Use of Synthetic Growth Regulator Herbicides; A Continuing Concern with Wine and Juice Grape Vineyards in Washington State Agriculture

Vince Hebert
WSU-Food and Environmental Quality Lab
http://feql.wsu.edu

WSDA – WSU Leaf Index Management Tool

Gail Amos, Washington State Department of Agriculture, Yakima WA

EPA-R7 Workshop March 4-5 2014
Stable and traditionally important industry

Ranks high in Washington agriculture

Use of good cultural practices and selective broadleaf herbicides are essential tools for high yields

Washington State Wheat Production
The Post War introduction of 2,4-D and other synthetic growth regulators (SGRs) revolutionized US and Canadian cereal grain production.

Before the introduction of SGRs, selective broadleaf weed control was performed using inorganic salts/acids and formulated phenol products.
Besides being selective, it was inexpensive to manufacture.
Selected Chemical and Physical Properties

Water solubility: 682 mg/L (pH 7)
pKa: 2.64 – 3.31
Vapor pressure: \(2.4 \times 10^{-5}\) mm Hg @ 25°C (estimated from water solubility and Henry’s Law)
Henry’s Law: \(1.02 \times 10^{-8}\) atm-m³/mol

Follow the water ....... You will be likely to find 2,4-D after an application event

2,4-Dichlorophenoxyacetic acid (2,4-D)

Mode of Action

Upper stem bending

Petioles twisting

Parallel venation in new leaves that are severely stunted

mimics indole-3-acetic acid
Other Important SGR Herbicide Chemistries

3,6-dichloropyridine-2-carboxylic acid (Clopyralid)

3,6-dichloro-2-methoxybenzoic acid (Dicamba)

4-amino-3,5-dichloro-6-fluoro-2-pyridyloxyacetic acid (Fluroxpyr)
2,4-D Formulation Chemistry (old to new)

High Volatility (HV) 2,4-D esters
- VP greater than $10^{-5}$ mm Hg (20°C)
- methyl, ethyl, isopropyl, **n-butyl**, isobutyl, and n-pentyl forms

Low Volatility (LV) 2,4-D esters
- VP $10^{-5}$ to $10^{-6}$ mm Hg (20°C)
- Low volatile 2,4-D includes the isooctyl, **butoxyethyl**, and propylene glycol butyl ether (PGBE) esters.

NV 2,4-D salts
- VP less than $10^{-7}$ mm Hg (20°C)
- Acid and **amine** compounds of 2,4-D

*New kid on the block! quaternary amine salt*
Aerial Application

We have come a long way in application technology to reduce **physical drift**

Huge advances in:

- Formulation chemistry, nozzle technology and boom design,
- Aircraft delivery and GIS navigation

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http://www.croplife.com/article/30867/a-snapshot-of-aerial-application
Physical Drift Defined:

EPA defines spray drift as the physical movement of pesticide droplets or particles through air at the time of pesticide application or soon thereafter, to any site other than that intended for application (often referred to as non-target).

EPA does not include in its definition the movement of pesticides to from the target sites non-or off-target sites caused by erosion, migration, volatility, or wind-blown particles that occurs after application unless specifically addressed on a pesticide product label with respect to drift control requirements.
Conflicting Agrochemical Land Use Practices

- Rapidly growing industry (from 12 to 750 wineries in 30 yrs)
- Crush was over 180,000 tons FY 2012
- 8.6 billion dollar business in 2012
- Second only to California in U.S. wine sales
- Highly susceptible to SGR herbicide chemistry

Photo by Gail Amos WSDA
Growing vines are highly susceptible to injury from ultra-low (\(\eta g/m^3\)) herbicide concentrations transported in the ambient air.

Critical period is from bud-break through full bloom (April through early July).

Not all grape cultivars are injured equally!

Vines can usually outgrow symptoms if not highly exposed.

In severe exposure incidences, carryover can result.
SGR Grape Vine Exposure Symptoms

Photo by Gail Amos. WSDA

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SGR Grape Vine Exposure Symptoms
no visible symptoms of phenoxy-like herbicide contact. Margins and lobes are well defined.

Diminished or possible lack of sinus. Leaf will be significantly smaller than those with a lesser rating.

possible rugose (bumpy) features on leaf surface. Possible shortening of lobes and sinus.

definite deformation of leaf margins and sinuses. Venation will appear almost parallel.

grossly deformed leaf. Veination will be parallel. The leaf will be severely dwarfed.

SGR Grape Vine Exposure Symptoms

Photo by Gail Amos. WSDA

Photo by Gail Amos. WSDA
Cluster Symptoms of SGR Exposure

cap lock, live green ovaries, reduced berry production

Photo by Gail Amos WSDA

Photo by Gail Amos WSDA

Photo by Gail Amos WSDA

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Cluster Symptoms of SGR Exposure

Photo by R. Coe


Photo by Gail Amos. WSDA


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Chronology of a Long-standing Regional Controversy

Starting in the 1950’s Columbia and Yakima River Valleys, later Walla Walla areas
Dr. Walter Clore

• 2,4-D problems first recognized in concord grape vineyards in central eastern Washington in 1950
Control physical particle drift and the neighborly concern will hopefully go away!

**Chronology of a Long-standing Controversy**

<table>
<thead>
<tr>
<th>Droplet Diameter (µm)</th>
<th>Type of Droplet</th>
<th>Number of Droplets/in.² from 1 gal of Spray/Acre</th>
<th>Time Required to Fall 10 ft in Still Air</th>
<th>Distance Droplet Will Travel in Falling 10 ft With a 3-mph Breeze</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>Brownian max.</td>
<td>—</td>
<td>6750 min</td>
<td>388 miles</td>
</tr>
<tr>
<td>5</td>
<td>Fog</td>
<td>9,000,000</td>
<td>66 min</td>
<td>3 miles</td>
</tr>
<tr>
<td>100</td>
<td>Mist</td>
<td>1,164</td>
<td>10 sec</td>
<td>440 ft</td>
</tr>
<tr>
<td>200</td>
<td>Drizzle</td>
<td>195</td>
<td>3.8 sec</td>
<td>17 ft</td>
</tr>
<tr>
<td>400</td>
<td>Fine rain</td>
<td>28</td>
<td>2.0 sec</td>
<td>9 ft</td>
</tr>
<tr>
<td>500 (½ in.)</td>
<td>Rain</td>
<td>9</td>
<td>1.5 sec</td>
<td>7 ft</td>
</tr>
<tr>
<td>1000 (2½ in.)</td>
<td>Heavy rain</td>
<td>1.1</td>
<td>1 sec</td>
<td>4.4 ft</td>
</tr>
</tbody>
</table>

The neighborly drift concern did not go away

- 2,4-D problems first recognized in concord grape vineyards in central eastern Washington in 1950
- Grape injury surveys were initiated from 1953 through 1955 due to chronic-severe symptoms.
  - Injunction requested but denied to stop Horse Heaven Hills 2,4-D aerial applications to wheat
  - Observation that problem was related to volatile esters
Field Measured 2,4-D Ester Volatilization

Volatilization rate and cumulative vapor losses of LV 2,4-D isooctyl ester over a 5-day period post-application on wheat

From: Grover et al., J. Environ. Quality (1985)
Chronology of a Long-standing Controversy

- **1959 to 1963** symptom severity triggered a systematic survey of 14 vineyards from Walla-Walla to Grandview
- **1964** HV 2,4-D esters banned in Benton and Yakima Counties
- **1964-1969** few symptoms were observed
- **1969-1973** General and severe damage was again observed but throughout all of central Washington...**1973 was worst year on record**
WSU – Chemical Engineering Studies 1973 - 1980

• Goal was to identify sources of 2,4-D air contamination.
• Air sampling included assessments of HV, LV and NV formulations.
• Most comprehensive regional air evaluation of 2,4-D performed to date!

Early 1970’s WSU-CE Field Sampling Network Investigations

Around the clock air monitoring for 2,4-D HV, LV, and NV formulations during the active grape-growing season

Grape and grain growing areas of central Washington in the WSU-CE 1974 Sampling network

High volatility 2,4-D control areas in Benton and Yakima counties 1974

Reisinger LM and Robinson E. Long distance transport of 2,4-D. J. App. Meteorol 15: 836-845

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# Average 2,4-D Concentration (µg/m³) by 2,4-D volatility classification May 1974

<table>
<thead>
<tr>
<th>Sampler Location</th>
<th>High volatile</th>
<th>Low volatile</th>
<th>Non-volatile</th>
<th>Total 2,4-D</th>
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<tbody>
<tr>
<td>Prosser</td>
<td>0.85</td>
<td>0.24</td>
<td>0.12</td>
<td>1.21</td>
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<tr>
<td>Kennewick</td>
<td>0.65</td>
<td>0.35</td>
<td>0.08</td>
<td>1.00</td>
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<tr>
<td>BentonCity</td>
<td>0.62</td>
<td>0.29</td>
<td>0.09</td>
<td>1.00</td>
</tr>
<tr>
<td>Snake River</td>
<td>0.48</td>
<td>0.16</td>
<td>0.08</td>
<td>0.72</td>
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<tr>
<td>Burbank</td>
<td>0.63</td>
<td>0.14</td>
<td>0.12</td>
<td>0.89</td>
</tr>
<tr>
<td>Mabton</td>
<td>0.44</td>
<td>0.07</td>
<td>0.10</td>
<td>0.61</td>
</tr>
<tr>
<td>Mercer</td>
<td>0.29</td>
<td>0.16</td>
<td>0.06</td>
<td>0.51</td>
</tr>
<tr>
<td>Travis</td>
<td>0.50</td>
<td>0.04</td>
<td>0.09</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Reisinger LM and Robinson E. Long distance transport of 2,4-D. J. App. Meteorol 15: 836-845
Early 1970’s WSU-CE Field Sampling Network Investigations

COMPARISON OF DAILY APPLICATION OF 2,4-D IN OREGON AND 12 SITE DAILY AVERAGE OF HV 2,4-D IN WASHINGTON

Fox L. and Robinson E. 1976. Atmospheric drift of 2,4-D in the Lower Yakima Valley. Report 76-34.5. APCA National Meeting.

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Meteorological conditions favoring off-target 2,4-D grape injury

- low pressure
- cloud cover
- well defined low level wind flow
- advection

**precipitation**

Figure 3. Typical synoptic weather pattern for relatively high concentrations of 2,4-D.

2,4-D symptoms being most apparent from purported aerosol plant deposition and light rain events made sense.

Fig. 2. Calculated median and variability range (5- and 95%-ile) of the residence time in the lower/middle troposphere (♦) and in the atmospheric boundary layer (■).

Franco et al., Atmospheric fate of non-volatile and ionizable compounds. Chemosphere 85 (2011)
Potential for Movement to Air of Ionizable SGRs from Soil Surfaces, Some Earlier Investigations
Potential for Movement to Air of Ionizable SGRs from Soil Surfaces, Some Earlier Investigations

Chronology of a Long-standing Controversy Continues

- **From 1974 to 1990** symptoms varied year to year from mild to severe. In almost all cases, 2,4-D type injury was uniformly observed.

- **1989 drift issues in Badger Canyon**
  - Tri-Citians Against Chemical Trespass (TRI-ACT)
  - WSDA Pesticide Response Team
  - Pesticide Incident Reporting and Tracking (PIRT) Panel

- **Early 1990’s**
  - WSU- bioassay and sentinel plant studies
  - Benton County Drift Task Force
Starting around 2000 conflicts started coming up among growers in the Walla Walla Valley on agricultural land uses.

As wineries grow in popularity, Walla Walla contemplates its heritage

By The Associated Press

WALLA WALLA — As a fifth-generation wheat farmer in the Walla Walla Valley, Phil Reser considers himself the real deal, not one of those “hobby” guys growing grapes and opening a winery.

“It’s a very touchy subject with a lot of us, who are really true farmers, who have been here for generations and worked the land, whose families fought for this ground,” Reser said.

Michael Murr, on the other hand, wants to build a small winery with a tasting room. And he takes exception to the notion that any investment of $10 million to $15 million in a vineyard and estate...
The 1994 WSU Sentinel Plant Monitoring Network

Injury more associated with light precipitation events and not with 2,4-D application records

From Allan Felsot
2003 Herbicide Monitoring Program

- Monitoring sites
  - air
  - deposition
  - plant observations

- Weather stations

Map showing Walla Walla Valley with monitoring sites and weather stations.
WSU’s Herbicide Monitoring Program
WSU Tri Cities Experimental Vineyard

Photo by Gail Amos. WSDA

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WSU Tri Cities Experimental Vineyard
WSU Tri Cities Experimental Vineyard
Regional Herbicide Issues will not Drift-Away

• The lower atmosphere can serve as a transport mechanism for 2,4-D after field application
• Mass transport by volatilization and post-application land surface evaporative processes remains underappreciated......
• Meteorological conditions will remain critical to assess, especially during the active growing season for juice and wine grapes

Communication, education, and cooperation among growers and season-long monitoring will be critical to index and minimize future vineyard SGR injury
Use of Synthetic Growth Regulator Herbicides; A Continuing Concern with Wine and Juice Grape Vineyards in Washington State Agriculture

Acknowledgements

• EPA Region 10
• Washington State Department of Agriculture
• Oregon State University Cooperative Extension
• The many growers who participated in this vineyard monitoring program
### WSDA – WSU Leaf Index Management Tool

Washington State Department of Agriculture
Leaf Indexing Report Form

Phone: 509-225-2047  Fax: 509-375-2210

<table>
<thead>
<tr>
<th>Name / Contact</th>
<th>Phone #</th>
<th>Vineyard Name</th>
<th>County</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHARLES GREEN</td>
<td>509-225-2047</td>
<td>SALISBURY</td>
<td>WILDCO</td>
<td>24</td>
</tr>
</tbody>
</table>

Location:
- Block: 3  Row: 11

Make observations at least once a week! One variety per sheet

<table>
<thead>
<tr>
<th>Variety</th>
<th>Emitted Leaf Position</th>
<th>Observation Date</th>
<th>Any Phenology Symptoms Observed</th>
<th>Severity Rating Scale 0-5</th>
<th>Did Not Rain Yes or No</th>
<th>Date</th>
<th>Amount</th>
<th>Duration</th>
<th>Wind Dir</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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WSDA – WSU Leaf Index Management Tool

- Introduction
- Leaf Indexing as a Management Tool
- Recording Observations
- Site Selection
- How to Get Started
- How to End
Washington State Department of Agriculture  
Leaf Indexing Report Form

Completed forms should be mailed to:  
WSDA Pesticide Management Division  
21 N. 1st Ave., Suite #236  
Yakima, WA 98902

Phone: 509-225-2647  Fax: 509-575-2210

<table>
<thead>
<tr>
<th>Name / Contact</th>
<th>Charles Carly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone #</td>
<td>509-225-2647</td>
</tr>
<tr>
<td>Vineyard Name</td>
<td>Downtown Vineyards</td>
</tr>
<tr>
<td>Location</td>
<td>ROAD 2004 - YAKIMA</td>
</tr>
<tr>
<td>County</td>
<td>Yakima</td>
</tr>
<tr>
<td>Section</td>
<td>24</td>
</tr>
<tr>
<td>Township</td>
<td>13N</td>
</tr>
<tr>
<td>Range</td>
<td>18E</td>
</tr>
</tbody>
</table>

Varieties Affected

<table>
<thead>
<tr>
<th>Variety</th>
<th>Bud Break</th>
<th>Bloom</th>
<th>Set</th>
<th>Pea Size</th>
</tr>
</thead>
</table>

Location (Block, Row): MERLOT BLOCK 3 NW  ROW 10

Make observations at least once a week/ One variety per sheet

<table>
<thead>
<tr>
<th>Variety: MERLOT</th>
<th>Year 2004</th>
<th>If Yes</th>
<th>If Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerged Leaf Position</td>
<td>Observation</td>
<td>Any Phenoxy Symptoms</td>
<td>Observed Yes or No</td>
</tr>
<tr>
<td>1 Basal</td>
<td>MAY 10</td>
<td>Y</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>Y</td>
<td>2</td>
</tr>
<tr>
<td>3 4</td>
<td>24</td>
<td>Y</td>
<td>2.3</td>
</tr>
<tr>
<td>5 6 7</td>
<td>31</td>
<td>Y</td>
<td>2.45</td>
</tr>
<tr>
<td>8 9 10</td>
<td>JUNE 7</td>
<td>Y</td>
<td>4.73</td>
</tr>
<tr>
<td>11 12 13</td>
<td>14</td>
<td>Y</td>
<td>5.54</td>
</tr>
<tr>
<td>14 15</td>
<td>21</td>
<td>Y</td>
<td>2.1</td>
</tr>
<tr>
<td>16 17</td>
<td>28</td>
<td>N</td>
<td>1.0</td>
</tr>
<tr>
<td>18 19 20</td>
<td>JULY 5</td>
<td>N</td>
<td>0.00</td>
</tr>
<tr>
<td>21 22</td>
<td>12</td>
<td>N</td>
<td>0.0</td>
</tr>
<tr>
<td>23 24</td>
<td>19</td>
<td>N</td>
<td>0.0</td>
</tr>
<tr>
<td>25 26</td>
<td>26</td>
<td>N</td>
<td>0.0</td>
</tr>
<tr>
<td>No New Leaves</td>
<td>AUGUST 2</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>
no visible symptoms of phenoxy-like herbicide contact. Margins and lobes are well defined.

possible rugose (bumpy) features on leaf surface. Possible shortening of lobes and sinus.

will have rugose features as well as marginal disfiguration. The leaf is not able to fully open

Diminished or possible lack of sinus. Leaf will be significantly smaller than those with a lesser rating

definite deformation of leaf margins and sinuses. Venation will appear almost parallel.

grossly deformed leaf. Veination will be parallel. The leaf will be severely dwarfed.

Leaf Indexing as a Management Tool

• Weekly producer observations can be critical for assessing timing-severity of herbicide exposure
• These observations must be conducted uniformly by someone on site **full time**
• After training, observers can be easily trained
Objective

- Record bud break
- Record the **date** leaves unfurl
- Numerically record the node/leaf position
- The number must correlate to a date
- Weekly readings returning to the same grape shoot to establish a historical record
The Observation Process

Same day of the week

• Record the date of Bud Break or Bud Burst
• Next week record the unfurling of any leaf
  Example: Two leaves unfurled since last week, the basal leaf is number 1, the next leaf is number two, RECORD THE DATE NEXT TO #1 and #2
• There is a lag time between the herbicide exposure and the expression of herbicide symptoms
The Observation Process, continued

• Next week look for and record any symptoms on #1 and #2 (the leaves that unfurled last week)
• Recording the date on the new leaf positions.
• A pattern develops, recording the date of new leaves and observing the development of the preceding leaves for symptoms.
• Always looking back for symptoms
Recording Observations

Recording Date/Observations

- Observations for herbicide symptoms will be recorded on next visit to site, April 11

<table>
<thead>
<tr>
<th>Emerged Leaf Position</th>
<th>Observation Date</th>
<th>Any Symptoms Observed Yes or No</th>
<th>Severity rating</th>
<th>Did it Rain Yes or No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Basal</td>
<td>April 4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Look back to record symptoms because of lag time between exposure and visual symptoms
Record Observations Weekly

**Record Observations**

<table>
<thead>
<tr>
<th>Name / Contact:</th>
<th>CHARLES CARLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone #:</td>
<td>509-225-2677</td>
</tr>
<tr>
<td>Vineyard Name:</td>
<td>DOWN TOWNE VINEYARDS</td>
</tr>
<tr>
<td>Location:</td>
<td>ROAD 2004 - YAKIMA</td>
</tr>
<tr>
<td>County:</td>
<td>YAKIMA</td>
</tr>
<tr>
<td>Section:</td>
<td>24</td>
</tr>
<tr>
<td>Township:</td>
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<td>Observation Date</td>
<td>Any Phenox Symptoms Observed Yes or No</td>
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</tr>
<tr>
<td>1 Basal</td>
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<td>Y</td>
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<td>Y</td>
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<td>3</td>
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<td>JUNE 7</td>
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<td>4.7</td>
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<td>6</td>
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<td>26</td>
<td>N</td>
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<tr>
<td>24</td>
<td>AUGUST 2</td>
<td>N</td>
<td>N</td>
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</tbody>
</table>

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Why Weekly Readings?

- Weekly readings places somebody in the vineyard specifically to make observations for herbicide symptoms.
- Timely decisions need to be made to grow the plants through the herbicide exposure using irrigation and a complete nutritional program as nitrogen alone is not enough.
- Weekly readings narrows the time frame of events if a case investigation is requested.
- Weekly readings will give the investigation a starting point.
## Recording Observations

### Recording Severity of Injury

<table>
<thead>
<tr>
<th>Name / Contact:</th>
<th><strong>CHARLES CARLY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phone #:</td>
<td>509-226-2677</td>
</tr>
<tr>
<td>Vineyard Name:</td>
<td>DOWNTOWN VINEYARDS</td>
</tr>
<tr>
<td>Location:</td>
<td>ROAD 2004 - YAKIMA</td>
</tr>
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</tr>
<tr>
<td>Section:</td>
<td>24</td>
</tr>
<tr>
<td>Township:</td>
<td>13N</td>
</tr>
<tr>
<td>Range:</td>
<td>16E</td>
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**Varieties Affected**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Bud Break</th>
<th>Bloom</th>
<th>Set</th>
<th>Pea Size</th>
</tr>
</thead>
</table>

**Location (Block, Row):** MERLOT BLOCK 3 NW ROW 10

**Make observations at least once a week/ One variety per sheet**

**Variety: MERLOT Year: 2004**

<table>
<thead>
<tr>
<th>Emerged Leaf Position</th>
<th>Observation Date</th>
<th>Any Phenox Symptoms Observed Yes or No</th>
<th>Severity rating Scale 0-5</th>
<th>Did it Rain Yes or No</th>
<th>Did it Rain Date</th>
<th>Amount</th>
<th>Duration</th>
<th>Wind Dir.</th>
</tr>
</thead>
<tbody>
<tr>
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<td>MAY 10</td>
<td>Y</td>
<td>2</td>
<td>N</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>Y</td>
<td>2</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 4</td>
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<td>Y</td>
<td>2 3</td>
<td>N</td>
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<td></td>
</tr>
<tr>
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<td>Y</td>
<td>2 4 6</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8 9 10</td>
<td>JUNE 7</td>
<td>Y</td>
<td>4 4 3</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 12 13</td>
<td>14</td>
<td>Y</td>
<td>6 5 4</td>
<td>Y</td>
<td>JUNE 1</td>
<td>0.34</td>
<td>4PM-5PM</td>
<td>5HRS</td>
</tr>
<tr>
<td>14 15</td>
<td>21</td>
<td>Y</td>
<td>2 1</td>
<td>Y</td>
<td>JUNE 9</td>
<td>0.2</td>
<td>8AM-3PM</td>
<td>6HRS</td>
</tr>
<tr>
<td>16 17</td>
<td>28</td>
<td>N</td>
<td>10</td>
<td>N</td>
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</tr>
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<td></td>
</tr>
<tr>
<td>No New Leaves</td>
<td>AUGUST 2</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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no visible symptoms of phenoxy-like herbicide contact. Margins and lobes are well defined.

Possible rugose (bumpy) features on leaf surface. Possible shortening of lobes and sinus.

Margins and lobes will have rugose features as well as marginal disfiguration. The leaf is not able to fully open.

Possible rugose (bumpy) features on leaf surface. Venation will appear almost parallel.

Definite deformation of leaf margins and sinuses. Venation will appear almost parallel.

Diminished or possible lack of sinus. Leaf will be significantly smaller than those with a lesser rating.

Grossly deformed leaf. Veination will be parallel. The leaf will be severely dwarfed.

What is Important

Changes in leaf size, shape and symptomology
What is Important – Node Spacing

SGR herbicide exposure event. What was the date this leaf unfurled?
Caution

- New shoots are tender and easily broken if handled. Observe and take notes in a pocket notebook.
- Once the shoot and leaves become more mature numbers can be written on the leaves and shoot.
## Recording Rain Events

### Varieties Affected

<table>
<thead>
<tr>
<th>Variety</th>
<th>Bud Break</th>
<th>Bloom</th>
<th>Set</th>
<th>Pea Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>MERLOT</td>
<td>MAY 6, 2004</td>
<td>JUNE 7-2004</td>
<td>JUNE 15-2004</td>
<td>JUNE 28-2004</td>
</tr>
</tbody>
</table>

### Observation Sheet

**Name / Contact:** Charles Carly  
**Phone #:** 509-226-2677  
**Vineyard Name:** Down Towne Vineyards  
**Location:** Road 2004 - Yakima  
**County:** Yakima  
**Section:** 24  
**Township:** 13N  
**Range:** 15E  

**Location (Block, Row):** MERLOT BLOCK 3 NW ROW 10

**Make observations at least once a week / One variety per sheet**

### Variety: MERLOT  
**Year:** 2004

<table>
<thead>
<tr>
<th>Emerged Leaf Position</th>
<th>Observation Date</th>
<th>Any Phenoxy Symptoms Observed Yes or No</th>
<th>Severity Rating Scale 0-5</th>
<th>Did it Rain Yes or No</th>
<th>Date</th>
<th>Amount</th>
<th>Duration</th>
<th>Wind Dir.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Basal</td>
<td>MAY 10</td>
<td>Y</td>
<td>2</td>
<td>N</td>
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<td>Y</td>
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<td>N</td>
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<td>JUNE 1</td>
<td>.34</td>
<td>6AM-3PM</td>
<td>9HRS SW</td>
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<tr>
<td>14-15</td>
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<td>Y</td>
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<td>AUGUST 2</td>
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<td></td>
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</tr>
</tbody>
</table>
Record Rain Events

Rainwater can transport certain herbicides

Leaf without cutin adsorbs rain

Leaf with cutin repels rain
Rain is a source of herbicide transport. Water beads are formed on leaves with the waxy cutin layer formed. Water soaks into the leaves on the shoot tip (center), and is a path for herbicide to enter the grape plant. This vineyard suffered $290,000 in damages from a single rain event, WSDA case 33Y-00.
How Many Locations Should be Checked and Which Variety?

• The number of shoots selected will depend on your time and ability to observe the shoots on a weekly basis throughout the growing season; a minimum of three is recommended.

• The variety selected for observation will not be as important as selecting a set of varietal shoots that you will be able to observe weekly.

• Generally white varieties exhibit more symptoms than red varieties.
How to Get Started

Tools
How to Get Started

Where Do I Start In This Vast Vineyard?
How to Get Started

Select a Location to Monitor

Landmark near a driveway. Make it easy!
Row Location Marker

Flagging tape

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Row Location Marker

Use a marker/color not common in the vineyard
Mark the shoot

Flagging tape works well to mark the shoot. Tie the vine/wire near the base of the shoot. ANYTHING TIED TO THE NEW SHOOT WILL CREATE WIND RESISTANCE AND IS EASILY BROKEN
A reference in the row is helpful

A ground reference is helpful when returning to the vineyard, flags are not always the best markers in windy areas.
Keep the shoot upright

Horizontal shoots will give false readings as they will not grow out of the symptom as illustrated in the photo.
How to Get Started

GPS location is helpful
How to Get Started

Inform Crews Not to Disturb Shoot
pruning, thinning, training...
How much time?

• Reading the shoot takes about 5 minutes
• 12 week period starting at bud break
• 12 observation X 5 minutes = **ONE HOUR** FOR THE SEASON

• Note: there is lag time between the exposure and the exhibition of herbicide symptoms
• Take readings same day of each week
Fully Time Person at the Vineyard?

- Most cases investigated by WSDA come about by a good observer working in the field full time and reporting the issue to management.
- An onsite full time person can also record weather events. It is very important to record rain events. There are many isolated showers and only a portion of the vineyard may receive rain.
Selecting an Observer

• Please do not push the observer duty to a field consultant or other service provider to the vineyard. They are not on the property full time and they are there looking for things other than herbicide symptoms.
How to End the Season

Remove the Indexed Shoot at the End of the Season for an Historical Record
## WSDA – WSU Leaf Index Management Tool

Washington State Department of Agriculture  
Leaf Indexing Report Form

Completed forms should be mailed to:  
WSDA Pest 
Management Division  
31 N. 1 st Ave., Suite 623A  
Yakima, WA 98902

Phone: 509-225-2547 Fax: 509-575-2270

### Photos by Gail Amos WSDA

### EPA-R7 Workshop March 4-5 2014

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### Name / Contact: **Charles grey**  
Phone #: **509-776-2649**  
Vineyard Name: **Barden**  
Location: **White Bluffs, Kennewick**  
County: **Walla Walla**  
Section: **26**  
Township: **13N**  
Range: **18E**

### Varieties Affected

<table>
<thead>
<tr>
<th>Variety</th>
<th>Bud Break</th>
<th>Bloom</th>
<th>Set</th>
<th>Peach Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAGOT</strong></td>
<td>MAGOT</td>
<td>MAGOT</td>
<td>MAGOT</td>
<td>MAGOT</td>
</tr>
</tbody>
</table>

### Make observations at least once a week! One variety per sheet

<table>
<thead>
<tr>
<th>Variety</th>
<th>MAGOT</th>
<th>Year</th>
<th>Block / Row</th>
<th>Observation</th>
<th>Any Phenomenon</th>
<th>Severity Rating</th>
<th>Did It Rain</th>
<th>Date</th>
<th>Amount</th>
<th>Duration</th>
<th>Wind Dir.</th>
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