2011 Farm Walk Program

*Education for farmers, by farmers*

Presented by
Tilth Producers of Washington
& WSU Small Farms Program

**Early 2011 Schedule**

May 16, 2011
Inaba Produce Farms, Wapato

May 23, 2011
Red Dog Farm, Chimacum

June 6, 2011
Welcome Table Farm, Walla Walla

June 13, 2011
WSU Research & Extension Unit,
Mount Vernon

June 27, 2011
Templeton Farm, Chewelah

July 11, 2011
Cloudview EcoFarms, Royal City

July 18, 2011
Middleton Organic Orchard, Eltopia

WSU Mt. Vernon - VIVA Farm Walk
June 13, 2011

[Website links]
http://smallfarms.wsu.edu
www.tilthproducers.org
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Farm Walk Evaluation form...
Please fill out and leave at the site!
Thank You!
Mission Statement: The mission of Washington State University Mount Vernon is to serve the agricultural, horticultural, and natural resource science interests of the state through research and extension activities that are enhanced by the unique conditions of northwestern Washington: its mild, marine climate, rich alluvial soils, diverse small and mid-sized farming enterprises, and unique rural–urban interface.

WSU Mount Vernon is located in the Skagit Valley of northwestern Washington, midway between Seattle, WA and Vancouver, B.C. The region is well known for its scenic beauty, the Cascade Mountain Range, and Puget Sound. The immediate five-county area supports a diverse agriculture, including dairy and livestock industries, and the production of over 60 fresh–market and processing crops on approximately 100,000 + acres. Blueberries, red raspberries, strawberries; cabbage, spinach, table beet and 20+ other vegetable and grass seed crops; cucumbers, green peas, red and yellow potatoes, and specialty vegetables; apple and grape and other specialty fruit cultivars; tulips, daffodils and irises; turf, nursery and greenhouse crops; and, various small grain crops flourish here because of the rich soils and mild, marine climate. WSU Mount Vernon receives support from the allied agricultural and horticultural industries, small farmers, and garden enthusiasts. Preservation of open space and farmland in an urbanizing environment is a key issue for the region.
History

WSU Mount Vernon is one of four off-campus WSU Research Centers operated by the College of Agricultural, Human and Natural Resource Sciences (CAHNRS). Established in 1947, WSU Mount Vernon has a long tradition of serving western Washington’s agricultural and horticultural communities. During the early years of WWII, WSU and USDA scientists working in the area were able to successfully control devastating diseases of beet and cabbage that were being grown for seed. Impressed by the value of research-based information, the community, including farmers, seed companies, processing firms and civic groups raised funds for a permanent facility. The facilities have continued to grow and improve over the years and in 2006, the new Agricultural Research & Technology Building opened. The vision for the building as a full-service research center was led by members of northwestern Washington’s agricultural community in collaboration with WSU and augmented by public appropriations and gifts reaching nearly $2.25 M. The efforts and partnerships here are truly unique, and considered a model for revitalizing R&E Centers throughout the U.S.
Research Programs

The Center houses research programs for entomology, small fruit horticulture, vegetable horticulture, vegetable pathology, vegetable seed pathology, weed science, and plant breeding. Cooperative research between scientists at WSU Mount Vernon and other sites, as well as regional, national and international collaboration, enhances the work of all. Currently, collaborative projects on alternative crops, bio-degradable mulches, high tunnel systems, pest and disease control measures for conventional and organic production systems, riparian buffers, specialty fruits and vegetables, and various bio-fuel crops are generating results that are applicable throughout the Pacific Northwest. Cooperative and interdisciplinary research activities involve personnel in WSU’s NW Extension District, other WSU locations in the state, faculty at other universities, and various public agencies, organizations and volunteer groups. Research activities are funded by grants obtained from local, regional, national, and international sources.

Olson Heritage Farm House

The 2004 renovation of the Olson Heritage Farm House provides housing for WSU graduate students and visiting scientists. Originally built in 1913 by Anders Olof (Andrew) and Maria Olson at a cost of $2,000, the house and surrounding eight acres were purchased by the Skagit Farm Bureau in 1999 as part of the “Land Security” project to ensure the future of research at the Center. Senator Patty Murray led the effort to secure HUD funds to reimburse the Farm Bureau. That year, Mr. Allan Osberg of Seattle, Olson’s grandson, donated $155,000 to Skagitonians to Preserve Farmland to renovate the house in memory of his grandparents. In 2003, the property was transferred to WSU and the house was remodeled to university standards.
**Pesticide Disclaimer**

Documents included in this packet may contain information regarding pesticides used in states other than Washington. It is the responsibility of the reader to determine whether those active ingredients or pesticide products are registered for use in Washington State.

Readers are reminded that all pesticide products, including products certified for use in organic production systems, must be registered by the Washington State Department of Agriculture’s Pesticide Division in order to be legal.

**Exención de Responsabilidad por uso de plaguicidas**

Los documentos incluidos en este paquete pueden contener información relativa a los plaguicidas utilizados en otros estados además de Washington. Es la responsabilidad del lector determinar si los ingredientes activos de los plaguicidas o productos estén registrados para su uso en el estado de Washington.

Recordamos a los lectores que todos los plaguicidas, incluyendo los productos certificados para su uso en la producción orgánica, deben ser registrados por la División de Plaguicidas del Departamento de Agricultura del Estado de Washington para ser legales.
PROJECT: Grafting vegetables for Verticillium Wilt resistance

DURATION: January 2010 – May 2012

PERSONNEL:
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OVERVIEW:
Eggplant, tomato and watermelon are significantly impacted by Verticillium wilt (Verticillium dahliae) throughout Washington; growers can experience up to 25% crop loss in most years and 100% loss in some years. Grafting with resistant rootstock is used throughout Asia, Europe and Canada for eggplant, tomato and watermelon to provide disease control. This project will evaluate vegetable rootstocks and grafting techniques for Verticillium wilt control under Washington conditions. Outcomes include an effective disease control method that can be utilized by all growers (organic and conventional), an expansion of crop options in the area due to effective disease management, and the opportunity for new agricultural industries to develop – the production of grafted transplants and rootstock. Project objectives are:
1. Test grafted eggplant, tomato and watermelon in Washington fields with high Verticillium wilt pressure.
2. Develop guidelines for producing grafted vegetables.

PROJECT OUTLINE:
This study is being conducted at WSU Mount Vernon NWREC and in a cooperating grower’s field in Eltopia, WA with high Verticillium wilt pressure. In 2010, resistant commercial rootstocks and seeding dates were identified, and grafting techniques tested and selected for each crop. Field studies of grafted tomato, eggplant and watermelon were conducted in 2010 and are being repeated in 2011. Research design is a randomized complete block with three to five replications. Treatments in each study are: ‘Epic’ eggplant grafted onto ‘Beaufort’ and Solanum aethiopicum rootstock; ‘Cherokee Purple’ (CP) heirloom tomato grafted onto ‘Maxifort’ and ‘Beaufort’ rootstocks; ‘Crisp’N Sweet’ triploid watermelon grafted on ‘Strong Tosa’ and ‘Emphasis’ rootstocks. In addition, self-grafted and non-grafted treatments are included for each crop. Plants were grafted in May and transplanted to the field by early June each year.
Plant health is rated weekly in the field, and all three crops assessed for vigor on a weekly basis. Plant height (tomato, eggplant) and stem diameter (watermelon) are measured three times during the growing season. Tomato and eggplant yield (fruit number and weight) are measured weekly, and watermelon yield is measured in late August. Fruit quality is measured through soluble solids (°Brix) and firmness. In late August, or before disease affected plants collapse completely, whole plants are harvested and whole-plant dry weight is measured where possible. Plants are assayed for *Verticillium* wilt in the laboratory. For trials with high *Verticillium* wilt severity, soil is assayed to determine density of the inoculum. A greenhouse inoculation study is being conducted in 2011 to confirm pathogenicity of field isolates - plants will be inoculated with *Verticillium dahlia* isolated from field studies and disease incidence will be rated.

In Winter 2011 we tested different healing chamber designs to identify simple, inexpensive and effective techniques suitable for small-scale growers who may be interested in creating their own grafted vegetables. We compared the survival rates of grafted transplants under three different healing chamber designs.

**PROGRESS TO DATE:**

This study is being carried out by Sacha Johnson, a Master of Science student at WSU. The first year of field trials has been completed at NWREC and Eltopia, and the second year is underway. All data has been entered and preliminary analysis is complete. Crop field trials will be completed by September and greenhouse studies will be completed by November. The healing chamber study has been completed and a journal publication is being prepared. A web site [http://vegetables.wsu.edu/graftingVegetables.html](http://vegetables.wsu.edu/graftingVegetables.html) has been posted with new information created from this project.

**FUNDING:**

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**MORE INFORMATION:**

Vegetable Grafting Web Page
[http://vegetables.wsu.edu/graftingVegetables.html](http://vegetables.wsu.edu/graftingVegetables.html)
PLOT MAPS:

Tomato Trial WSU Mount Vernon NWREC

REP 1  REP 2  REP 3  REP 4  REP 5

104  4

204  1

304  2

404  1

504  4

103  2

203  3

303  4

403  3

503  1

102  3

202  4

302  3

402  2

502  3

101  1

201  2

301  1

401  4

501  2

TREATMENTS:

1: Self grafted Cherokee Purple
2: Non-grafted Cherokee Purple
3: Cherokee Purple:Maxifort Graft
4: Cherokee Purple:Beaufort Graft

Buffer: Stupice and Plum Crimson

6 plants per treatment
Eggplant Trial WSU Mount Vernon NWREC

Treatments:
- 1: Self grafted Variety
- 2: Non-grafted Variety
- 3: Epic:Beaufort Graft
- 4: Epic:POS Graft

Buffer: Nadia and Millionaire

6 plants per treatment
Watermelon Trial WSU Mount Vernon NWREC

REP 1
REP 2
REP 3
REP 4
REP 5

POLLINIZER

104
3

204
2

304
3

404
4

504
2

103
2

203
3

303
4

403
2

503
3

102
4

202
1

302
1

402
1

502
1

101
1

201
1

301
2

401
3

501
4

Treatments:
1: Self grafted Variety
2: Non-grafted Variety
3: CS:Emphasis Graft
4: CS: Strong Tosa Graft
Pollinizer: Yellow Shipper
Wildflowers - 6 ft. per row
6 plants per treatment
The healing chamber is a covered structure with controlled humidity and low light where grafted plants are placed immediately after grafting. It takes an average of 7 days for the scion and rootstock to heal together. During these 7 days, the scion is unable to take up water. Therefore, environmental conditions must be controlled to minimize transpiration (water loss) from the scion. The purpose of the healing chamber is to minimize water loss from the grafted plant. The size and design of the healing chamber depends on the scale of production of grafted plants. A home gardener could modify the healing chamber instructions in this handout to create a small healing chamber from a flat, a plastic propagation dome, and shade cloth or a large black plastic bag.

**Healing Chamber Construction**

Our healing chamber is constructed on a bench in the greenhouse. The bench serves as the floor of the healing chamber. The healing chamber can also be set up on the greenhouse floor. Line the floor with clear plastic sheeting to prevent water loss.

The healing chamber height should be 1.5-3 feet tall. Increasing the height decreases the ability to maintain consistently high levels of humidity. A width of less than 5 feet is easier to manage when opening and closing the healing chamber.

**Step by Step Instructions for Constructing a Healing Chamber.**
1. Line the floor of the healing chamber with clear plastic sheeting.
2. Construct a lightweight frame to support plastic and shade cloth. PVC pipe works well for the healing chamber frame.
3. Drape clear plastic sheeting over the frame. Plastic on all sides of the healing chamber prevents moisture loss from the healing chamber.
4. If using a PVC frame, cut segments of slightly larger diameter PVC pipe to use as clips to secure plastic to frame.
5. Drape two layers of shade cloth over the plastic sheeting to block out all light.
**Healing Chamber Management**

Before grafting, spray inner plastic down with water using a hose and spray nozzle until four walls, floor and ceiling are wet and water begins to accumulate on the bottom of the healing chamber. Do this a few hours before placing plants in the healing chamber. Mist the healing chamber and plants well when placing them in the healing chamber. Seal the chamber tightly with clips to prevent water loss and low humidity. Clothespins or bulldog clips work well for tightly closing the healing chamber.

The greenhouse has lower relative humidity than the healing chamber. Therefore, grafted plants need to be gradually introduced to the greenhouse environment. For information on acclimating plants from healing chamber to greenhouse, refer to the ‘How to Graft Eggplants and Tomatoes’ handout.

**Healing Chamber Troubleshooting**

If the humidity is too low or plants are taken out of the healing chamber too soon or too abruptly, scion leaves will begin to wilt. If this is observed, mist plants well and place them back in the healing chamber.

If the humidity is too high or plants are left in the healing chamber for too long, plants may begin to develop physiological disorders. Roots may develop on scion at the graft union (Photo 1). These should be removed with a sharp clean razor blade. Scion leaves may develop edema, a disorder characterized by callus growth on leaf veins (Photo 2). Edema is irreversible, once it develops on a leaf. However, if the plant is moved to a lower humidity environment, new growth will not have edema symptoms.

Because the healing chamber is a warm moist environment, it provides an ideal environment for unwanted organisms such as fungi. When not in use, plastic should be removed and wiped down with a disinfectant such as 10% bleach solution or 70% isopropyl alcohol solution.
Grafting Techniques for Eggplant and Tomato
Sacha Johnson, Carol Miles, and Patti Kreider
WSU Mount Vernon NWREC
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Tel. 360-848-6150 Email milesc@wsu.edu

There are several different techniques used for grafting eggplant and tomato. Deciding which technique to use depends on quantity of plants to be grafted, the size of the plant at time of grafting, whether purchasing special grafting clips is feasible, and personal preferences. This handout provides the basic information on the most common techniques used to graft eggplant and tomato.

Cleft Grafting
- Also known as apical grafting.

  - **Technique.** Cut the rootstock stem horizontally to remove the top. Then cut a 0.5 cm vertical incision in the rootstock. Cut the scion stem into a 0.5 cm wedge and insert it into the cleft incision in the rootstock. The cut surfaces are held tightly in contact with a plastic clip or parafilm.

  - **Advantages.** The cleft cut holds the scion more tightly than splice grafting, so it is possible to use parafilm rather than grafting clips to secure the graft union.

  - **Disadvantages.** This technique takes more time than splice grafting. The rootstock stem may split if the scion wedge is too wide.

Splice Grafting
- Also known as top grafting, tube grafting and slant-cut grafting. This is the most widely used grafting technique for tomatoes and also works well for eggplant.

  - **Technique.** Cut rootstock and scion at matching 45° angles and clip together with a silicone grafting clip.

  - **Advantages.** Easy technique to learn, and a fast way to graft large quantities of plants.

  - **Disadvantages.** Grafting clips are required to hold scion and rootstock in close contact.
Side Grafting

- Also known as tongue approach grafting.

![Diagram of side grafting process]

- **Technique.** Cut matching 45° incisions in scion and rootstock stems to create matching ‘tongues’ of stem. Piece these stem ‘tongues’ together, such that the cut surfaces are in contact. Wrap graft union tightly in parafilm to prevent moisture loss. After 5 days, gradually sever rootstock crown and scion roots from the grafted plant over 2-3 days.

- **Advantages.** This technique has a high success rate. It is less stressful on the plant, as the scion maintains its root system during the healing process. High humidity is not required to heal grafts, so a healing chamber, although recommended, is not necessary. Larger plant material can be used, and stems can have slightly different diameters.

- **Disadvantages.** Rootstock and scion must be transplanted together into a larger container at the time of grafting. Therefore, this technique is slower and more inconvenient than splice grafting or cleft grafting. The scion and rootstock can get confused and should be labeled if they look similar, so that the graft does not end up with the rootstock variety on top and the scion variety on the bottom.
The techniques used for grafting eggplants and tomatoes are very similar. This handout will provide a step-by-step process for grafting both eggplant and tomato using the splice grafting technique. Splice grafting is the most commonly used grafting method for eggplant and tomato because it has a high success rate (95%), is relatively simple, and can be used to graft a large number of plants in a short amount of time.

**Seeding Scion and Rootstock**
For a successful graft union to form, the cambium of the rootstock and scion must be well aligned and in contact with one another. The cambium is a thin layer of actively dividing cells just inside the outer surface of the stem. The scion and rootstock plants must therefore have similar stem diameters at the time of grafting. However, the scion and rootstock may not germinate or grow at the same rate. Do a preliminary trial to determine the growth rates of rootstock and scion plants in your growing environment to determine if you need to seed them at different times.

Seed both scion and rootstock varieties 14-21 days before the desired grafting date. Seed more plants than necessary, so there is a greater selection for matching stem diameters. It is rare to get 100% graft survival, so it is always recommended to graft additional plants to account for some graft failure.

**Grafting**
Plants are ready for grafting when they have 2-4 true leaves. Grafting should be done when plant transpiration is lowest, such as early in the morning, to reduce water stress in the newly grafted plants.

**Preparing for grafting.**
Water both rootstock and scion plants 12-24 hours before grafting. Unless absolutely necessary, it is not advisable to water plants immediately before grafting. If reusing grafting clips, make sure they have been sterilized. A few hours before grafting, spray the healing chamber surfaces with water to raise the relative humidity within the chamber (see ‘Healing Chamber’ handout for more information on healing chamber construction and management). Razor blades must be clean and sanitize hands with antibacterial soap or hand gel. Fill one or two spray bottles with tap water to have on hand, so plants can be misted frequently while grafting.

**The grafting process**
Cut the rootstock stem at a 45° angle below the cotyledons to prevent unwanted rootstock growth. Select a scion with a stem diameter that matches the rootstock stem diameter, and cut at a 45° angle either above or below the cotyledons; choose the scion stem location that best matches the rootstock diameter. Slip a silicone grafting clip onto the rootstock. Slip the scion into grafting slip such that cut surfaces of both stems are in
close contact and air is not trapped between them. If the cut surface of the scion or the rootstock dries out, the graft will fail.

Once you are comfortable with the grafting process, you can cut multiple rootstocks and scions at once to speed up the process. To minimize confusion, discard rootstock tops immediately. Mist all plants with water frequently to reduce water stress.

After you have finished grafting a flat of plants, place it immediately in a healing chamber. See the ‘Healing Chamber’ handout for more information on healing chamber construction and management.

**Healing the Grafted Plants**

When placing newly grafted plants in the healing chamber, mist the inside walls and top of the healing chamber surfaces very well. Seal the healing chamber and do not disturb for two days. On Day 3, open the healing chamber, spray plastic well with water to raise humidity and close again. Water collecting at the graft union can lead to disease, necrotic tissue, and graft failure. If these symptoms are observed, avoid misting plants directly. Do not disturb the healing chamber on Day 4. On Day 5, open the healing chamber for 30 minutes, then spray plastic surfaces well and close tightly. On Day 6, open the healing chamber for one hour, then spray the healing chamber well and close tightly. On Day 7, open the healing chamber for 6-8 hours, then spray the healing chamber well and close tightly. On Day 8, remove the plants from the healing chamber.

This healing schedule is based on our greenhouse grafting environment. Your greenhouse or grafting environment may be different (higher or lower humidity and temperature), and so you may need to adjust the exposure times. The key is to slowly acclimatize the grafted plants without causing permanent wilting which will lead to plant death.

**Transplanting into the Field**

It takes approximately 14 days from grafting for the graft union to fully heal. After removing plants from the healing chamber, allow them to rest in the greenhouse for 1-2 days before hardening them off for 5-7 days before transplanting.

Do not place grafted transplants into the field under windy conditions. If wind is an issue in your area, silicone grafting clips can be left on for support for a few weeks, or the clips can be removed and graft unions wrapped with parafilm to support the graft union. Parafilm will break away from the stem as the stem increases in diameter. Silicone grafting clips will fall off as the stem increases in diameter.

When transplanting, make sure that the graft union remains above the soil line. If the graft union is buried, the scion will root into soil and resistance to soil-borne diseases will be nullified.

**Field Maintenance of Grafted Plants**

If grafting clips are left on plants, check that the clip does not girdle the stem. Remove the clips 2-3 weeks after field transplanting. Check plants every week or two for rootstock growth and remove it immediately. Many commercial rootstocks are extremely vigorous and will quickly overtake scion.
PROJECT DURATION: September 2009 through August 2012

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Note: This list includes only the personnel involved at WSU Mount Vernon NWREC; other participants are located at Washington State University, Pullman, WA, University of Tennessee – Knoxville, TN, Texas Tech University, Lubbock, TX, and USDA-ARS Corvallis, OR.

PROJECT OVERVIEW:
Specialty crops are defined by the USDA as ‘fruits and vegetables, tree nuts, dried fruits and horticulture and nursery crops, including floriculture.’ Specialty Crop Research Initiative (SCRI) projects are designed to solve critical industry issues through research and extension activities that are multistate, multi-institutional, and trans-disciplinary.

Our SCRI project is a collaboration of an inter-disciplinary team of scientists at Washington State University, University of Tennessee, Texas A&M University, Texas Tech University, and the USDA Agricultural Research Service (ARS), specializing in textiles, horticulture, soil microbiology, plant pathology, weed science, agricultural economics, biosystems engineering, and rural sociology. The purpose is to investigate the use of biodegradable mulches (BDMs) in horticultural crop production systems that utilize protective high tunnels (HTs). HTs are passively heated, three or four season field structures that are widely utilized as a way to extend the growing season, make use of limited farmland, and grow crops organically. Polyethylene
plastic mulches made primarily from petroleum are commonly used to reduce weed competition and water loss in specialty crops grown in HTs and open fields. Drawbacks of plastic mulches include the costs of purchase, labor and disposal as well as the negative environmental consequences of using non-renewable and non-degradable feedstocks.

Project goals:
- Network with national leaders in BDM materials to achieve state of the art knowledge, based on how to evaluate BDMs in protective crop culture systems, especially in regards to their ability to fully biodegrade.
- Improve research-based information on growing fruits and vegetables under HTs in three underserved areas (Pacific Northwest, Mid-South, Southeast) of the U.S. with climatic extremes to enhance production and profitability, food and environmental security, and mitigate pest/disease threats.
- Obtain baseline socio-economic data for measuring and communicating short-term, intermediate and long-term outcomes and impacts of the project’s accomplishments.

RESEARCH OUTLINE:
A three-year field experiment is underway in Mount Vernon, Washington, Knoxville, Tennessee, and Lubbock, Texas, and includes one study of BDMs (Table 1) with a tomato crop (cultivar ‘Celebrity’), and three cultivar studies of the primary crops (tomato, lettuce, and strawberry; Table 2) grown in HTs. The main plot is cropping system (HT or open field) and the sub plot is BDM or cultivar. Issues addressed by the agricultural research team include crop productivity, production efficiency, pests and disease identification and management, and system profitability. Key objectives are:

- Evaluate cultivars of three primary crops (tomato, lettuce, strawberry) commonly used in high tunnel production in relation to productivity (yield and quality), environmental conditions, pest/disease threats, and profitability in three contrasting environments.
- Evaluate tomatoes grown in HT versus open field settings with five different BDM treatments plus a non-mulch control.
- Study BDMs in greenhouse and field settings in terms of impacts on soil ecology and root health as well as meeting ASTM standards for bio-degradability.
- Ascertain the economic costs and benefits of HT and BDM use.
- Identify barriers and bridges to HT and BDM adaptation through focus groups.

Methods in Washington: Four high tunnels (‘Solo’ model, Haygrove LTD, UK) measuring 120 by 27.5 feet were erected April 19, 2010 in a field at WSU Mount Vernon NWREC managed organically for 4 years. Each main plot consists of four beds spaced 6 feet apart, 3 ft wide and 120 ft long. Organic fertilizer Par 4 9-3-7 (North Pacific Ag Products, Portland, OR) was broadcast-applied at 80 lb N/acre to bed centers and incorporated. For variety trials (tomato, lettuce, and strawberry; Table 2), beds are 9 in. high and drip tape (low flow, 5/8 in. diameter, 8 mil wall thickness, 8 in. emitter spacing; T-Tape, San Diego, CA) and black plastic mulch (1.0 mil embossed; Pliant Corporation, Washington, GA) were laid on the beds when they were shaped with a Model 2600 Raised Bed Mulch Layer (Rain-Flo Irrigation, East Pearl, PA). In the BDM study, drip tape was hand laid on the bed then covered with mulch treatments (Table 1).

1 American Society for Testing and Materials (ASTM) is globally recognized for developing and delivering international voluntary consensus standards for testing methods, specifications, guides, and practices that support industries and governments worldwide.
Tomato plots (both the BDM and cultivar study) include a single row of 7 plants (2 feet in-row spacing), and strawberry and lettuce cultivar study plots include a double row of 14 plants (1 foot in-row spacing) for a total of 28 plants per plot. Six-wk-old seedlings were transplanted in spring for lettuce (4/23/2010; 4/22/2011), in early summer for tomato (inside 5/27/2010, outside 6/3/2010; inside 5/12/2011, outside 6/01/2011), and in spring and fall for strawberries (4/29/2010, 10/20/2010). Tomato plants are staked using a Florida Weave training system. Soil moisture is monitored twice a week (Watermark sensor, Irrometer Corp., Riverside, CA) at four locations within each main plot (one per row). Irrigation is applied through drip tape (0.34 gal/min per 100 ft at 8 psi), and outside rate is adjusted based on precipitation. Application in 2010 was 0.5 in. once a week beginning at transplanting, and then 0.25 in. twice a week from August 12 until the end of the growing season. In 2011, irrigation started on May 2 for lettuce and May 13 for tomatoes, and is 0.25 twice a week.

Converted Organics 521 fertilizer (Converted Organics of California LLC, Gonzales, CA) is injected into the drip irrigation system beginning 2 days after transplanting. Application rates are 0.5 lb N/acre/day every 7 days for strawberries, 7 lbs N/acre/week for tomato, and 10 lbs N/acre every 2 weeks for lettuce. Fertilization application in 2010 was from May 27 to September 15 (12 applications), and in 2011 started on May 6 and will go until mid September. Nutrient levels are monitored by visual examination for all crops and strawberry foliar testing was done at a commercial laboratory 4-6 weeks after planting. In 2010, four applications of Pyganic Crop Protection EC 1.4 (MGK Company, Minneapolis, MN) were made to all crops on June 11, July 9 and 19, and August 4 at a rate of 2 oz/gal (7 gal/1500 ft) for aphid and thrip control. Two applications of NuCop 50 WP (Albaugh, Inc., Ankeny, IA) at 3 lb/acre in 90 gpa were made to tomatoes on August 20 and September 3 to delay onset of late blight. Organic BioLink Cal Plus (Westbridge, Vista, CA) was applied to tomato foliage (2 qt/acre) on September 8 and 22 for blossom end rot control.

Environmental data on air and soil temperature, relative humidity, leaf wetness, PAR (light transmission), wind speed, and wind gust speed are recorded every 15 min by a Hobo weather station (Onset Computer, Bourne, MA) located within one main plot replication from first transplanting through final harvest. Tomatoes and strawberries are harvested when fruits are at least 75% ripe, once or twice a week as needed. Lettuce is harvested when 75% of plants in a plot reached marketable head size. Crop yield measurements include days to first harvest, number of harvest dates, total weight, marketable weight, total number, marketable number, and quality rankings. Other variables that are monitored and recorded include bolting in lettuce, blossom end rot in tomatoes, misshapen fruit in strawberries, and diseases in all crops. Following peak harvest, tomato and strawberry fruit quality is evaluated, including firmness, soluble solids, pH, and titratable acidity.
Table 1. BDMs evaluated in SCRI high tunnel project in 2010 and 2011 at WSU Mount Vernon NWREC.

<table>
<thead>
<tr>
<th>Mulch Product</th>
<th>Company</th>
<th>Mulch Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 BioBag Ag-Film</td>
<td>BioBag; Palm Harbor, FL</td>
<td>Cornstarch and non-disclosed biopolymers, biodegradable &amp; compostable</td>
</tr>
<tr>
<td>2 BioTelo Ag</td>
<td>Dubois Agrinovation; Waterford, ON, CAN</td>
<td>Cornstarch and non-disclosed biopolymers, biodegradable &amp; compostable</td>
</tr>
<tr>
<td>3 Experimental spunbond nonwoven</td>
<td>Saxon, GER; NatureWorks LLC, Blair, NE</td>
<td>100% PLA</td>
</tr>
<tr>
<td>4 Black Plastic, 1.0 mil</td>
<td>Pliant Corp.; Schaumburg, IL</td>
<td>Standard polyethylene, agricultural plastic control</td>
</tr>
<tr>
<td>5 Weed Guard Plus</td>
<td>Sunshine Paper Co. LLC; Aurora, CO</td>
<td>Cellulosic, biodegradable control</td>
</tr>
<tr>
<td>6 Non-mulch control</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Cultivars evaluated in SCRI high tunnel project in 2010 and 2011 at WSU Mount Vernon NWREC.

<table>
<thead>
<tr>
<th>Tomato</th>
<th>Lettuce</th>
<th>Strawberry2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celebrity (D)</td>
<td>Adriana (Boston)</td>
<td>Albion (EB)</td>
</tr>
<tr>
<td>Cherokee Purple (ID)</td>
<td>Coastal Star (romaine)</td>
<td>San Andreas (EB)</td>
</tr>
<tr>
<td>Early Girl (ID)</td>
<td>Ermosa (Boston)</td>
<td>Seascape (EB, 2010 only3)</td>
</tr>
<tr>
<td>Oregon Spring (D)</td>
<td>Greenstar (green/redleaf)</td>
<td>Chandler (JB)</td>
</tr>
<tr>
<td>Red Brandywine (ID)</td>
<td>Jericho Star (romaine)</td>
<td>LCN (JB)</td>
</tr>
<tr>
<td>Stupice (ID)</td>
<td>New Red Fire (green/redleaf)</td>
<td>Strawberry Festival (JB)</td>
</tr>
</tbody>
</table>

1D=determinate; ID=indeterminate
2EB=Everbearing; JB=June bearing
3Seascape strawberry was in the 2010 trial but plants were not available for 2011.

PROGRESS TO DATE:
The field studies were initiated in 2010 and are being repeated in 2011 and 2012. Preliminary findings include:

Outreach
- A public website [http://mtvernon.wsu.edu/hightunnels/](http://mtvernon.wsu.edu/hightunnels/) was created for general outreach.
- A glossary of common definitions was created to standardize the nomenclature used among team members and the public, and is posted on our website [http://mtvernon.wsu.edu/hightunnels/Glossary.pdf](http://mtvernon.wsu.edu/hightunnels/Glossary.pdf).
- Numerous presentations on the project were given to growers in the three states, and several scientific abstracts and proceedings were published as well; a complete list of outreach activities in 2011 is also posted on the website [http://mtvernon.wsu.edu/hightunnels/presentations.html](http://mtvernon.wsu.edu/hightunnels/presentations.html).
Biodegradable Mulches

- Total number and weight of ‘Celebrity’ tomato fruit were significantly less in bareground and spunbond treatments than in BioBag and BioTelo treatments.
- Tomato fruit cracking (primary disorder leading to unmarketability in WA) was least in the bareground treatment.
- There was a significant interaction between mulch treatments and location (HT and OF) for number of tears and visual assessment of degradation; spunbond and black plastic mulch had the least degradation assessed visually throughout the study in both HT and OF while BioTelo and cellulose control had the most; visual degradation was 2-4 times greater in OF than in HT for all treatments.
- Weeds did not differ between HT and OF; weed number and weight were significantly greater in spunbond mulch than in all other mulch treatments; all other mulch treatments were statistically equivalent to black plastic in regards to weed number and weight, and had significantly fewer weeds than the bareground treatment which was handweeded as needed.
- In OF, black plastic mulch tended to have less soil moisture than the other treatments; in HT, bareground tended to dry out more rapidly and had more pronounced wet/dry cycles.
- Mulch and soil samples are being analyzed in different labs for multiple physical and chemical characteristics.
- An experimental protocol (mesh bag study) was developed for uniform system analysis of (bio)degradation of mulch samples for up to 2 years following tillage into the soil.
- Alternative feedstocks are being investigated for new nonwoven blends, which may better meet the weed suppression and mulch degradation potential required for agricultural uses.
- The definition of biodegradability within an agricultural soil environment is being developed by this SCRI team, and may contribute to a new ASTM standard.

High Tunnels

- All yield parameters for tomato cultivar ‘Celebrity’ in the BDM study were significantly greater in HT than OF treatments; percent marketable yield was also greater in HT than OF.
- All yield parameters of tomato cultivars were 2-6 times greater on average in HT than in OF, and percent marketability was 2 times greater in HT than in OF.
- A strong windstorm on May 3, 2010 revealed structural weaknesses to the model of Haygrove high tunnel in WA; a WSU Undergraduate Senior Design Project in the Mechanical & Materials Engineering Department investigated how to improve the design to withstand strong winds; the need to improve design factors and to educate growers on wind and risk management were unexpected project developments.
- Air temperatures were slightly higher in HT than OF, especially June through August; soil temperatures were also consistently higher inside HT than in OF.
- Leaf wetness was much reduced in HTs, especially during rainy periods.
- Risk management tools, including crop and other insurance options, for high tunnel production, particularly under conditions of flooding and high winds, have been identified.

Crop Cultivars

- Tomato cultivars performed similarly in HT and OF; ‘Early Girl’ produced the most marketable fruit weight while ‘Cherokee Purple’ produced the least; the majority of fruit of heirloom cultivars ‘Cherokee Purple’ and ‘Brandywine’ did not meet USDA
marketability standards and our marketability data is not representative of marketability that growers generally achieve with these cultivars.

- Cracking was the primary unmarketability factor for all tomato cultivars in both HT and OF, followed by X-small fruit, ripening disorder, misshapen fruit, and zippering.
- Lettuce yield did not differ for cultivar or location (HT and OF); however, head height, head diameter and core length were greater in the HT compared to the OF.
- Strawberry total yield for all cultivars were comparable in HT and OF, but marketable yield was greater and culls were less in HTs; culls accounted for 29% of the berries in HTs, and for 46% of the berries in OF; there were fewer overripe and damaged fruit in HTs.
- ‘Seascape’ produced more marketable strawberries and more culls than ‘San Andreas’ or ‘Albion’ in both HT and OF.
- Type III Bronzing was the most common cause of culled strawberry fruit; catfacing was also common, and in OF ‘Seascape’ had the highest catface levels; Botrytis fruit mold and water damage occurred in OF but not HT.
- Crop budgets for growing lettuce, strawberry and tomato under high tunnels in TN, TX and WA, previously unavailable, are now being drafted.

**Crop Diseases**

- Disease ratings in 2010 indicate that HT can dramatically alter both incidence and severity of foliar pathogens compared to open field (OF) settings:
  - Late blight on tomato was significantly less in HT than OF; HT provided excellent control of late blight in western Washington.
  - There were no significant differences among tomato cultivars in foliage susceptibility to late blight as all were susceptible; Celebrity had significantly more blighted fruit.
  - Leaf mould (*Fulvia*) on tomato was significantly more severe in HT than OF (opposite of late blight), leaves in lower canopy primarily affected.
  - Tomato cultivars vary in susceptibility to leaf mould; Brandywine most susceptible; Celebrity most resistant.
  - Tomato physiological leaf roll is not necessarily more severe in HT than OF; but, the story is complicated (soil temperature and water likely play a role); Oregon Spring and Red Brandywine generally had significantly lower physiological leaf roll severity across all rating days.
  - There were no significant differences among BDM treatments for tomato physiological leaf roll on Celebrity in HT plots.
  - Celebrity planted in the OF bareground and SB-PLA had significantly less physiological leaf roll than in the other BDM treatments.
- Root diseases, and soil and plant health in 2010 indicate that greater focus is needed on soilborne disease progression in HT versus OF environments:
  - Lettuce: no difference in incidence of Sclerotina white mold among cultivars or by plot location; Botrytis gray mold significantly more severe on Coastal Star and Jericho Star (seedborne infection suspected); Botrytis disease incidence tended to be higher in HT than OF but not statistically different.
  - Strawberry: Verticillium wilt incidence not different among cultivars, but % incidence was significantly higher in HT (15.8%) than OF (7.5%); in contrast,
Botrytis incidence on strawberry fruit not different among cultivars, but significantly more severe in OF (2.2%) than HT (0.2%).

**Soil**
- Soil moisture and temperature data at various depths have been collected across sites, using environmental monitoring instruments.
- Baseline soil samples from WA, TX and TN have been analyzed for bulk density, wet aggregate stability, and aggregate size distribution; also, electrical conductivity, pH, and cation exchange capacity; and finally, microbial biomass C, two enzyme potentials related to C and N cycling, potentially mineralizable N, and microbial community structure via phospholipid fatty acid profiling.
- Preliminary analysis on % area loss of BDM materials exposed to field conditions during Year 1 showed geographic location as a major driver in degradation losses. Few BDM samples showed measurable losses from TN or WA. In contrast, some TX samples displayed up to 28% area reduction.
- The cellulose control (WeedGuard Plus) which degraded up to 100% at all geographic locations appears to have held up well over the growing season giving adequate weed control.
- Project researchers continue to perform biological and chemical analyses on soil collected from buried mesh bags that contain BDM samples in order to determine how (bio)degradation of these products might influence important properties such as nutrient cycling, enzymatic activities, pH, electrical conductivity, total organic C and total N.

**Sociology**
- Grower knowledge about BDM, HTs and HT/BDM systems appears to be generally low as much of the expertise needed to understand and make decisions about these technologies is lacking. However, there is a large demand for learning more about HTs, BDMs and HT/BDM technologies among the growers.
- Growers appear to have more knowledge about HTs, less knowledge about BDMs, and even less knowledge about BDM/ HT systems. Participation in a field demonstration and focus group meeting significantly increased grower knowledge about BDMs, HTs and HT/BDM technologies.
- Knowledge about the barriers and bridges to the successful design, development and adoption of these technologies also significantly increased between these two time periods.
- Growers often seemed to be more aware and concerned about the barriers than the bridges to these technologies. Most of the bridges that were identified related to the nature and performance of the materials, quality of the crops, and providing effective outreach and education to growers and consumers.

**FUNDING:**
USDA Specialty Crop Research Initiative (SCRI): $1,999,002 (project total at 3 sites, 2009-2012)
WSU CSANR BIOAg: $ 22,799 (2010) (Jeremy Cowan, Ph.D. student, tomato fruit quality)
WSU CSANR BIOAg: $ 18,666 (2010) (Sacha Johnson, M.S. student, tomato grafting for disease management in high tunnels)
MORE INFORMATION:
SCRI Project on High Tunnels and Biodegradable Mulch
http://mtvernon.wsu.edu/hightunnels/

SCRI-SREP Project CRIS Report: Biodegradable Mulches for Specialty Crops Produced Under Protective Covers, Year 1, October 1, 2009 – September 30, 2010
http://mtvernon.wsu.edu/hightunnels/SCRI-CRIS-2010.pdf

Wind Damage to High Tunnel Structures (May 3, 2010, WSU Mount Vernon)
http://vegetables.wsu.edu/HighTunnelDamageWA5-10.pdf

PUBLICATIONS:


Jones, R., A. Kirschner, J. Lamphere, A. Corbin, A. Wszeleki, R. Wallace, E. Malayter, A. Basinger, D. Inglis, and C. Miles. 2011. Identifying the barriers and bridges to high tunnel/BDM production systems among specialty crop producers and other stakeholders. 17th International Symposium for Society and Natural Resource Management, June 4-8, Madison, WI.
**PROJECT:** Barley Varieties for Food, Feed, and Malt in Western Washington

**DURATION:** Fall 2009 – Summer 2011

**PERSONNEL:**
Jeffrey Endelman, Graduate Research Assistant, WSU Mount Vernon NWREC; 360-848-6129; j.endelman@wsu.edu
Stephen Jones, Professor, WSU Mount Vernon NWREC; 360-848-6120; joness@wsu.edu
Steve Lyon, Senior Scientific Assistant, WSU Mount Vernon NWREC; 360-848-6121; slyon@wsu.edu

**OVERVIEW:**
Barley is a versatile grain that can be used for food, feed, and malt. Selecting a variety that is adapted to the maritime conditions of western Washington and that has the appropriate quality characteristics (e.g., malting quality, hulless for food) is critical to the success of a farming operation. However, there is currently no scientific information available about the performance of barley varieties in western Washington. Because of the diverse microclimates and farming systems in the region, this project is testing barley varieties and advanced breeding lines at several locations, under both conventional and organic conditions.

**PROJECT OUTLINE:**
Replicated trials of spring and winter barley lines have been conducted on the research farm at WSU Mount Vernon and in the fields of cooperating farmers near Lynden and Coupeville.

**PROGRESS TO DATE:**
Results for yield, test weight, height, and disease reaction from the 2010 trials at WSU Mount Vernon have been posted at [http://plantbreeding.wsu.edu/varietyTrialsWesternWA.html](http://plantbreeding.wsu.edu/varietyTrialsWesternWA.html).

For winter barley, one of the few modern varieties specifically adapted to the maritime Pacific Northwest (PNW) is Strider, released by Oregon State University (OSU) in 1998. A new variety called Alba from OSU is in the final stages of release. In the 2010 trial in Mount Vernon, Strider yielded 2.6 ton/acre while Alba yielded 3.3 ton/acre. Neither Strider nor Alba are suitable as malting barley. Consult the website for more information about the performance of several winter malting barley lines from OSU that have yet to be released.

Western Washington growers have a number of options for spring barley. Bob, Champion, and Baronesse are excellent feed varieties, with yields in the range 2.8–3.2 ton/acre under conventional conditions in Mount Vernon in 2010. The semi-dwarf spring barley BCD47 (a limited release from OSU) stood out for its resistance to lodging and stripe rust and its high yield (3.5 ton/acre). Comparable yields were observed under conventional conditions in Coupeville, while the yields under organic conditions in Coupeville and Lynden were reduced by 20% on average. For spring malting barley, the varieties AC Metcalfe, Harrington, and
CDC Copeland all had good agronomic performance in Mount Vernon. (Malt quality of the grain was not evaluated.)

Several hulless spring and winter barley lines, which produce naked grain (like wheat) that can marketed as a food crop, had good agronomic performance in 2010. None of these lines are commercially available yet.

The results from 2010 indicate that barley varieties developed under conventional conditions in the PNW are also suitable for organic production.

**FUNDING:**
WSU Center for Sustaining Agriculture and Natural Resources (CSANR)

**PLOT MAP:**
Available upon request

**MORE INFORMATION:**
http://plantbreeding.wsu.edu/
PROJECT: Improving the nitrogen efficiency of bread wheat in diverse production systems of western Washington State.

DURATION: October 2009 – April 2012

PERSONNEL:
Lucas Patzek, Ph.D. Student, Department of Crop and Soil Sciences, WSU Mount Vernon NWREC; 360-848-6120; lpatzek@wsu.edu.
Stephen Jones, Professor, Department of Crop and Soil Sciences, WSU Mount Vernon NWREC; 360-416-5210; joness@wsu.edu.
Carlo Leifert, Professor, Ecological Agriculture, Newcastle University, United Kingdom; +44 (0) 166 183 0222; c.leifert@ncl.ac.uk.

OVERVIEW:
The purpose of this research is to reduce the input of nitrogen (N) fertilizer in diverse bread wheat production systems in high-rainfall regions without impacting the yield and quality of the baking flour. Wheat is commonly rotated with vegetable, fruit and ornamental cash crops in western Washington in order to reduce nutrient loss, as well as to provide organic matter to the soil, and to break pest cycles. N nutrients are easily lost from farmland by various processes to water as well as the atmosphere, which can pose serious pollution, conservation and health concerns. The potential for this loss is exacerbated with increased precipitation. Understanding how to improve the N efficiency of high-rainfall production systems without severely impacting grain yields, baking quality or the nutritional value of the flour has become tantamount due to a strong and increasing demand for local wheat. The hard red class of wheat, bread wheat, has a unique high N requirement, as baking quality relates to protein content, which in turn relates to N content. Therefore, too little N fertilizer will result in poor yields and poor baking quality, but too much N fertilizer can pose an unnecessary financial burden to farmers and result in harmful environmental impacts if N escapes the farmland. The specific goals of this research are:

1. To evaluate the effect of nitrogen fertilizer (organic versus mineral forms; and 3 different rates of application) on yield, flour extraction rate, baking quality and antioxidant content of 6 different hard red (bread) winter wheat varieties;
2. To evaluate the effect of wheat residues and nitrogen treatments on nitrogen fixation by winter peas grown in rotation with the winter wheat.

PROJECT OUTLINE:
Hard red (bread) winter wheat – winter pea rotations have been established at four different field sites at WSU Mount Vernon. Two plantings are offset in time from the other two by one growing season, thus the rotational system is replicated over time, allowing the researchers to assess the effects of location and year on N dynamics.

Study 1 – Effect of nitrogen treatment on yield and quality characteristics of hard red winter wheat. Six hard red (bread) winter wheat varieties identified as having contrasting agronomic performance under low-input versus high-input conditions are being grown under
two N input types (poultry feather meal and sulfur-coated urea) and three N input levels (0, 85 and 170 kg total N/ha). We utilize a split-plot design with a two-way factorial at the whole plot level. Whole plots are replicated four times at each location and sub-plots are randomized within each whole plot. The two whole-plot factors are N input type and N input level, and winter wheat variety is the split-plot factor. Only wheat heads are harvested, allowing for the incorporation of plant residues into the soil and the study of N availability over time in the cropping sequence. In-season agronomic assessments are made of plant heights, lodging (tendency to fall over) and disease susceptibility. Post-harvest assessments are made of yield and test weight, which is correlated with flour extraction rate. Grain quality tests are performed at the USDA-ARS Western Wheat Quality Lab to quantify grain protein content, the rising strength of the dough and sprouting damage. An analysis of phenolic acid composition and concentration in the wheat grain is performed at Newcastle University in the United Kingdom. Grain phenolics have been shown to have anti-oxidant activity and antitumor properties, yet little is known about how N fertility, especially organic versus mineral N, affect the total phenolic content in the grain.

**Study 2 – Effect of nitrogen treatment wheat residue on nitrogen fixation by winter peas.** The wheat is followed by a uniform fall planting of N-fixing winter peas, which are treated as a green manure crop and incorporated into the soil before setting seed in the early spring. Therefore, any N fixed by the peas should enter the soil N pool. The above-ground portions of all pea plants within a randomly placed 0.14 m² frame are harvested by hand in each plot. Dry above-ground biomass is quantified, along with above-ground N content per unit area. Both biomass and N content are highly correlated with the amount of N which might be available to the spring cash crop following this green manure pea crop.

**PROGRESS TO DATE:**
This research is performed as part of European Union grant *KBBE-2007-1-2-15: Reducing the utilization of mineral fertilizers by improving the efficiency of nutrient use in European crops*, with Prof. Carlo Leifert as the lead on the grant. The project is carried out by Lucas Patzek as part of his Ph.D. dissertation in Crop Science under Prof. Stephen Jones. It was initiated in October 2009, and at present all four research field sites are established at WSU Mount Vernon. One season of the wheat-pea rotation has been completed. One additional season will be completed in spring of 2012.

**FUNDING:**
European Union grant *KBBE-2007-1-2-15: Reducing the utilization of mineral fertilizers by improving the efficiency of nutrient use in European crops*
Organically Grown Company

**PLOT MAP:**
Upon request.

**MORE INFORMATION:**
[http://plantbreeding.wsu.edu](http://plantbreeding.wsu.edu)
**PROJECT:** Improving the production of organic bread wheat in western Washington

**DURATION:** 10/09 to 10/11

**PERSONNEL:**
Karen Hills, Graduate Research Assistant, WSU Mount Vernon NWREC; 360-848-6129; khills@wsu.edu
Dr. Stephen Jones, Professor, WSU Mount Vernon NWREC; 360-848-6120; joness@wsu.edu
Steve Lyon, Senior Scientific Assistant, WSU Mount Vernon NWREC; 360-848-6121; slyon@wsu.edu

**OVERVIEW:**
Small grains are currently used in rotations in the Skagit Valley of northwestern Washington to break disease cycles and improve soil quality, but are sold through the commodity market and rarely generate much profit for the grower. Improvement for local farmers is aimed at the potential for connecting bakers, millers and growers to create a decentralized small grain supply chain. This type of supply chain takes advantage of the local food movement and proximity to populated areas to help the farmers get maximum value from their small grains through sale of organic wheat flour either to artisan bakers or directly to consumers. A survey is currently underway to assess the level of interest by commercial bakers in sourcing wheat and flour from Western Washington. Winter wheat fits well into organic crop rotations both because of its spring weed competitiveness and earliness of harvest. Protein is generally the limiting factor for the production of high quality organic winter wheat for bread. Late season topdressing with a nitrogen fertilizer is sometimes used to improve protein levels in conventional wheat, however it has not been determined whether this type of technique would be effective or economical in organic systems. This is the focus of current field research.

**PROJECT OUTLINE:**
**Survey:** A related project is underway to determine the level of interest among commercial bakers in Western Washington in sourcing regionally produced (West of the Cascades) wheat and flour. The survey covers 19 counties of western WA and will investigate which type of bakers are most likely to place an importance on sourcing regionally produced wheat and flour, how bakers define “local,” bakers’ perceptions of barriers to sourcing locally, and the potential for the future development of a short wheat flour supply chain in the region.

**Field Trial:** Two winter wheat trials were planted in October 2009, one on-farm in La Conner (Sumas silt loam soil) and one on-station at WSU Mount Vernon NWREC (Skagit silt loam soil), to investigate the effects of cultivar and rate of application of a commercially available blended fertilizer approved for organic production. The area receives approximately 32 inches of rainfall per year, with most falling between October and April. The cultivars planted were all hard winter wheat and included two reds (Bauermeister and WA-8022) and one white (MDM). WA-8022 is a breeding line that has not been commercially released, but showed promise for western WA in previous trials. The experimental design was a randomized
A blended fertilizer (Perfect Blend™ 7-2-2) was surface applied to all plots at a rate of 30 lbs N/acre in early spring and at rates of 0, 20, 40, 60, and 80 lbs N/acre at boot stage.

**Progress to Date:***

**Survey:** To date 70 completed surveys have been received from eligible respondents. Results are currently being compiled.

**Field trial:** One field season has been completed and results are summarized below. Field trials were repeated in both locations and will be harvested in August 2011.

**Summary of Results***

**Survey:** Results will be available on the website http://plantbreeding.wsu.edu by early 2012

**Field Trial:** Protein quantity, averaged across varieties, increased from 11.49 % and 12.02 % for the controls at the two sites to 12.35 % and 13.50 % for the plots receiving 60 lbs of N at the boot stage. Protein increases were negligible beyond 60 lbs N/acre. There were no significant differences in yield between fertility treatments. Protein quality was measured by SDS sedimentation at the USDA quality lab in Pullman. Protein quality averaged across varieties increased from 8.8 and 12.1 cc/g for the controls at each site to 10.0 and 12.8 cc/g for the plots receiving 60 lbs N/acre at boot stage. Like with protein quantity, protein quality increases were negligible beyond 60 lbs N/acre. These values were slightly lower than the average of similar samples analyzed at the quality lab (mean = 14.1 cc/g), but are within a normal range for samples with comparable protein quantity. These tests will be repeated with the 2011 samples.

**Funding:**

Glen D. Franklin Endowed Graduate Fellowship in Crops and Soils, $47,000

WSU College of Agriculture Human and Natural Resources

**Plot Map:**

Upon request

**More Information:**

http://plantbreeding.wsu.edu
Organic Viticulture Resources

There are many things to consider when deciding if organic viticulture production is right for your future goals and business plans. In addition to the information below on establishing organic vineyards, there are considerations that need to be made regarding Organic Vineyard Management and Organic Pest, Disease and Weed Management.

Establishing An Organic Vineyard


WSU-Mount Vernon also has some excellent available resources regarding organic vineyard establishment and production.

Cornell University also produces an annual Organic Grape Production Guide.

Materials and Supplies

WSDA Organic Materials List and Information
This list is subject to change annually; please check current list.

WSDA Seed and Planting Stock Guidelines

Resources

LIVE (Low Input Viticulture and Enology, Inc) is a non-profit organization based in Salem, OR that provides education and independent third-party certification for vineyards and wineries using international standards of sustainable viticultural and enological practices in both wine-grape and wine production. Checklists, guides, workbooks and resources available.

Northwest Berry & Grape Information Network is a comprehensive information and communications resource for berry and grape production practices, research, and marketing. This Northwest network is sponsored by Oregon State University, University of Idaho, Washington State University and USDA's Agriculture Research Service.

Puget Sound Wine Grower's Association is a membership-based organization that supports wine grape growers and vintners in the Puget Sound region. They host public and member-only listervs, events, and seminars.

Washington Association of Wine Grape Growers is a statewide membership-based association that advocates for the wine growing industry by providing promotion, information, representation and education. In 2005, they made available their VineWise Guide: A Washington Guide to Sustainable Viticulture, which is a series of self-assessment evaluation forms covering a wide array of business and sustainable viticulture topics.

Disclaimer:
Any lists of sources are designed to help users find materials, supplies and further resources. We do not endorse any of the businesses listed nor do we detract from any business not listed. Our web site provides links to external sites for the convenience of users. These external sites are not managed by WSU extension. Furthermore, WSU Extension does not review, control or take responsibility for the content of these sites, nor do these sites implicitly or explicitly represent official positions and policies of WSU Extension.

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Organic Certification and Sustainability

Washington Tilth Association is a statewide nonprofit organization dedicated to provide support for and promotion of biologically sound and socially equitable agriculture.

WSDA Organic Food Program - Provides information on the procedures of becoming certified organic, and is a certifying agency for growers.

USDA National Organic Program - The NOP develops and administers national production, handling, and labeling standards for organic agricultural products.
**Project:** Management of powdery mildew (*Erisiphe necator*) in organic wine grapes in western Washington

**Duration:** May 2011 – May 2013

**Personnel:**
Carol A. Miles, Vegetable Horticulture Specialist, WSU Mount Vernon NWREC; 360-848-6150; milesca@wsu.edu
Michelle Moyer, Viticulture Extension Specialist, WSU Prosser IAREC; 509-786-9234; michelle.moyer@wsu.edu
Walter Mahaffee, Research Plant Pathologist, USDA-ARS, 541-738-4036; Walt.Mahaffee@ars.usda.gov
Jonathan F. Roozen, Agricultural Research Technologist, WSU Mount Vernon NWREC; 360-416-5206; jfroozen@wsu.edu
Jacqueline King, Technical Assistant, WSU Mount Vernon NWREC; 360-848-6130; kingjack@wsu.edu
David Wheeler, M.S. candidate, WSU Mount Vernon NWREC

**Overview:**
Organic wine grape growers in western Washington report serious problems in controlling grape powdery mildew. The overall goal of this research project is to improve the economic and environmental sustainability of disease management in organic vineyards by:

1.) Evaluating different organically-allowable fungicides for control of grape powdery mildew (GPM) in both the canopy and on fruit; and
2.) Evaluating the impact of fruit zone leaf pulling on fruit GPM incidence and severity.

**Project Outline:**
An on-farm trial will be conducted in a commercial vineyard in Whatcom County. The 3-acre vineyard was planted in 2008 and consists of Madeline Angevine, a common white wine variety grown in western Washington. The research design is a randomized complete block with split plot treatments where the main plot is fungicide and the split plot is leaf pulling. The main plot is 1 row wide and 40 plants long (240 feet) and treatments are: 1.) Serenade; 2.) Sonata; 3.) Regalia; 4.) Kumulus DF (standard organic sulfur); and 5.) water control. All treatments will be applied from the time grape vine shoots are 6-in. long until fruit set. The split plot is 5 plants long (30 feet) and fruit-zone leaf pulling treatments are: 1.) prebloom; 2.) fruit set; 3.) fruit at pea size; and 4.) none (control). Data to be collected includes weekly canopy ratings for incidence and severity of GPM to determine levels at pre-application, prebloom, fruit set, and véraison. GPM incidence and severity on fruit will be rated at fruit set. A greenhouse study will be conducted to verify GPM virulence from inoculum collected from the spray study vineyard and to further evaluate the efficacy of the biological fungicides evaluated in the field study. Temperature and relative humidity sensors (Hobo™) will be placed at 4-6 vineyard sites in western Washington to validate the powdery mildew disease forecasting model that has been developed by WSU, OSU and USDA-ARS for the Pacific Northwest. Grape phenology (growth stage) and GPM incidence and severity will be monitored at these sites 6-8 times from prebloom until fruit set.
**PROGRESS TO DATE:**
This project was initiated in May 2011. An MS graduate student has been recruited (David Wheeler), an organic commercial vineyard has been identified and prepared for the studies, and treatments have been assigned to plots.

**FUNDING:**
Washington State Center for Pesticide Registration  $15,000
NARF & Puget Sound Wine Grape Growers      $  5,030
Washington State Grape and Wine Research      $10,000 (pending)

**MORE INFORMATION:**
Tree Fruit & Alternative Fruits Western Washington: Grape Research
http://extension.wsu.edu/MARITIMEFRUIT/Pages/Grapes.aspx

Organic Vineyard Establishment: Trellis and Planting Stock Considerations

Organic Viticulture Resources
http://wine.wsu.edu/research-extension/organic/
PROJECT: Weed Management in a Newly Established Transition to Organic Wine Grape Vineyard

DURATION: May 2008 – May 2011

PERSONNEL:
Carol A. Miles, Vegetable Horticulture Specialist, WSU Mount Vernon NWREC; 360-848-6150; milesc@wsu.edu
Timothy W. Miller, Extension Weed Scientist, WSU Mount Vernon NWREC; 360-848-6138 twmiller@wsu.edu
Jonathan F. Roozen, Agricultural Research Technologist, WSU Mount Vernon NWREC; 360-416-5206; jfroozen@wsu.edu
Callie Bolton, Graduate Student, WSU Mount Vernon NWREC; callie.bolton@email.wsu.edu
Mercy Olmstead, Assistant Professor, Ag-Horticultural Sciences, University of Florida, Gainesville, FL, mercy1@ufl.edu
Jacqueline King, Technical Assistant, WSU Mount Vernon NWREC; 360-848-6130; kingjack@wsu.edu

OVERVIEW:
Weed management in newly established organic wine grape vineyards was identified by local growers and wine makers in a 2007 meeting at WSU Mount Vernon NWREC as the primary constraint to establishing organic wine grape production in the region. The overall goals of this research project were to:

1.) Evaluate organic and sustainable methods for weed management in a newly established wine grape vineyard.
2.) Establish a replicated-plot organic wine grape vineyard for future research in organic wine grape production.

This project established a 2.5 acre replicated-plot organic vineyard at WSU Mount Vernon NWREC in 2009 and investigated five organic weed management options for the establishment years. The vineyard was established with two wine grape cultivars, ‘Pinot Noir Précoce’ (PNP) and ‘Madeleine Angevine’ (MA), both grafted on Couderc 3309. Five cover crop plus tillage treatments were applied during the first two years of establishment: standard clean cultivation in-row and between-row; in-row tillage with Wonder Weeder® (new mechanical in-row cultivator) plus a perennial grass cover crop seeded between-row maintained by mowing; winter wheat cover crop plus mowing between-row and in-row string-trimming; Austrian winter pea cover crop plus mowing between-row and in-row string-trimming; and wheat plus pea cover crop mix plus mowing between row and in-row string-trimming.

Results indicate that all wheat and pea cover crop treatments tended to reduce grape vine shoot growth, vine pruning weights, and vine diameter in both grape cultivars likely due to in-row competition. Weed and cover crop biomass tended to be lowest in the standard treatment, next lowest in the Wonder Weeder treatment, and highest in the wheat and pea cover crop treatments in both 2009 and 2010. Future research is needed to determine if any of these
factors positively or negatively impact fruit yield and quality. Time for weed management was significantly greater in the standard and Wonder Weeder treatments than in the wheat and pea cover crop treatments, especially in the first year of establishment. The Wonder Weeder provided good in-row weed management but caused significant damage to the young vines and so it could not be used to manage weeds directly around vines, and these weeds had to be controlled by hand. Further modifications of the equipment or planting are needed to enable the Wonder Weeder to be used in a newly established vineyard.

PROJECT OUTLINE:
A 2.5-acre vineyard was established at WSU Mount Vernon NWREC in 2009 and transition to organic was completed in November 2010 (Figure 1). The study was a split plot randomized complete block design with 3 replications. Weed control treatment was the main plot and grape cultivar (‘Pinot Noir Précoce’ and ‘Madeleine Angevine’) was the sub plot. Sub plot size was 14 plants long (84 feet) and 5 rows wide for ‘Madeleine Angevine’ and 4 rows wide for ‘Pinot Noir Précoce.’ Subplot size was determined by the number of vines needed to produce 5 gallons of wine, the minimum requirement for future wine studies. The 5 weed control treatments were:

1.) Standard/current control practices for organic vineyard management: cultivating in alleys and hand weeding under vines as necessary to maintain weed-free (clean cultivation).
2.) In-row tillage with Wonder Weeder® (new mechanical in-row cultivator) and grass 
(Lolium perenne ssp. perenne L. and Festuca rubra L. ssp. arenaria F. Aresch.) cover crop seeded at 10 lbs/A between-row plus mowing.
3.) Winter wheat (Triticum aestivum L.) cover crop at 300 lbs/A plus mowing between-row and in-row string-trimming.
4.) Austrian winter pea (Pisum sativum L. ssp. sativum var. arvense (L.) Poir) cover crop at 300 lbs/A plus mowing between-row and in-row string-trimming.
5.) Winter wheat cover crop at 200 lbs/A plus winter peas at 100 lbs/A with mowing in alleys and in-row string-trimming.

Data collected included weed and cover crop biomass, weed maintenance time, vine shoot growth, vine diameter, and vine pruning weights of 5 grape vines in each treatment plot.

Figure 1. Left - planting crew of established transition to organic vineyard in 2009 with graduate student, Callie Bolton, on far right. Right - vine shoot growth in vineyard in 2010.
**PROGRESS TO DATE:**
This project was initiated in January 2009 and completed in May 2011. In Sept. 2009 weed biomass was greatest in the pea cover crop treatment and least in the standard and Wonder Weeder treatments. In July 2010 Weed biomass was greatest in all annual cover crop treatments (wheat, pea and wheat/pea) than in standard and Wonder Weeder treatments. By September 2010, however, weed biomass was not different among any of the treatments. Plot maintenance in the standard standard treatment for the two growing seasons combined required more time than all other treatments, and the Wonder Weeder treatment required the second greatest amount of time. However, time spent in the Wonder Weeder treatment was in operating a tractor-powered cultivator where as time spent in the standard treatment was in hand hoeing. In 2009 there were no differences between cultivars in any of the treatments, however in September 2010 ‘Madeleine Angevine’ produced more shoot growth than ‘Pinot Noir Précoce.’ Both cultivars produced significantly longer shoots in the standard treatment than in any other treatment.

Callie Bolton, the M.S. student on the project completed her MS program in May 2011, and two publications are being prepared: weed control in a newly established transition to organic vineyard (Journal of HortScience), and establishing a new organic vineyard (WSU Extension publication). Project results have been shared with wine grape growers through workshops, field days and web sites. The organic vineyard established by this project will be used for another WSU Masters student project starting in 2011.

**FUNDING:**

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<th>2009</th>
<th>2010</th>
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<td>NARF and Puget Sound Wine Grape Growers</td>
<td>$5,000</td>
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**MORE INFORMATION:**

**Presentations**


Web pages
Tree Fruit & Alternative Fruits Western Washington: Grape Research
http://extension.wsu.edu/MARITIMEFRUIT/Pages/Grapes.aspx

Organic Vineyard Establishment: Trellis and Planting Stock Considerations

Organic Viticulture Resources
http://wine.wsu.edu/research-extension/organic/
**Plot Plan:**

**Main Plot:**
1. Red fescue (red)
2. Mestikoula (white)

**Split Plot:**
1. Control: Plowed, seeded with red fescuegrass Companion mix @ 10 lbs/A.
2. Treatment 1: Above, but use Wonder Wonder for weed control. Seeded with red fescuegrass Companion mix @ 10 lbs/A.
3. Treatment 2: Control treatment plus winter wheat @ 200 lbs/A.
4. Treatment 3: Control treatment plus winter wheat @ 200 lbs/A and winter cover @ 100 lbs/A.

Control:
- Plow and seed wheat in early April.
- Sharpen before early April; harrow as needed; till in late June or early July.
- Disk, harrow, and roll again if weedy in late August.
**PROJECT:** Management of seedling blights in organic vegetable production in the Pacific Northwest

**DURATION:** 01-2009 to 12-2012

**PERSONNEL:** Lindsey du Toit, Associate Prof./Plant Pathologist; Lyndon Porter, USDA ARS Plant Pathologist; Ana Vida Alcala, PhD student; Mike Derie, Scientific Assistant

**OVERVIEW:** Ana Vida (Avi) Alcala, a PhD student at WSU, surveyed organic vegetable growers in spring 2009 to assess the primary concerns and needs regarding damping-off, and to design specific components of her research project. This study addresses management of damping-off in organic vegetable production in the Pacific Northwest, particularly damping-off caused by *Pythium* species in organic pea and sweet corn crops in central Washington, the highest priority crops and region of concern based on Avi’s survey. The pathogens are being examined under conditions of low soil temperature and high soil moisture, typical for early spring in the Columbia Basin when losses to damping-off are most severe. In 2009, Avi collected soil samples from 37 certified organic fields across the Columbia Basin, from which she obtained >300 *Pythium* isolates. Avi used molecular methods to identify the species of these isolates, and then tested up to 9 isolates per species for pathogenicity on pea under cool, moist conditions to identify the primary species associated with damping-off in early spring. In spring 2011, Avi set up three pea field trials to evaluate a diversity of organic seed and/or drench treatments (microbial and non-microbial) for management of damping-off of pea. Two trials are in commercial, grower-cooperator pea crops in the Basin, and one is at the WSU Mount Vernon NWREC. In addition, Avi set up a sweet corn field trial at the WSU Mount Vernon NWREC alongside the pea trial. The latter two trials are in ground under transition to organic certification, and the plots were inoculated with a known pathogenic isolate of *P. ultimum*. In addition, Avi is assessing whether the measurement of seed electrolyte leakage can be used to predict the risk of damping-off of pea and sweet corn under cool, moist spring soil conditions. The overall objective is to enhance organic vegetable production in the Pacific Northwest by providing research-based information that optimizes management of damping-off in organic vegetable crops.

**PROGRESS TO DATE:**
In October 2009, soil samples were collected from 37 certified organic fields with a history of pea and/or sweet corn production. *Pythium* spp. were baited from the soils using grass leaves and root baiting (planting pea and sweet corn seeds). Approximately 300 isolates were obtained and identified to species by sequencing the ITS region of rDNA. Nineteen species were identified, with *P. irregulare*, *P. torulosum*, and *P. ultimum* the most prevalent. Pathogenicity of isolates of each *Pythium* species was tested on pea planted into inoculated soil under low temperature and high soil moisture conditions in a growth chamber. At least six *Pythium* species (*P. abappressorium*, *P. dissotocum*, *P. irregulare*, *P. sylvaticum*, *P. ultimum*, and *P. violae*) caused damping-off, with differences in aggressiveness detected among isolates. Levels of the pathogenic species in the sampled soils will be quantified using molecular methods.
Fourteen organic or experimental (with potential for use in certified organic production) seed and drench treatments are being evaluated in three pea field trials (two grower-cooperator field trials in the Columbia Basin, and one trial at the WSU Mount Vernon NWREC) and one sweet corn field trial (at the WSU Mount Vernon NWREC) in 2011. Damping-off is severe in one of the grower-cooperator field trials in the Columbia Basin, where both *Rhizoctonia* and *Pythium* appear to be causing damping-off. The second grower-cooperator trial has a very low incidence of damping-off, but the NWREC pea trial has a high level of damping-off. Preliminary results of the Basin trial with damping-off from *Rhizoctonia* and *Pythium* demonstrated that two treatments show significant potential at reducing losses to damping-off in pea, i.e., Nodox (an organic cuprous hydroxide), and priming pea seed for 16 hours followed by drying the seed for 8 hours within a few days of planting. Results are too preliminary for the other three field trials as of late May 2011.

Research on the electrolyte leakage component of Avi’s PhD project will be initiated in fall 2011.

**Funding:**
WSU Center for Sustaining Agriculture & Natural Resources.

**Plot Map:**
This project is not included in the official NWREC Farm Walk on 13 June 2011. If you would like to tour the pea and/or sweet corn trials that day, please contact Lindsey du Toit at 360-848-6140 or Avi Alcala at 509-263-7919.

Pea seed and drench treatment trials at the WSU Mount Vernon NWREC (left) and in the Columbia Basin (right).

**More Information:** Contact Lindsey du Toit at 360-848-6140 or dutoit@wsu.edu or Avi Alcala at 509-263-7919 or avialcala@wsu.edu
Tillage reduction and cover cropping for enhanced soil quality and weed management in western Washington organic vegetable farms.
CSANR BIOAg 2010 Project; USDA OREI 2009 Planning Grant

**PROJECT DURATION:** April 2009 – October 2011

**PERSONNEL:**
Doug Collins, Small Farms Extension Educator, WSU Puyallup REC; 253-445-4658; dpcollins@wsu.edu
Andrew Corbin, Agriculture and Natural Resources Extension Educator, WSU Snohomish County Extension; 425-357-6012; corbina@wsu.edu
Chris Benedict, Agriculture and Natural Resources Extension Educator, WSU Whatcom County Extension; (360) 676-6736; chrisbenedict@wsu.edu
Craig Cogger, Soil Scientist/Extension Specialist, WSU Puyallup REC; 253-445-4512; cogger@wsu.edu
Andy Bary, Senior Scientist, WSU Puyallup REC; 253-445-4588; bary@wsu.edu
Carol Miles, Vegetable Horticulture, WSU Mount Vernon NWREC; 360-848-6150; milesc@wsu.edu
Jonathan Roozen, Agricultural Research Technologist, WSU Mount Vernon NWREC; 360-848-6135; jfroozan@wsu.edu

**PROJECT OVERVIEW:** Organic vegetable growers rely on tillage to prepare ground for planting and for weed management. In western Washington, it is not uncommon for growers to make 10 to 20 passes each year with equipment ranging from a mold board plow to a spring tooth harrow. Tillage reduces earthworm populations, fungal-based food webs, organic matter, soil aggregates, and initiates germination of many weed species. Increasingly, researchers and growers are weighing the agronomic benefits of tillage against potential deleterious effects on soil structure, soil erosion, soil compaction, fuel consumption, and contribution to greenhouse gases. For these reasons, many organic growers are looking to incorporate reduced till systems onto their farms.

Conventional agriculture producers have used no- and reduced-till systems in combination with herbicides for many years and have been able to show improved soil quality and reduced weed pressure. The use of manure and compost soil amendments in organic farming can also lead to increased soil organic matter (OM) and soil quality. Researchers in Maryland found organic practices, especially manure addition, increased OM to a greater degree than conventional no-till. However, these researchers only compared conventional no-till systems with organic tillage systems that include manure amendments, and did not examine an organic no-till system.

Organic no- and reduced-till systems have mostly included field crops such as corn, wheat and soybeans but very little has been done with vegetable crops. In response to organic vegetable growers who wish to improve soil quality through tillage reduction and reduce costly weed pressure, Washington State University agriculture faculty began an organic vegetable no- and reduced-till systems research and extension project. A two-day symposium and planning
session was held in October 2009 where barriers were identified and direction was provided for the project. Participating growers identified specific barriers to successful implementation of no- or reduced-till organic systems as: 1) inability to control fall-planted cover crops without herbicides or tillage; 2) shortened growing season due to delayed vegetable crop planting; 3) inability to manage weeds without mechanical cultivation; and 4) decrease in soil tilth (i.e. loss of the short-term benefits of tillage in preparing the seed bed).

**Tools for organic no-till.** Reducing tillage in organic systems starts with a robust fall-planted cover crop stand that will suppress summer weed growth. The second critical step is to kill the cover crop without tillage or herbicides. John Brubaker (farmer, Kutztown, PA) and Jeff Moyer (Rodale Institute) developed a roller/crimper, a metal cylinder (16.5 in. diameter) with welded metal plates (4 in X 3/8 in.), that crimps and crushes the cover crop stems. Timing is critical as regrowth will occur if the cover crop is rolled/crimped too early. Other important no-till tools include no-till transplanter and no-till seeders for planting into the rolled cover crop. Strip tillers are commonly used in reduced-till systems; they create a narrow (10-12 in.) tilled band of soil for planting.

**Project goals:** 1) identify production methods that effectively integrate cover crops and reduced tillage technologies while reducing in-season weed pressure and weed seed bank populations on western WA organic farms; 2) evaluate profitability and greenhouse gas impacts of reduced tillage cropping systems on these farms; and 3) facilitate adoption of reduced tillage technologies to a wide audience.

**RESEARCH OUTLINE:** Our third year of trials was planted in fall 2010 at WSU Puyallup REC and WSU Mount Vernon NWREC to evaluate 4 cover crops for their suitability in reduced tillage systems. At both sites, two barley varieties, ‘Strider’ and ‘OR-09913’ (OSU), and two vetch varieties, ‘Lana’ and ‘Chickling’, were planted on certified organic ground. This study also includes five tillage treatments: flailing+no-till, flailing+strip till, flailing+complete till, roller/crimper+strip till, and roller/crimper+no-till. These treatments will be implemented in the ‘Strider’ variety, which has shown the most promise for an overwintering cover crop suitable for terminating with a roller crimper in the spring or early summer. The ‘Chickling’ vetch did not establish well nor survive the winter. Triticale was planted in these plots May 17, 2011 at 100 pounds/acre (see plot map). Tillage treatments will be implemented in these plots in the late summer or fall 2011 and broccoli will be transplanted.

**PROGRESS TO DATE:**

**Cover crop variety trial fall 2009 – spring 2010 WSU-Puyallup.**
A winter cover crop variety trial planted fall 2009 at Puyallup indicated differences in maturity stage among barley varieties ‘Strider’ and ‘Kold’ and wheat varieties ‘Alpowa’ and ‘Stephens’ by late spring. We have found that the efficacy of rolling/crimping is increased when cereals are terminated after pollination. Our selection process is aimed at finding varieties that produce good biomass and mature quickly in the spring. By May 25, 2010 ‘Strider’ had reached late milk, ‘Kold’ was at watery ripe, both wheat varieties were at flowering, and cereal rye planted 4 days
earlier in an adjacent field was even less mature (Table 1). There were no significant
differences in above ground biomass production (dry tons/acre) among the cover crops
‘Stephens’ (3.2), ‘Strider’ (3.1), ‘Kold’ (2.8), and ‘Alpowa’ (2.3).

**On-farm no-till trial 2010 WSU-Puyallup.**
Three tillage systems were assessed in a barley cover crop trial to determine impact on
butternut squash yield, earthworm biomass, and weed populations. Tillage (roto-tilling) and
roller/crimper were performed in the ‘Strider’ plots, while flailing was performed in the ‘Kold’
plots. Barley residue was cut in a 2 in wide, 4 in deep swath using a custom-built tractor-drawn
implement, and butternut squash was transplanted with a hand-operated transplanter.

Butternut squash yield was greater in the flailed plot (10.6 tons/acre) than in the roller/crimper
(6.2 tons/acre) and tilled (6.1 tons/acre) plots (Table 2). Significant differences were observed
between plots in weed numbers but not weed biomass. There was a notable difference in
earthworms between the tilled (44.7 g/m²) and roller/crimper (119.0 g/m²) plots.

**Reflections on preliminary experiments**
Tillage stimulates germination of many common summer annual weeds species. We have
provided early season weed control by removing tillage and adding a mulch layer by
rolling/crimping or flailing winter cover crops.

Researchers in Maryland found that rolling/crimping at the onset of flowering provided greater
than 85% termination in cereal rye. In early experiments with cereal rye, we rolled/crimped the
cover crop when 75% of the plants were in flower; however kill was not sufficient for
transplanting so the cover crop was rolled again two weeks later. In 2010 the barley matured
earlier and did not significantly delay vegetable planting. The kill date for a cover crop can
significantly impact the vegetable planting date and is an important consideration in western
Washington where the growing season can be limited due to poor weather conditions in the
spring and fall.

In our studies to date, tillage decreased soil bulk density and compaction and caused greater
infiltration during the growing season. This “loosening” of the soil may increase root
penetration and is a short-term benefit to tillage. A benefit of reduced tillage has been the
increase in earthworm populations. Earthworms are known as “ecosystem engineers” because
as they consume organic matter they mix it with minerals to form water-stable aggregates.
Earthworm burrows also contribute to soil aeration, drainage, and porosity. To date, however,
rolling/crimping has not significantly reduced yield compared to tilling in our trials with winter
squatish.

**FUNDING:** Funding for this study is from the WSU Center for Sustaining Agriculture and
Natural Resources’ Biologically Intensive and Organic Agriculture program. Our group was also
recently awarded a 3-year Western SARE grant. More on-farm and research station
experiments and demonstrations will be initiated late summer2011.
PUBLICATIONS:


Table 1. Cover crop maturity at WSU Puyallup May 27, 2010

<table>
<thead>
<tr>
<th>Variety</th>
<th>Crop Maturity State at Termination</th>
<th>Planting Date</th>
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<tbody>
<tr>
<td>‘Strider’</td>
<td>Late milk</td>
<td>September 18, 2009</td>
</tr>
<tr>
<td>‘Kold’</td>
<td>Kernel watery ripe</td>
<td>September 18, 2009</td>
</tr>
<tr>
<td>‘Stephens’</td>
<td>Late anthesis* to kernel watery ripe</td>
<td>September 18, 2009</td>
</tr>
<tr>
<td>‘Alpowa’</td>
<td>Anthesis complete</td>
<td>September 18, 2009</td>
</tr>
<tr>
<td>Rye†</td>
<td>Inflorescence emerged (pre-anthesis)</td>
<td>September 14, 2009</td>
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*Anthesis = flowering. †Planted in a nearby field.

Table 2. Soil quality parameters and butternut squash yield with tilled and no-till with roller crimper and no-till with fail-mower.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Roller/Crimper</th>
<th>Tilled</th>
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<tr>
<td>Squash yield</td>
<td>tons/acre</td>
<td>6.17 a</td>
<td>6.12 a</td>
<td>10.55 b</td>
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<td>Earthworms*</td>
<td>g/m²</td>
<td>119 a</td>
<td>47 a</td>
<td>N/A</td>
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<td>Weed biomass†</td>
<td>g/m²</td>
<td>336.9 a</td>
<td>468.3 a</td>
<td>288.9 a</td>
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<tr>
<td>Weed count†</td>
<td>number/m²</td>
<td>80 a</td>
<td>551 b</td>
<td>36 a</td>
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Means sharing the same letter are not statistically different within a given parameter at p<0.05, n=3. *October 6, 2010, p<0.054; †July, 20, 2010, 31 days after transplant, p<0.21; ‡July 15, 2010, 26 days after transplant.
‘Lana’ vetch and barley varieties were planted September 30, 2010. Spring triticale was planted May 20, 2011. Lana was flailed June 3, 2011 at ~ 50% flowering. Strider was rolled/crimped or flailed June 9th, 2011 at early dough.
WHAT IS VIVA FARMS?

Viva Farms is a farm incubator operated by the nonprofit GrowFood in partnership with WSU’s Small, Beginning & Immigrant Farming programs. Viva Farms supports new farm enterprises by offering:

- bilingual Cultivating Success™ courses
- access to land, equipment and infrastructure
- bilingual marketing and distribution support
- bilingual technical assistance with production and business development
- start-up financing

HOW DOES IT WORK?

Viva Farms serves beginning farmers and farm workers who want to become farm owners. Viva offers multiple entry points, to match participants’ previous experience with farming and business management.

<table>
<thead>
<tr>
<th>ENTRY POINT</th>
<th>DESCRIPTION</th>
<th>PRE-REQUISITE</th>
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<tbody>
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<td>GrowFood.org</td>
<td>2,200+ farm internship, apprenticeship and volunteer opportunities in all 50 states &amp; 56 countries. Ideal for people exploring farming as an occupation and for experienced farmers interested in what other farmers are trying.</td>
<td>No prior farming experience required.</td>
</tr>
<tr>
<td>Cultivating Success™ Sustainable Small Farming &amp; Ranching Course</td>
<td>12 week course. Introduces participants to a variety of small farm enterprise models. Helps determine what kind of operation suits their resources, skills, interests, personality. Ideal for people seriously considering sustainable farming as an occupation &amp; experienced farmers looking to diversify or transition to a direct-market orientation.</td>
<td>Prior farming experience not required, but recommended.</td>
</tr>
<tr>
<td>Cultivating Success™ Agricultural Entrepreneurship &amp; Farm Business Planning Course</td>
<td>12 week course. Introduces participants to business planning &amp; areas of critical importance to farm owners/operators. Ideal for people who plan to start, or have already started a farm enterprise.</td>
<td>Prior farming/farm management experience not required but strongly recommended.</td>
</tr>
<tr>
<td>Viva’s Incubator Farm</td>
<td>Leases land, equipment and infrastructure. On-site technical assistance with production and business development. Marketing &amp; distribution support. Ideal for start up farmers.</td>
<td>Prior farming and/or farm management experience. Written business plan. Serious commitment to farming as primary occupation.</td>
</tr>
<tr>
<td>Viva Farms Co.</td>
<td>Nonprofit wholesale, marketing and distribution company. Buys direct from emerging farmers to supply wholesale, retail, restaurant, institution, food bank and CSA markets.</td>
<td>Premium quality, sustainably grown product.</td>
</tr>
</tbody>
</table>

LOCATION

Viva Farms is based in Mount Vernon, WA. The incubator farm is located at the intersection of Hwy 20 & Higgins Airport Way on land owned by the Port of Skagit. Courses/workshops are taught on the farm, at the WSU NW Research Center and Skagit County Extension.

¿QUIERE SER DUEÑO DE SU PROPIO RANCHO O GRANJA?

VIVA FARMS LE OFRECE 3 PUNTOS DE PARTIDA:

1. EL CURSO "AGRICULTURA ORGÁNICA A PEQUEÑA ESCALA"
   Combina experiencias en el salón de clase y visitas a granjas exitosas. 12 semanas – los miércoles. 6-9pm en Mount Vernon (Otoño: Sept-Dic)

2. EL CURSO “EMPRESAS AGRÍCOLAS”
   Principios administrativos básicos a su operación agrícola a pequeña escala. Estrategia de mercadeo. Preparación para buscar préstamos. 12 semanas - los jueves 6-9pm en Mount Vernon. (Invierno: Enero-Abril)

3. VIVA FARMS: “LA INCUBADORA” DE EMPRESAS AGRÍCOLAS
   La Incubadora de Granjas provee tierra, equipos, invernaderos y asistencia técnica a tasas accesibles para apoyar nuevas empresas agrícolas. El terreno está en Burlington.

¿PARA QUIÉN ES? El programa es para pequeños agricultores y rancheros o futuros pequeños agricultores, estudiantes agrícolas y profesionales agrícolas.

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