Efficient Nitrogen Management
-the 4 R’s-

• Apply the **Right Rate**
  • Match supply with tree demand (all inputs- fertilizer, organic N, water, soil).

• Apply at the **Right Time**
  • Apply coincident with tree demand and root uptake.

• Apply in the **Right Place**
  • Ensure delivery to the active roots.
  • Minimize movement below root zone

• **Using the Right Source and Monitoring**
  • Maximize uptake, maximize response and minimize loss.

*The 4 R’s are specific to every orchard each year.*
Optimizing N Use in Tree Crops

Supply (Rate) = Demand (Amount and Timing)
The Right Rate Equation

Demand Function

Supply Function

- N mineralized in the soil
- N in the water
- N in the fertilization

Efficiency Factor
N Demand
Peach, Cherry, Apricot, Apple, Pear
N Partitioning: Peach Experiment

N Partitioning: Peach Experiment Results

% N requirements through the season in three peach varieties:

## N Partitioning: Peach Experiment Results

<table>
<thead>
<tr>
<th></th>
<th>‘Calanda’</th>
<th>‘Catherina’</th>
<th>‘Babygold5’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Canning</td>
<td>Mid-season</td>
<td>Late-harvest</td>
</tr>
<tr>
<td>Orchard age (years)</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Density (trees/acre)</td>
<td>500</td>
<td>670</td>
<td>670</td>
</tr>
<tr>
<td>Yield (tons/acre)</td>
<td>13.5</td>
<td>3.88</td>
<td>3.97</td>
</tr>
<tr>
<td>Storage (lbs N/acre)</td>
<td>10.6</td>
<td>5.98</td>
<td>6.46</td>
</tr>
<tr>
<td>*Demand (lbs N/acre)</td>
<td>152</td>
<td>61.5</td>
<td>58.3</td>
</tr>
<tr>
<td>Flowers/thinned fruit</td>
<td>4.59</td>
<td>2.96</td>
<td>2.40</td>
</tr>
<tr>
<td>Summer prunings</td>
<td>13.3</td>
<td>10.6</td>
<td>7.20</td>
</tr>
<tr>
<td>Harvested fruit</td>
<td>31.1</td>
<td>12.4</td>
<td>9.14</td>
</tr>
<tr>
<td>Leaf litter</td>
<td>38.4</td>
<td>17.0</td>
<td>23.3</td>
</tr>
<tr>
<td>Winter prunings</td>
<td>64.3</td>
<td>27.2</td>
<td>16.3</td>
</tr>
</tbody>
</table>

*Demand equals flowers and thinned fruits, summer prunings, harvested fruit, leaf litter and winter prunings
N Demand and Timing: Peach

- In O’Henry peach, the first 25-30 days of the growing season are supplied exclusively by N storage from perennial tissues.
- After that, about 0.89 lbs N per acre per day are taken up by the trees after the spring flush until harvest.
- After harvest, a positive net N storage occurs as a result of a large decrease in the N demand from growth.
- Much of the N that is taken up by the tree is returned to the soil as leaf litter and prunings.

Summary: Peach

• Only 15-20% of total N demand is allocated to harvested fruit, overall demand is significantly lower than in nuts.

• Proportionately larger demand for N in leaves, thinned fruit, and perennial structures.

• The rate at which N in leaves, prunings, and thinnings is available for uptake in subsequent seasons remains uncertain and the rate of release and efficiency of N recycling from returned leaves/prunings/thinnings are determined by management, irrigation and soil conditions.

• Current best estimate is that 50% of N in leaves, prunings, and thinnings becomes available in the first year, with a subsequent 50% in the second year and so on. The majority of N release from these sources occurs in spring as soil OM mineralizes
N Demand and Timing: Cherry, Apricot, Apple, Pear

• Data on crop offtake is available for apple and sweet cherry
  – Apple 0.5 - 0.6 lbs N per 1000 lbs fruit
  – Sweet cherry 2.0 - 2.35 lbs N per 1000 lbs fruit

• Data on uptake patterns for these crops is currently not available, though it can be inferred that the patterns will resemble peach: (Worth showing peach curve?)
  – Early season demand (until 80% leaf expansion) is met by stored N
  – Timing of leaf and fruit development will determine timing of uptake
  – Information on when N is allocated to perennial storage is inadequate.
N Accumulation and Partitioning: Apple

0.56 lb N per 1000 lb fruit

Yield = 17 US tons per acre

One acre

Apple

N Demand
Grape Varieties
### N Demand and Partitioning: Red Globe

#### Table 1. Nitrogen accumulation and distribution (kg N/ha) in various parts of grape plants.

<table>
<thead>
<tr>
<th>Plant part</th>
<th>March 30</th>
<th>May 10</th>
<th>June 30</th>
<th>Aug. 20</th>
<th>Sept. 30</th>
<th>Nov. 30</th>
<th>Net accumulated N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaves</td>
<td>-</td>
<td>2.6</td>
<td>16.7</td>
<td>26.8</td>
<td>31.2</td>
<td>-</td>
<td>31.2</td>
</tr>
<tr>
<td>Fruits</td>
<td>-</td>
<td>-</td>
<td>5.5</td>
<td>18.2</td>
<td>28.7</td>
<td>-</td>
<td>28.7</td>
</tr>
<tr>
<td>New shoots</td>
<td>3.9</td>
<td>-</td>
<td>17.9</td>
<td>19.4</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Branch</td>
<td>5.1</td>
<td>4.4</td>
<td>4.7</td>
<td>5.3</td>
<td>5.5</td>
<td>6.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Trunk</td>
<td>18</td>
<td>5.1</td>
<td>5.2</td>
<td>5.5</td>
<td>5.9</td>
<td>6.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Roots</td>
<td>27</td>
<td>15.8</td>
<td>11.6</td>
<td>12.6</td>
<td>17.6</td>
<td>20.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Total plant</td>
<td>106</td>
<td>27.8</td>
<td>61.6</td>
<td>87.8</td>
<td>114</td>
<td>58</td>
<td>91</td>
</tr>
</tbody>
</table>

Note: Net accumulated N in leaves, fruits, and new shoots equal to total accumulated in the last sampling. Net accumulated N in branches, trunks, and roots equal to N accumulation in the last sampling value minus N accumulation in the first sampling value.
N Partitioning: Grape

Grape ‘Cabernet’

Yield = 3.5 US tons per acre

1.1 lb N per 1000 lb fruit

SOIL

One acre
**N Demand Timing: Table Grape, Red Globe**

![Graph showing the relative nitrogen demand for Table Grape, Red Globe throughout the growing season.](image)

- **38%** nitrogen demand during sprouting & early foliage growth.
- **29%** nitrogen demand during fruit expansion and sprouting & early foliage growth.
- **29%** nitrogen demand during fruit expansion and new shoot & fruit development.
- **29%** nitrogen demand during maturity and dormancy.

Tong et al. 2010

N Demand Timing & Partitioning: Thompson Seedless

KEY:

BB = budbreak
A = anthesis (flowering)
V = veraison (berry softening)
H = fruit harvest
# N Partitioning After Harvest: Thompson Seedless

Amount of N in the vine at harvest (9/5) and at the end of the growing season (EOS) when all leaves have fallen from the vine

<table>
<thead>
<tr>
<th>Date</th>
<th>Clusters</th>
<th>Leaves</th>
<th>Stems</th>
<th>Fruiting canes</th>
<th>Trunk</th>
<th>Roots</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/5</td>
<td>32.0</td>
<td>30.0</td>
<td>11.1</td>
<td>2.2</td>
<td>7.0</td>
<td>18.8</td>
</tr>
<tr>
<td>EOS</td>
<td>-</td>
<td>15.6</td>
<td>12.1</td>
<td>2.5</td>
<td>11.1</td>
<td>31.7</td>
</tr>
<tr>
<td>Remobilized N</td>
<td>---</td>
<td>-14.4</td>
<td>+1.0</td>
<td>+0.3</td>
<td>+4.1</td>
<td>+12.9</td>
</tr>
</tbody>
</table>

Note: Bottom row is the change in N from harvest to end of season (EOS). Values above are equivalent to lbs per acre.
Total N Removed: Multiple Table Grape Varieties

‘Flame Seedless’ 181 lb N/acre
‘Scarlet Royal’ 160 lb N/acre
‘Crimson Seedless’ 91 lb N/acre

Note: Total N demand is the sum of the N in leaves, stems and clusters. Differences in total N at harvest is based on harvest dates and differences in leaf and stem biomass.

24 ton/acre yield
Nitrogen Management Training
for Certified Crop Advisers

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