Missing Parts: The cost of missing cordons, canes and vines
By Janet Van Zoeren, Tim Martinson, Donald Caldwell, and Hans Walter-Peterson

Canopy fill is important for vineyard productivity and health. A full canopy maximizes light interception and cropping potential. Gaps in the canopy reduce productivity and lead to wasted inputs of fertilizers and pesticides targeted at empty vine or canopy spaces. The many causes of missing parts include winter injury, foliar diseases (a primary cause of late-season defoliation), and a variety of trunk diseases that spread slowly but over time can lead to loss of cordons, trunks, and vines.

In an effort to quantify how much “missing canopy” was present in the region, we surveyed 61 blocks in 17 commercial vineyards in the Finger Lakes. In this article, we report what we found, and will provide some simple estimates of how much missing canopy is costing growers.

Why we undertook this survey
Grower concern about the impact of grapevine trunk diseases increased in 2018 and 2019 following consultant visits and webinars (see webinar recording by Dr. Jose Urbez-Torres entitled Grapevine trunk diseases: The fungi that cause them, how they develop and spread, and how they are managed). We decided to undertake a symptom-based survey to try to answer this question: How big of a problem is canopy loss associated with trunk diseases, crown gall, and other causes, and what are the economic impacts on growers in NY?

Background
Grapevine trunk diseases (GTD) are not as immediately obvious to a grower as the key foliar or fruit pathogens that growers need to control each year, but trunk diseases can cause significant long-term crop loss as well as reduced vine productivity and lifespan. GTD can be challenging to identify and research due to their slow spread, hidden symptoms, and non-specific nature. Symptoms such as blind buds, dead cordons or missing vines can be linked to multiple causes. Moreover, they often do not pose an immediate threat but rather gradually expand to rob a vineyard of its productivity.

In addition, the term GTD refers to several disease complexes, each of which is caused by varying numbers of fungal species, with multiple and similar symptoms that are difficult to distinguish. For example, in 2000, 15 species of fungi from 10 genera were known to be associated with GTDs, but by 2019, researchers had identified 133 different species from 34 genera. In a recent survey, the most common GTDs found in New York included Eutypa dieback, Phomopsis canker and Botryosphaeria canker (Rolshausen & Kiyamoto 2007).

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In addition to these fungal trunk diseases, Crown Gall, a bacterial disease caused by Agrobacterium vitis, is also widespread. The galls that often form following winter injury to grapevines also significantly reduce canopy fill and vineyard productivity.

**Survey methods**

We assessed canopy fill by surveying 61 blocks in 17 commercial vineyards from May 28 to June 17, 2019. Of these, 32 blocks were native or hybrid vines (predominantly Concord, Niagara, Elvira and Catawba) and 29 blocks were Vitis vinifera (predominantly Riesling, Cabernet franc, Lemberger and Cabernet sauvignon). Nearly all of the native and hybrids were cordon-trained, while all but three of the vinifera blocks were cane-pruned.

At each vineyard, we examined 300 vines (50 vines in 6 adjacent rows) and scored each vine for the following visible attributes:

- **Eutypa**: Presence of shoots showing foliar Eutypa symptoms (curling or chlorotic leaves, short internodes, stunted growth).
- **Crown gall**: Presence or absence of crown gall symptoms.
- **Missing canopy**: Percentage of canopy missing due to count nodes that didn’t produce shoots (cane-pruned vinifera) or dead/missing cordons.
- **Missing vines**: Number of missing vines.

**Evaluating missing canopy.** For each vine, we scored the amount of missing canopy (cords) or nodes that didn’t produce live shoots (cane-pruned) to the nearest 25%. Please note that we made no effort to identify any pathogens, so we don’t know what caused the missing canopy.

**Diseases with visible symptoms.** We were able to score vines for visible symptoms of Eutypa dieback and crown gall.

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**Figure 1.** Arrangement of 300-vine sampling scheme (L), and scoring for missing canopy (R). Photo by Tim Martinson.
Eutypa dieback. Out of the 32 native/hybrid blocks assessed, Eutypa incidence ranged from 0% to 10% of vines per block affected, with a median incidence of 1.5% in the native blocks, and 0.3% in the hybrid blocks.

No symptoms of Eutypa were seen in any of the 29 vinifera vineyard blocks.

Figure 2. Incidence of visible Eutypa symptoms in hybrid, native, and vinifera blocks. Box plots show the range of results from all blocks sampled. Middle horizontal line within each box indicates the 50% (median) percentage of vines infected, each box extends from the 25th to the 75th percentile, and the vertical lines ‘whiskers’ represent the rest of the range. Grey dots outside the whiskers represent outliers.
**Crown Gall.** The percentage of vines with visible galls varied widely among blocks. In the hybrid and native blocks, the median percentage (half of the vineyards sampled having more and half having less) was well under 1% (0.3% for natives and 0.2% for other hybrids) – but blocks above the median ranged up to 31-40%. For vinifera, the median value was 5%, but the upper half had a wide range (5-94%) of vines with visible galls.

*Figure 3. Range of visible A. vitis galls on native (Concord, Catawba, Niagara), hybrid and V. vinifera vines. Box plots show range of values among the 61 vineyard blocks surveyed.*
Figure 4. Missing Canopy. The percentage of missing canopy ranged from 0.5 to 26% in the hybrid and native blocks, with a median value of 5%. In the V. vinifera blocks, the median amount of missing canopy was 11%, and the range was 1.0 to 44%. These numbers apply only to the live vines in the 300-vine sample.

Figure 5. Missing vines. We separately counted the number of missing vines within our 300-vine sampling array. Among the natives and hybrids (many of which were planted 20-30 years ago), the median percentage of missing vines was 3.2% (range 0-16.7%). Median percentage of missing vines in V. vinifera blocks was 6.7%, with a range of 0% to 39%.
Figure 6. Total % of Canopy Missing. Adding the percentage of missing canopy and the percentage of missing vines (with 100% missing canopy) together, the median amount of missing canopy is 8.8% (range of 1.3-35.8%) for natives and hybrids and 20.5% (range of 1.3-35.8%) for natives and hybrids and 20.5% (range of 2-54%) for V. vinifera blocks.

The Cost of Missing Parts. Using figures for the median amount of missing vines and missing canopy, we calculated very simple estimates of annual per-acre losses due to missing canopy and missing vines. We used separate assumptions of average yield and price per ton for different categories of grapes. For the native varieties, we modeled bulk Concord prices ($230/ton) and yield (8 T/acre). For the hybrid category, we used recent ‘Cayuga White’ prices ($600/T) and a conservative yield estimate (6 T/acre). For the V. vinifera category, we modeled 4 T/acre yield at $1600 /T. Grape prices were chosen based on the 2019 Finger Lake Grape Price Survey.

Table 1. The Cost of Missing Parts

<table>
<thead>
<tr>
<th>Category</th>
<th>Price per ton</th>
<th>Tons per Acre</th>
<th>% Missing Canopy</th>
<th>$ Missing Canopy</th>
<th>Missing vines</th>
<th>$ Missing vine</th>
<th>Total</th>
<th>$ total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native</td>
<td>$230</td>
<td>8</td>
<td>5</td>
<td>$92</td>
<td>3.8</td>
<td>$70</td>
<td>8.8</td>
<td>$162</td>
</tr>
<tr>
<td>Hybrid</td>
<td>$600</td>
<td>6</td>
<td>5</td>
<td>$180</td>
<td>3.8</td>
<td>$137</td>
<td>8.8</td>
<td>$317</td>
</tr>
<tr>
<td>V. vinifera</td>
<td>$1,600</td>
<td>4</td>
<td>11</td>
<td>$704</td>
<td>9.5</td>
<td>$608</td>
<td>20.5</td>
<td>$1,312</td>
</tr>
</tbody>
</table>

These numbers give us a ‘ballpark’ figure on vineyard blocks that in some sense have ‘average’ amounts of missing canopy and vines. “Median” means that half of the blocks we sampled had less missing canopy and vines, and half had more than the median value. Some conclusions:

- **Missing vines accounted for roughly as much potential revenue loss as did missing canopy on the remaining vines.** For natives and hybrids, 57% of total losses was from missing canopy and 43% was from missing vines. For vinifera, losses were almost equal at 54 to 46%.
- **Projected losses were significant for ‘median’ vineyards,** ranging from $162/acre (Concord) and $317 per acre (Cayuga white) to $1,312 per acre (V. vinifera). For a Concord grower, $162 per acre would be roughly equivalent to material cost for a seasonal 4-5 spray fungicide program.
- Above the ‘median’ level, projected losses ranged as high as 35% (Natives and hybrids) to 54% (vinifera).

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• For natives and hybrids, missing canopy in each block was related to crown gall incidence \((p=0.01)\). For \textit{vinifera}, although both the \% of missing canopy and crown gall incidence were much higher, the two were not well correlated.

• \textit{Eutypa dieback}. Visible foliar symptoms were only observed in 14 native (Concrod, Catawba, Niagara, Elvira, Isabella) and 4 hybrid (Aurore, Vignoles, Valvin muscat, and Chancellor) blocks. Its incidence only exceeded 1\% of vines sampled in 5 Concord blocks and 1 Isabella block. Although there may be more trunk cankers than we were able to observe, foliar symptoms affected relatively few vines, and mostly in older native blocks.

• \textit{Crown gall} appears to be a significant driver of ‘missing canopy’ in the ‘Native/hybrid’ varieties, but a more serious problem in \textit{vinifera} blocks, with up to 94\% of vines in one vineyard showing galls.

Although recent publicity about grapevine trunk diseases such as \textit{Botryosphaeria}, \textit{Phomopsis}, and \textit{Eutypa} cankers and other grapevine trunk diseases motivated us to undertake this survey, we did not directly observe or identify the pathogens. Because of this, we cannot attribute the ‘missing parts’ to specific causes – which undoubtedly include environmental stresses as well as trunk pathogens. Identifying specific pathogens and their impact will require additional research.

Trunk pathogens spread slowly, but can significantly reduce productivity over time. Our survey provided some preliminary evidence of problems, but the relatively low incidence of ‘missing canopy’ in the lower half of the vineyards surveyed suggests that management can limit future problems.

Clearly, there are significant costs to ignoring the potential impact of trunk pathogens or other causes of ‘missing parts’. Regularly renewing and replacing trunks, cordons, and missing vines may make the difference between a profitable vineyard and an unprofitable vineyard.

To learn more please see the related links below.


Úrbez-Torres, J.R. 2018. \textit{Grapevine trunk diseases: The fungi that cause them, how they develop and spread, and how they are managed}. Northern Grapes Webinar, recorded December 11, 2018.


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