Current Issues in Organic Fruit Production

Where: Grand Gallery (main level) Room C  
Recertification credits: 2 (1C, PRIV OR COMM CORE)  
CCA Credits: PM(2.0)  
Moderator: Matt Grieshop, Entomology Dept., MSU

1:00 p.m. The Apple Flea Weevil  
• Anne Nielson, Entomology Dept., MSU  
• Matt Grieshop, Entomology Dept., MSU

1:20 p.m. Floor Management in Organic Fruit Production  
• Ian Merwin, Horticulture Dept., Cornell University

2:00 p.m. Post-Harvest Clean Up Crew: Flash-Grazed Hogs in Organic Fruit Orchards  
• Krista Buehrer, Entomology Dept., MSU  
• Matt Grieshop, Entomology Dept., MSU

2:15 p.m. Options for Nutrient and Weed Management in Organic Blueberries  
• Eric Hanson, Horticulture Dept., MSU

2:45 p.m. Will Microbial Pesticides Ever Measure Up for "O" Growers in the Upper Midwest?  
• Pete Nelson, Entomology Dept., MSU  
• Mark Whalon, Entomology Dept., MSU
Groundcover Management for Soil Health in Organic Orchards of the East

Ian Merwin & Greg Peck

Organic fruit & nut production value in US (2008 data from USDA-ERS)

<table>
<thead>
<tr>
<th>State</th>
<th>Number of organic orchards</th>
<th>Organic tree-fruit acres</th>
<th>Value of Sales ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NY</td>
<td>62</td>
<td>601</td>
<td>1.4</td>
</tr>
<tr>
<td>WA</td>
<td>421</td>
<td>18,929</td>
<td>154.8</td>
</tr>
<tr>
<td>CA</td>
<td>1,539</td>
<td>45,523</td>
<td>218.0</td>
</tr>
<tr>
<td>MI</td>
<td>56</td>
<td>703</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Challenges to Organic Tree Fruit Production in the Eastern USA

- Formidable pest complex
- 15 diseases & long susceptibility periods
- > 50 insect pests
- Pest pressure builds over time
- Crop load adjustment
- Higher production costs compared with arid western regions
- Season-long weed pressure
- Maintaining soil fertility and adequate tree nutrition

Basic philosophy of Organics

- Minimize off-farm and chemical inputs
- Grow the best adapted crop varieties for your site and region
- Manage the entire farm as a localized agroecosystem, not just a commodity production system
- Promote and protect “soil health”

What is organic soil “health”? Can it be described, quantified, and compared among different orchard management systems?

- Biological activity (e.g. microbial respiration)
- Nutrient release to plants (short vs. long-term)
- Soil’s ability to resist erosion and retain water
- Specific associations or communities of soil organisms (molecular approaches…)
- Long-term orchard health & productivity
Organic weed control options

- Mechanical cultivation
- Thermal (steam/flame)
- Herbicides
  - Acetic acid
  - Clove oil/pine oil
- Living mulches
- Synthetic mulches

Organic groundcover and soil management

- Fruit trees have sparse root systems and compete poorly with weeds and cover crops, especially young trees on dwarfing rootstocks.
- Mechanical cultivation and cover crops are mainstays of weed control in organic orchards.
- Organic herbicides are expensive and not very effective (poor chemical substitutes...).
- Cover crops, composts, and mulches are essential to maintain soil O.M. and fertility when orchard soils are cultivated often each year.

Peach trees grown in a mowed hard fescue sod compared with bark mulch, Lansing NY

Different turfgrasses in mow & blow tests, Ithaca NY

Hay-straw mulch and mowed grass clippings

Mow & blow drive-lane grass clippings into tree rows. Good source of nutrients, few vole problems, promotes water availability, limited weed control.

Hay mulches good for low OM orchard soils, provide K, P, Ca but expensive, short-term, and ideal habitat for meadow voles.

Mechanical cultivation with groundcovers in center of tree row ("Swiss sandwich system")
Orchard Floor Management for Soil Health

**Orchard soil Organic Matter content (%) after six years under different Groundcover Management Systems (GMSs)**

<table>
<thead>
<tr>
<th>Groundcover Management Systems</th>
<th>Initial soil O.M. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilled</td>
<td>2</td>
</tr>
<tr>
<td>Pre-HBC</td>
<td>4</td>
</tr>
<tr>
<td>Post-HBC</td>
<td>5</td>
</tr>
<tr>
<td>Vetch</td>
<td>6</td>
</tr>
<tr>
<td>Grass</td>
<td>7</td>
</tr>
<tr>
<td>Mulch</td>
<td>3</td>
</tr>
</tbody>
</table>

**Organic nutrient management**

- Cover crops
- Composts & Mulches
- Fish emulsions
- Kelp/seaweed extracts
- Bone meal
- Blood meal
- Fish meal
- Plant meals
- Chilean nitrate

**Orchard cover crops**

- A good cover crop is usually competitive with trees as well as weeds
- Legumes fix Nitrogen, but also consume N and H2O, and are relatively deep rooted
- Fall-seeded Brassicas may provide winter cover and some Spring till down C & N
- Dormant season cover crops provide O.M. and N when mowed or tilled, but N-East winters usually too long and cold to gain enough biomass & nutrients from cover crops

**Mustard CC in NY orchard, mid March & May**
Wild radish CC in CA plum orchard, mid March

Bell bean cover crop in Ryder organic orchard, Santa Cruz CA, mid March 2005

Bark mulch and Poultry manure: Soil health in integrated vs. organic ‘Liberty’ apple production

Nutrient Management

**IFP**
- Hardwood Bark Mulch (applied Nov. 2005)
- Foliar Urea
- Foliar boron, zinc, calcium
- Sulfate of potash magnesia (Sul-Po-Mag)

**Organic**
- Chicken Manure compost (Nov. 2005)
- Foliar fish powder (Mermaid’s)
- Sulfate of potash magnesia (K-Mag)

Greg Peck’s PhD project
- 2004-2007
- Ithaca NY

Integrated Fruit Production

- Integrates “conventional” & “organic” systems
- Science-based system
- Utilizes IPM
- Emphasizes soil fertility/soil quality
- Plant health and nutrient budgeting
- Standard production system in Europe & New Zealand
- Certification schemes similar to organic
- Some restrictions:
  - Organophosphate and carbamate pesticides mostly prohibited, except prebloom and for crop thinning
  - Fertilizer applications must be warranted
**Peck PhD**

**IFP**
- Bark mulch (Nov 2005)
- Glyphosate as needed (0-2 times/season)
- Mowing

**Fruit thinning**
- NAA & carbaryl
- Hand thinning

**Plum curculio**
- Actara, Avaunt

**Lepidoptera**
- Avaunt, Calypso, Bt, SpinTor, Pheromone Mating Disruption

**Apple maggot**
- SpinTor, Assail, Baited Sticky Traps

**Mites**
- Acramite

**Nitrogen**
- Bark mulch (Nov 2005)
- Foliar urea

**Fertility**
- Foliar urea

**Organic**
- Mechanical Cultivation (2-3 times/season)
- Hoeing & Mowing
- Fish Oil + Lime Sulfur Hand thinning
- Surround, PyGanic Surround, Bt, Entrust, Cyd-X, Pheromone Mating Disruption
- Surround, Entrust, Baited Sticky Traps
- JMS Stylet Oil
- Poultry manure compost (Nov 2005)
- Fish emulsion

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**Fruit yields for 'Liberty' on M9:**
Similar first four years, but have been dropping since 2008...

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**Soil Organic Matter (%)**
(at 0-6 cm & 6-12 cm depths)

<table>
<thead>
<tr>
<th>Effect</th>
<th>P &lt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.6</td>
</tr>
<tr>
<td>Interaction</td>
<td>0.0073</td>
</tr>
</tbody>
</table>

**Soil Microbial Biomass Carbon**
(0-6 cm depth)

<table>
<thead>
<tr>
<th>Effect</th>
<th>P &lt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>0.0133</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.6591</td>
</tr>
<tr>
<td>Interaction</td>
<td>ns</td>
</tr>
</tbody>
</table>

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**Soil respiration (~ microbial activity)**
in IFP vs. OFP (0-6 cm depth)

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**Soil aggregate stability (~ erosion resistance)**
(0-6 cm depth)

* P < 0.05
**Potentially Mineralizable Nitrogen (0-6 cm soil depth) for 2 yrs after bark mulch and poultry manure additions in Nov. 2005**

* P < 0.05

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**Leaf Nutrient Content 2004-2007**

<table>
<thead>
<tr>
<th>Year</th>
<th>Treatment</th>
<th>N (%)</th>
<th>P (%)</th>
<th>Ca (%)</th>
<th>Mg (%)</th>
<th>Na (%)</th>
<th>K (%)</th>
<th>Fe (%)</th>
<th>Cu (%)</th>
<th>Mn (%)</th>
<th>Zn (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>IFP</td>
<td>1.80</td>
<td>0.14</td>
<td>1.30</td>
<td>0.24</td>
<td>0.25</td>
<td>20.3</td>
<td>3.30</td>
<td>0.20</td>
<td>0.33</td>
<td>0.33</td>
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<tr>
<td>2004</td>
<td>OFP</td>
<td>1.24</td>
<td>0.17</td>
<td>1.26</td>
<td>0.21</td>
<td>0.20</td>
<td>22.6</td>
<td>5.05</td>
<td>0.38</td>
<td>0.17</td>
<td>0.17</td>
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<tr>
<td>2005</td>
<td>IFP</td>
<td>0.95</td>
<td>0.21</td>
<td>1.10</td>
<td>0.10</td>
<td>0.02</td>
<td>16.3</td>
<td>6.88</td>
<td>5.67</td>
<td>5.88</td>
<td>5.88</td>
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<tr>
<td>2005</td>
<td>OFP</td>
<td>1.75</td>
<td>0.26</td>
<td>1.32</td>
<td>0.17</td>
<td>0.27</td>
<td>20.6</td>
<td>46.3</td>
<td>6.35</td>
<td>4.25</td>
<td>22.5</td>
</tr>
<tr>
<td>2006</td>
<td>IFP</td>
<td>1.75</td>
<td>0.26</td>
<td>1.32</td>
<td>0.19</td>
<td>0.20</td>
<td>20.6</td>
<td>46.3</td>
<td>6.35</td>
<td>4.25</td>
<td>22.5</td>
</tr>
<tr>
<td>2006</td>
<td>OFP</td>
<td>1.75</td>
<td>0.26</td>
<td>1.32</td>
<td>0.19</td>
<td>0.20</td>
<td>20.6</td>
<td>46.3</td>
<td>6.35</td>
<td>4.25</td>
<td>22.5</td>
</tr>
<tr>
<td>2007</td>
<td>IFP</td>
<td>1.75</td>
<td>0.26</td>
<td>1.32</td>
<td>0.19</td>
<td>0.20</td>
<td>20.6</td>
<td>46.3</td>
<td>6.35</td>
<td>4.25</td>
<td>22.5</td>
</tr>
<tr>
<td>2007</td>
<td>OFP</td>
<td>1.75</td>
<td>0.26</td>
<td>1.32</td>
<td>0.19</td>
<td>0.20</td>
<td>20.6</td>
<td>46.3</td>
<td>6.35</td>
<td>4.25</td>
<td>22.5</td>
</tr>
</tbody>
</table>

**Hilfiker (1998) and Voroney et al (2005) studies:**

Long-term N deficits in IFP and OFP orchards?

Surround (kaolin clay) high Al content, may accumulate with long-term usage...

Leaf blotch and preharvest foliar and fruit drop worsened from 2007 to 2010...likely related to dogwood borer infestations in IFP and OFP

Cumulative organic fungicide (Cu and S) residues may eventually cause soil health problems unless disease-resistant apple varieties are grown...
Long-term (1992-2010) comparisons of organic (bark mulch and grass) vs. herbicide groundcover management systems

<table>
<thead>
<tr>
<th>GMS</th>
<th>P%</th>
<th>K%</th>
<th>Mg%</th>
<th>Ca ppm</th>
<th>Fe ppm</th>
<th>Mn ppm</th>
<th>Zn ppm</th>
<th>pH</th>
<th>O.M. %</th>
<th>N%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bark Mulch</td>
<td>3.1ab</td>
<td>117a</td>
<td>242b</td>
<td>3606a</td>
<td>22.4a</td>
<td>32.4a</td>
<td>3.5</td>
<td>2.0a</td>
<td>7.2a</td>
<td>0.7a</td>
</tr>
<tr>
<td>Pre-Herb (Glyphosate+Dithranol)</td>
<td>1.1b</td>
<td>92bc</td>
<td>340a</td>
<td>1578b</td>
<td>6.6c</td>
<td>17.9b</td>
<td>2.1</td>
<td>1.2b</td>
<td>6.9ab</td>
<td>4.9b</td>
</tr>
<tr>
<td>Post-Herb</td>
<td>1.0b</td>
<td>111ab</td>
<td>360a</td>
<td>1800b</td>
<td>0.5c</td>
<td>18.8b</td>
<td>3.1</td>
<td>1.0b</td>
<td>6.7ab</td>
<td>4.6b</td>
</tr>
<tr>
<td>Mowed Sod</td>
<td>0.9b</td>
<td>98c</td>
<td>317a</td>
<td>1406b</td>
<td>1.4b</td>
<td>15.5b</td>
<td>3.1</td>
<td>0.9b</td>
<td>6.6c</td>
<td>4.9b</td>
</tr>
</tbody>
</table>

Means followed by different letters were significantly different at P=0.05.

Tree size (‘Empire’ on M.9/MM.111) increase from 1992 to 2008

* significant difference at P<0.05 among treatments in a given year
Fruit yields (kg/tree) among GMSs from 1994 to 2008

![Fruit yields graph]

* significant difference at P<0.05 among treatments in that year.

**Concluding Thoughts…**

- Maintaining soil fertility and tree nutrition will be very challenging in Eastern organic orchards
- Hardwood bark mulch may improve orchard soil health more than composted poultry manure
- There are effective weed cultivators for orchards, but they won’t work in conjunction with biomass mulches
- Groundcover management systems greatly influence soil microbial activity and communities in the root-zone
- Soil health was generally better under IPF than Organic production systems in our New York orchard tests
- More info available in the following (free online PDF)

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**Orchard GMS Nitrogen Budgets with (2005) and without (2007) N fertilizers (A. Atucha PhD study)**

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. EXTERNAL N INPUTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer application</td>
<td>60</td>
<td>60</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>109.2</td>
<td>84.6</td>
</tr>
<tr>
<td>Rain water</td>
<td>0.9</td>
<td>1.2</td>
<td>0.9</td>
<td>0.9</td>
<td>1.2</td>
<td>0.9</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Irrigation Water</td>
<td>1.8</td>
<td>1.8</td>
<td>0.0</td>
<td>0.0</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Total Inputs</strong></td>
<td>62.7</td>
<td>62.7</td>
<td>1.2</td>
<td>1.2</td>
<td>62.7</td>
<td>62.7</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td><strong>B. INTERNAL N FLUXES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recycling surface vegetation</td>
<td>15.1</td>
<td>19.5</td>
<td>20.9</td>
<td>21.5</td>
<td>21.6</td>
<td>27.3</td>
<td>25.1</td>
<td>26.4</td>
</tr>
<tr>
<td>Soil mineralization</td>
<td>16.7</td>
<td>18.4</td>
<td>20</td>
<td>20.9</td>
<td>22.1</td>
<td>24.2</td>
<td>29.8</td>
<td>35.9</td>
</tr>
<tr>
<td>Leaf litter Fall</td>
<td>16.4</td>
<td>10.7</td>
<td>11.6</td>
<td>14.2</td>
<td>10.3</td>
<td>15.4</td>
<td>10.3</td>
<td>15.9</td>
</tr>
<tr>
<td>Pruned wood</td>
<td>4.1</td>
<td>11.6</td>
<td>5.6</td>
<td>4.0</td>
<td>14.4</td>
<td>5.6</td>
<td>14.4</td>
<td>5.6</td>
</tr>
<tr>
<td><strong>Total internal fluxes</strong></td>
<td>56.6</td>
<td>67.5</td>
<td>58.6</td>
<td>68.9</td>
<td>66.6</td>
<td>81.0</td>
<td>70.4</td>
<td>87.5</td>
</tr>
<tr>
<td><strong>C. N OUTPUTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvested fruit</td>
<td>68.3</td>
<td>75.2</td>
<td>80.5</td>
<td>80.5</td>
<td>81.0</td>
<td>81.0</td>
<td>70.4</td>
<td>87.5</td>
</tr>
<tr>
<td>Surface runoff</td>
<td>1.7</td>
<td>5.0</td>
<td>1.5</td>
<td>7.7</td>
<td>0.6</td>
<td>4.9</td>
<td>0.5</td>
<td>4.1</td>
</tr>
<tr>
<td>Subsurface leaching</td>
<td>12.2</td>
<td>2.5</td>
<td>13.9</td>
<td>2.6</td>
<td>12.2</td>
<td>3.2</td>
<td>15.9</td>
<td>3.7</td>
</tr>
<tr>
<td><strong>Total outputs</strong></td>
<td>83.2</td>
<td>64.9</td>
<td>97.4</td>
<td>80.6</td>
<td>67.7</td>
<td>79.1</td>
<td>97.3</td>
<td>85.8</td>
</tr>
<tr>
<td><strong>N-BALANCE = (A+B)-C</strong></td>
<td>-31.8</td>
<td>-35.6</td>
<td>25.3</td>
<td>-9.6</td>
<td>55.8</td>
<td>12.1</td>
<td>35.8 (2007)</td>
<td>2.5 (2005)</td>
</tr>
</tbody>
</table>

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**Table of Contents:**

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- Systems approaches
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- Cultivar and rootstock selection
- Arthropod management
- Disease management
- Vertebrate management
- Allowable pesticides
- Crop load management
- Economics and marketing
Organic Nutrient and Weed Management in Blueberries

Eric Hanson, Department of Horticulture, Michigan State University

Although there are only a few organic blueberry farms in Michigan, additional producers are considering the feasibility of organics. A group of researchers at MSU have been working on specific aspects of organic systems for several years. The primary participants are Annemiek Schilder (plant pathology) and Rufus Isaacs and Matt Grieshop (entomology). Work has been conducted in an organic planting on the MSU campus and several commercial farms. This paper will summarize some of the preliminary results of work with nutrition and weeds.

Nutrition and Fertilization

Two of the most important aspects of conventional and organic blueberry nutrition are to maintain an acidic soil pH (4.0 to 5.5) and an adequate supply of available nitrogen (N). Soil pH is easily managed with the use of OMRI approved sulfur. Soils with a native acidic pH tend to revert back to their original pH. Soils with a more alkaline native pH are more difficult to keep in the acidic range as. Composts and manures often have a neutral or alkaline pH, so additions may need to be accompanied by periodic applications of acidifying sulfur.

Blueberries need adequate N from bloom in May until the end of harvest in August in order to grow and produce well. High levels of available N after harvest can promote late season growth and inhibit acclimation to cold so that bushes are more susceptible to winter injury.

In conventional blueberry fields, soil organic matter tends to be relatively stable and resistant to breakdown by microbes. Since N is released from organic matter by microbial activity, less N may be released in conventional soils, so annually applied fertilizers are a key source of plant N. Nitrogen from these fertilizers is available to plants almost immediately. Healthy organic blueberry soils should contain a higher percentage of the organic matter in forms that are readily used by microbes. Blueberries in these soils rely more heavily on microbial activity that releases N from organic matter.

During transition from conventional to organic, it is important to both build soil organic reserves and supply adequate N for growth. If only low-N organic amendments are added (wood chips, bark), these may cause plants to become deficient in N because microbes decomposing the amendments compete with plants for available N. Organic amendments with carbon to nitrogen ratios (C:N) of 25 to 30 tend to have little effect on available N during the year they are applied. Materials with C:N ratios lower than 25 tend to add to the available N pool. Those with very high ratios diminish available N, so they need to be accompanied by high N materials. Adding organic amendments gradually increases soil organic content and soils tend to develop a balance of readily available, slowly available, and resistant organic components.

Weed Management

This is a big challenge in organic systems, and growers have taken different approaches. Whether you are starting a new organic planting or converting an established conventional field, make sure perennial weeds are under control from the beginning. Some particularly troublesome species include brambles, goldenrod, yellow nutsedge, quackgrass, Virginia creeper vine, common milkweed, and poison ivy. Weed “control” is not economical in organic blueberries, but effective weed management is possible.
Mulching. Surface applications of organic mulches (bark, woodchips, straw) or synthetic materials (plastic film, woven weed barrier) can suppress weeds and reduce hand weeding times in new plantings. They are most effective during the first years in new plantings because most of the weeds are annuals. By the third or fourth year, quackgrass and other perennials usually become established, and many thrive in organic mulches. Organic mulches will eventually enhance soil organic matter and nutrient cycling. Synthetic woven weed barrier is very persistent and can provide years of weed suppression. These materials are not perfect, as weeds usually become established in the plant holes and are difficult to extract. Their use does increase organic matter content.

Organic herbicides. A number of organically approved products are available that contain various organic acids and oils. These are weak “burn-down” products. Our experiences indicate they can kill some small young weeds, but not established weeds. Most are very expensive and need to be applied multiple times since they have no residual activity. I don’t think they have much value in organic blueberries.

Mechanical tools. Rotary hoes, such as those manufactured by Weed Badger, provide a means of tilling between blueberry bushes. These were well, but are slow (0.4 to 0.5 acres per hour) and need to be used two or three times per season for adequate control. A limitation of rotary hoeing is that weeds next to the bushes cannot be removed. In the long run, the repeated cultivation may not promote good soil health, since this tends to hasten breakdown of organic matter. Some newer cultivation tools, such as the Wonder Weeder, may provide a means of strip cultivation immediately adjacent to the bushes.

An alternative to cultivation is to use mowers and weed whips to keep weeds low and out of the bush canopy. Although this is also time consuming and does not manage weeds growing up next to the bushes, maintaining a weed cover beneath plants may help maintain soil organic matter. Hand cutting and removal will still be needed for some weeds. The goal is to encourage weed species that are low-growing and less competitive and discourage those that are most disruptive.