

Screening strawberry varieties for resistance to powdery mildew

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- Powdery mildew disease is a constant problem for strawberry producers nationally.
- The ASBP has recently completed two years of powdery mildew resistance screenings of varieties and breeding accessions.
- The varieties and accessions tested showed varying degrees of powdery mildew resistance.
- Promising accessions with sources of powdery mildew resistance will continue to be incorporated in our breeding program to develop new tolerant/resistant varieties.

The Australian Strawberry Breeding Program (ASBP) has recently completed 2 years of powdery mildew resistance screenings of current and historical strawberry varieties and breeding accessions to identify sources of resistance. Results from these experiments showed varied responses to powdery mildew, from resistant to susceptible.

Several varieties for the temperate, subtropical, and Mediterranean production zones scored well for powdery mildew resistance, including 'Summer Song' (temperate), 'Venus-ASBP' (subtropical) and 'Fanfare-ASBP' (Mediterranean).

Other promising breeding accessions will be further investigated and released as new varieties themselves or used as parents for increased tolerance/resistance. Screening for powdery mildew resistance will continue in 2021.

One of the main activities of the ASBP (Hort Innovation project BS17000) is to develop new strawberry varieties with increased disease resistances. To do this we screen strawberry varieties and breeding accessions from all three of Australia's major production regions (temperate, subtropical, and Mediterranean) for their disease resistance.

These experiments help determine the level of resistance in our varieties and breeding accessions and guide our activities to develop breeding populations with increased tolerance and resistance.

In addition to screening for resistance to crown rot diseases such as Fusarium wilt, Colletotrichum crown rot, and Charcoal rot, experiments have also been conducted in recent years to identify sources of resistance against powdery mildew.

This disease is a constant problem for producers nationally, and with the greater uptake of protected cropping and limited management options, powdery mildew has become increasingly important and economically significant.

Powdery mildew

Powdery mildew is caused by the pathogen *Podosphaera aphanis*. It is a fungal pathogen that appears as white patches of fungal growth on the lower and upper surface of the leaf (Figure 1 a, b, c, d).

Leaf edges also curl upwards. Purple to reddish blotches and necrotic spots may also develop on the lower and upper leaf surfaces. The fungus can infect petioles, flowers, calyces, fruit stalks, and the fruit. In addition to causing a white powdery coating on the fruit, fruit surfaces may also harden and crack as a result of the disease.

The white fungal mildew contains large numbers of spores that may be spread by wind. Spores on the leaves are sources of inoculum which can affect fruit quality and lead to yield losses. Dry conditions and temperatures between 15 °C to 27 °C favour the disease. High humidity also promotes disease infections.

Incidence of powdery mildew can be higher in strawberry production under protected cropping than in plants grown outdoors.

Regardless of production systems being utilised, management of powdery mildew relies mainly on the use of fungicides.

There are however some challenges with the current fungicide options, such as limited fungicide groups available and maximum sprays allowed, and the lack of an effective protectant fungicide for rotation with other fungicide groups (i.e., with a multi-site activity, like the previous industry standard Euparen Multi).

Resistance screening

In 2019 and 2020, powdery mildew resistance screening trials were conducted on substrate (tabletop) in a protected cropping environment at the Department of Agriculture and Fisheries (DAF) Maroochy Research Facility in Nambour, Queensland. Current and historical varieties, and advanced breeding accessions were evaluated to identify sources of resistance.

The plants were grown as per commercial growing practices but with no fungicide sprays applied. The study relied on the natural development and spread of powdery mildew inoculum. Plants were established in coir bags in March of each year. The severity of the disease symptoms on leaves and fruits were rated three times each season at monthly intervals, around late June to August.

Powdery mildew disease severity (PMDS) was scored from one to five for leaves and fruit based on disease symptoms as described in Table 1. A higher value indicated a more severely affected organ (leaf or fruit). The PMDS ratings across assessment times in both years were combined and analysed.

Results

The varieties and accessions tested showed varying degrees of powdery mildew resistance. The heritage variety Phenomenal showed a score of one (no infections) for both leaf and fruit PMDS (Figure 2). Of the ASBP varieties, Summer Song (temperate), Venus-ASBP (subtropical) and Fanfare-ASBP (Mediterranean) showed high tolerance to powdery mildew on both fruit and leaves.

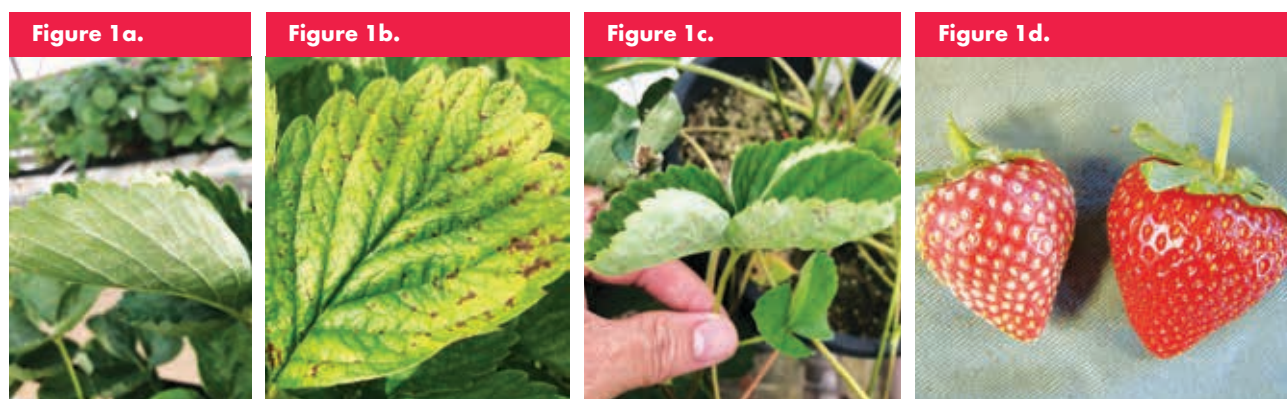


Figure 1. Symptoms of powdery mildew on strawberries. (a) White powdery fungal structures on the lower side of a leaf; (b) blotches/spots on the upper side of a leaf; (c) Powdery mildew blotches/spots on the lower side of a leaf and abnormal leaf curl; (d) infected fruit showing achenes with white fungal growth (left), compared with non-infected fruit (right). © State of Queensland, through the Department of Agriculture and Fisheries, Photo credits: Apollo Gomez

Figure 2a. Predictions for (a) leaf and (b) fruit PMDS score across all measurement times in 2019 and 2020. 1 = No symptoms; 2 = Mild symptoms; 3 = Moderate symptoms; 4 = Severe symptoms; 5 = Very severe symptoms; blue = varieties primarily grown in temperate regions; green = Mediterranean varieties; orange = subtropical varieties; grey = ASBP breeding accessions. Error bars indicate significant differences between accessions.

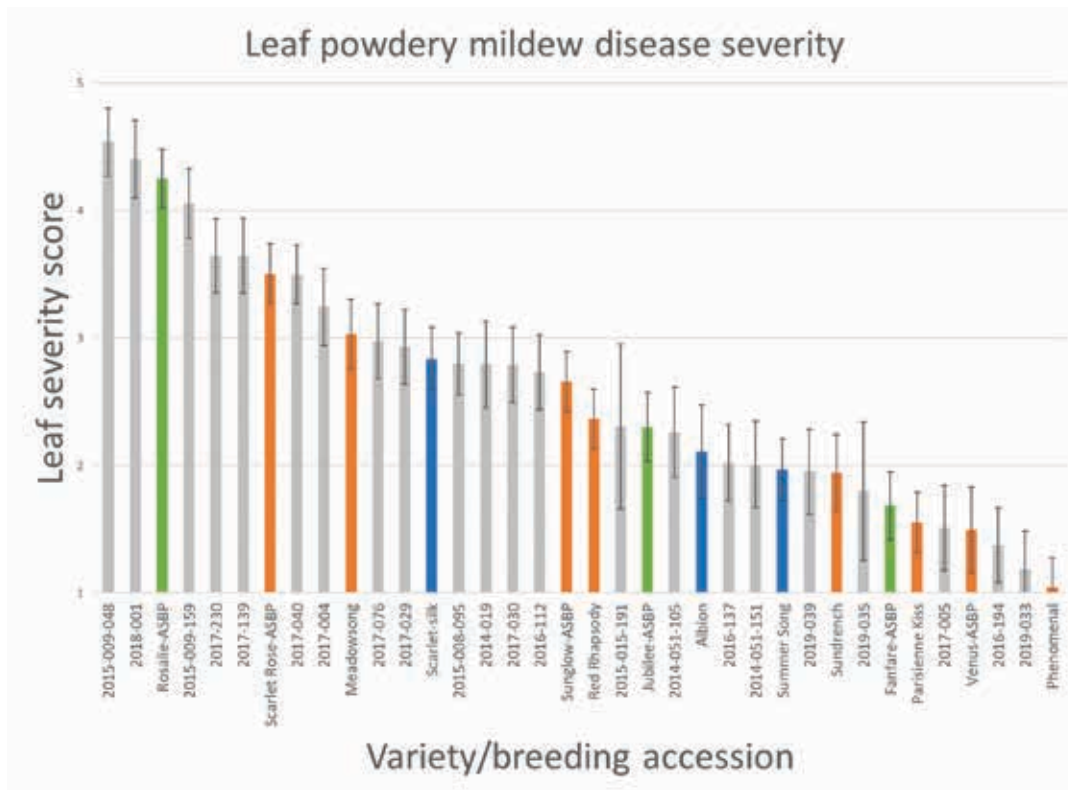


Figure 2b. Fruit from 2020 powdery mildew resistance experiment. (a) Red Rhapsody fruit showing powdery mildew symptoms; (b) powdery mildew tolerant accession 2019-033. © State of Queensland, through the Department of Agriculture and Fisheries, Photo credit: Katie O'Connor

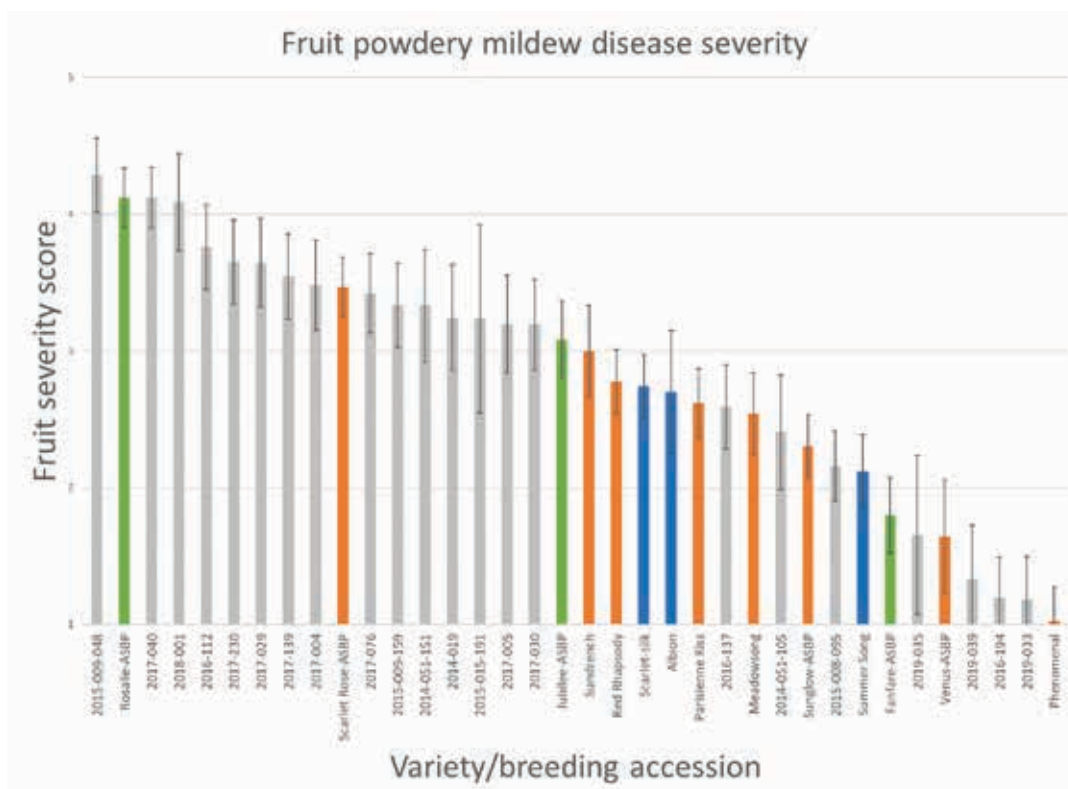
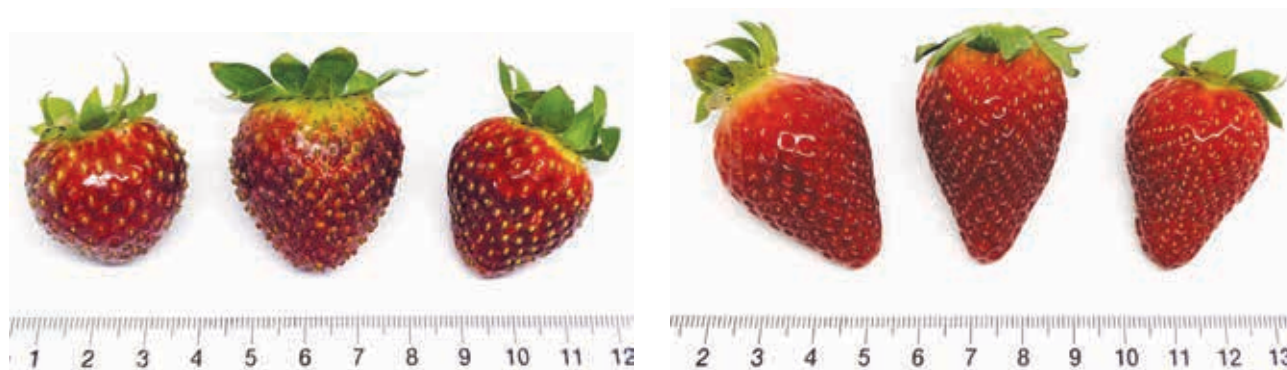


Table 1. Powdery mildew disease severity (PMDS) scores for leaf and fruit.

Score	Leaf PMDS	Fruit PMDS
1	No symptoms	No achenes infected
2 (Mild)	Live mycelium, but no Abnormal Leaf Curl (ALC) symptoms	< 25% of achenes infected
3 (Moderate)	< 25% of the plant with symptoms	25%-50% of achenes infected
4 (Severe)	25% to 50% of the plant with symptoms	50%-75% of achenes infected
5 (Very Severe)	> 50% of the plant with symptoms	75%-100% of achenes infected

Figure 3. Fruit from 2020 powdery mildew resistance experiment. (a) Red Rhapsody fruit showing powdery mildew symptoms; (b) powdery mildew tolerant accession 2019-033.

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Breeding accession 2016-194 and its daughter 2019-033 also performed extremely well (Figure 3). These accessions have exceptional flavour, however, lack other traits necessary to be acceptable as new varieties. Both accessions as well as the variety Phenomenal have been used extensively as parents for all three production regions in order to incorporate their high powdery mildew tolerance with other important plant and fruit traits.

Implications for industry & future work

Screening for powdery mildew resistance will continue in 2021. Promising accessions with sources of powdery mildew resistance will continue to be incorporated in our breeding program to develop new varieties with tolerance/resistance to powdery mildew. This will result in a more profitable and sustainable national strawberry industry, with more robust plants and reduced reliance on fungicides.

Acknowledgements

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