 0 | 1.3 | 0.3 | 0 | 0 | 0.7 | 0 |
| Viktoira Airoto | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1.7 | 0 |
| Viktoira | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Rotjki | | | | | | | | | |

Table 4. Mean disease and pest scores on samples of 20 leaves taken from each variety in plot TL159 in early October 2003

| Variety | Leaf diseases | | | Caterpillars | Leaf miner | | | | Galls |
|-----------|---------------|--------|-----------|----------------------|------------|-----------|----------|---------------|------------|
| | Scab | Mildew | Leaf spot | Summer fruit tortrix | Stigmella | Leucoptra | Lyonetia | Phyllonorycta | Leaf midge |
| Angold | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Dantes | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| Delor | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 0 |
| Denar | 2 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 0 |
| Dublet | 3 | 2 | 1 | 0 | 0 | 0 | 2 | 1 | 0 |
| Julia | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 2 |
| Melodie | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| Nabella | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| Otava | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| Rajka | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 0 |
| Realka | 0 | 2 | 2 | 0 | 0 | 0 | 1 | 3 | 1 |
| Reanda | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| Reglindis | 0 | 3 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Reka | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 2 | 0 |
| Relinda | 3 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 1 |
| Resista | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| Retina | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 2 | 0 |
| Rosana | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| Rubinola | 1 | 3 | 1 | 0 | 0 | 0 | 2 | 3 | 0 |
| Selena | 0 | 3 | 4 | 0 | 0 | 0 | 1 | 1 | 0 |
| Topaz | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |
| Vanda | 1 | 4 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |
| Vesna | 0 | 4 | 4 | 0 | 0 | 1 | 1 | 3 | 0 |