Applying ‘Vine Row Volume’ (Plant Row Volume or PRV) Principles to Rate Selection and Spray Machinery Operations

P. MILLER and R. MAYER
1. Agricultural Assessments, 667 Burwood Road, Hawthorn, Victoria 3122
2. Phytech Development Pty Ltd, PO Box 208, Wandin North, Victoria 3139

Background
The concept of Plant Row Volume (PRV) as a standardisation technique in the spraying of horticultural crops was developed because so many plants are grown in so many different ways. The authors became interested in this approach in the early 1980s after a series of seminars with fruitgrowers when it became evident that while the concept of spray volume (amount of water and chemical mixture applied per hectare) was familiar to most growers, there was a large variation in what was considered a dilute or high volume application. This meant that there were similar disparities in what was considered ‘concentrate’ or low volume spraying. At this stage there was no common method of describing or comparing spray applications.

The other reason for developing PRV was that most research on agricultural chemicals and other foliar sprays was done with high-pressure hand guns while all fruitgrowers were using airblast sprayers of various sizes and configurations. We needed to relate the hand gun work to the various types of airblast spraying.

In the last ten years the PRV concept has been used to standardise agricultural spraying of varied techniques from hand gun and boom through high volume and low volume airblast spraying and even to aerial application.

This paper summarizes our findings and practical experience and relates these to the spraying of grapevines. This should be a starting point for those who are interested in being able to better analyse their operations and in improving their spray efficiency.

Calculation of Plant Row Volume (PRV)
PRV refers to the volume of plants and air which make up the target for spraying. As most horticultural plants are cultivated in rows, the usual way to calculate PRV is to stand at the end of a row and to measure the external dimensions of the canopy of foliage as a cross section of the row. The surface area of this cross section is then calculated and multiplied by the metres of row per hectare to give PRV in cubic metres per hectare (m³/ha).

It is very important to consider the target to be sprayed first. It can be the case that the tips of foliage are to be sprayed or only the lower part of the plant is to be sprayed and so PRV is the volume that this part fills (including air).

Consider the following cases:

For Vineyard A
- 1st calculation, m of row per ha = 10,000/row spacing = 10,000/3 = 3,333 m/ha
- 2nd calculation, cross sectional area of vine row = 1.6m × 1.3m = 2.08 m²
- 3rd calculation, \( PRV = 2.08 \times 3,333 = 6,933 \text{ m}^3/\text{ha} \)

For Vineyard B
- 1st calculation, m of row per ha = 10,000/row spacing = 10,000/3 = 3,333 m/ha
- 2nd calculation, cross sectional area of vine row = \( \pi r^2 \) (the area of a circle where \( \pi = 3.1416 \) and \( r \) is the radius or half the diameter) = 3.1416 × 0.5 m × 0.5 m = 0.79 m²
- 3rd calculation, \( PRV = 0.79 \times 3,333 = 2,618 \text{ m}^3/\text{ha} \)

For Vineyard C
- 1st calculation, m of row per ha = 10,000/row spacing = 10,000/2.4 = 4,167 m/ha

Figure 1. Diagram of three types of vineyards mid to late season
• 2nd calculation, cross sectional area of vine row = 0.5 m × 1.2 m = 0.6 m²
• 3rd calculation, PRV = 0.6 × 4,167 = 2,500 m³/ha

Rates of spray solution per unit of PRV
The so-called dilute rate of water/chemical mixture which should be applied per hectare is usually determined by the results of hand-sprayed experimental trials while a chemical is being developed. These sprays are directed into the canopy and are applied just to the point where the spray solution begins to run off the plant surfaces (run-off point).

A steep canopy grows and becomes more dense it takes more spray solution to achieve the desired result.

In our experience, the rates of spray solution per 1,000 m³ of PRV to achieve the equivalent to a hand sprayed result are from 80 L/1,000 m³ to 180 L/1,000 m³.

It is important to note that the PRV must be re-calculated during a season as it will change dramatically as the plants grow.

Let us take Vineyard A from above as an example.

**VINEYARD A**

Seasonal changes in PRV

<table>
<thead>
<tr>
<th>Category</th>
<th>Chemical concentration factor</th>
<th>Example of chemical product</th>
<th>Spray volume L/1,000 m³ of PRV concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early season</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-late season</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Volume (HV)</td>
<td>1×</td>
<td>100 mL/100L</td>
<td>160</td>
</tr>
<tr>
<td>Medium Volume (MV)</td>
<td>3×</td>
<td>300 mL/100L</td>
<td>53</td>
</tr>
<tr>
<td>Low Volume (LV)</td>
<td>16×</td>
<td>1600 mL/100L</td>
<td>10</td>
</tr>
<tr>
<td>Very Low Volume (VLV)</td>
<td>80×</td>
<td>8000 mL/100L</td>
<td>2</td>
</tr>
<tr>
<td>Ultra Low Volume (ULV)</td>
<td>400×</td>
<td>40,000 mL/100L</td>
<td>0.4</td>
</tr>
</tbody>
</table>

If we take the examples from Figure 1, where the PRVs were 6,933 m³/ha for Vineyard A, 2,618 m³/ha for Vineyard B and 2,500 m³/ha for Vineyard C, the spray volumes per hectare for these various canopy sizes are as follows.

**Table 3. Spray volumes per hectare as affected by category and concentration factor for the PRVs show in Figure 1 (dilute volume = 160 L/1,000 m³ of PRV)**

<table>
<thead>
<tr>
<th>Category, concentration factor, and L/1,000 m³ of PRV</th>
<th>Vineyard A</th>
<th>Vineyard B</th>
<th>Vineyard C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray volume L/ha</td>
<td>160</td>
<td>110</td>
<td>419</td>
</tr>
<tr>
<td>Spray volume L/ha</td>
<td>370</td>
<td>140</td>
<td>133</td>
</tr>
<tr>
<td>Spray volume L/ha</td>
<td>70</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Spray volume L/ha</td>
<td>14</td>
<td>5.2</td>
<td>5.0</td>
</tr>
<tr>
<td>Spray volume L/ha</td>
<td>2.8</td>
<td>1.05</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**U ndirected spraying: aerial applications**

Aircraft broadcast their spray and so spray the entire land underneath the machine. Because of this, the PRV must be considered to be the depth of the canopy times the area of a hectare. So for Vineyard A, this would be 1.3 m × 10,000 m²
Vineyard C would be 12,000 m³/ha. Vineyard B would be 10,000 m³/ha while Vineyard C would be 12,000 m³/ha. This affects the dose per hectare but not the dose per unit of PRV.

Using a rate of 100mL/100L of chemical for HV applications, then the chemical dose per hectare would change with aerial applications as follows:

- **Vineyard A**
  - ground applied and directed spray, 1.11 L of chemical per ha
  - aerial broadcast application, 2.08 L of chemical per ha

- **Vineyard B**
  - ground applied and directed spray, 0.419 L of chemical per ha
  - aerial broadcast application, 1.60 L of chemical per ha

- **Vineyard C**
  - ground applied and directed spray, 0.400 L of chemical per ha
  - aerial broadcast application, 1.92 L of chemical per ha

For narrow vertical canopies, in particular, the amount of chemical per ha which must be applied from the air to maintain dose per unit of PRV can be around 5 times that of directed ground based sprayers.

Note that there are some special ULV non-aqueous formulations of chemicals which perform quite differently at ULV than traditional formulations and so must be considered on a case-by-case basis.

Some practical considerations of PRV and spraying

The calculation of PRV is an extremely useful technique to maintain accurate doses of chemical between different canopy sizes and styles. It can save growers chemical costs but these must be considered within the overall context of the costs of running a vineyard.

Spraying efficiency also relies upon sprayer design. In our experience the best sprayers are those which most effectively displace the air within the PRV spray filled air but do not blast it out the other side.

Given that most research with agricultural chemicals is done with hand sprayers or booms at high volume, there is a risk involved in spraying more concentrated chemicals at lower volumes. Often growers are moving into unknown areas with regard to chemical performance with very concentrated sprays, especially where chemicals are mixed in the spray vat to save time. Growers should be wary of lower volume applications unless they are backed by research results which are shown as chemical container label recommendations.

We have found that at volumes lower than HV, droplet size can dramatically affect chemical performance and weather factors are much more critical.

### Acknowledgements

These projects were possible through financial support of the GRWDC and CRCV.

We wish to acknowledge the contribution and support of the following wine companies: Southcorp, Orlando/Wyndham, BRL Hardy, Yalumba and Henschke.

### References


### Conclusion

These studies indicate that ‘leaf area to fruit weight ratio’ is a critical factor in determining grape composition. In particular grape colour. However, measures of ‘effective leaf area to fruit weight ratio’ are required to more meaningfully describe the relationship between vine performance and grape composition.

A range of techniques are being evaluated to investigate ways to rapidly and precisely describe canopies. Studies during the 1994 season indicate that the ceptometer is a useful instrument for this purpose and it, as well as the imaging techniques, may provide a means to define the ‘effective leaf area to fruit weight ratio’.