Sustaining the Pacific Northwest

Food, Farm, & Natural Resource Systems

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Biochar and Pyrolysis: Renewable Soil Carbon and Energy

David Granatstein & Chad Kruger, WSU Center for Sustaining Agriculture and Natural Resources, Wenatchee, WA; Manuel Garcia-Perez, WSU Biosystems Engineering, Pullman, WA; Hal Collins, USDA-ARS, Prosser, WA; Jonathan Yoder & Suzette Galinato, WSU School of Economic Sciences, Pullman, WA

What is biochar?

Biochar is a carbonaceous product made from the pyrolysis of organic materials (usually lignocellulosic, or woody, materials). Essentially a charcoal material, biochar is being studied for its application to soil. It gained recent notoriety due to studies of Amazonian black earth (Terra Preta) soils that have significant enrichment with biochar-like materials. Researchers hypothesize that biochar in these systems is responsible for observed improved soil fertility and crop yields, and has stored carbon for a thousand years or more. Biochar is now being proposed as a carbon sequestration strategy that can be immediately deployed in many parts of the world. However, it is not clear that the benefits from biochar additions seen in tropical soils will occur in other regions. Biochar can also be burned for energy and processed into activated charcoal for water purification and other uses (it may have some of these purification properties without further processing).

How is biochar made?

Biochar results from pyrolysis, a thermochemical conversion process for biomass materials. Pyrolysis means breaking chemical bonds (lysis) with heat (pyro). The chemical bonds in biomass break during the pyrolysis process under low oxygen conditions (so the material does not just combust) and different compounds form and recondense into different end products. Together with the cracking reactions responsible for the formation of volatiles (gases and liquids), polycondensation reactions also occur which form biochar. Pyrolysis generally generates three products: a gas, a liquid, and a solid. Biochar is the solid. Charcoal production, practiced for millennia, is a low tech, slow pyrolysis process. In recent years, fast pyrolysis processes have been developed because of their ability to produce high yields of liquid fuels. Current research and development emphasizes fast pyrolysis

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Center for Sustaining Agriculture & Natural Resources

WASHINGTON STATE UNIVERSITY EXTENSION

WSU Small Farms Team

Sustaining the Pacific Northwest Food, Farm, & Natural Resource Systems

This quarterly newsletter provides information for people working towards community-based sustainable food, farm, and natural resource systems using interdisciplinary oriented research and practitioner knowledge.

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for producing bio-oil that can be refined to 'green gasoline' and 'green diesel.'

Slow and fast pyrolysis are distinguished mostly by the rate of temperature increase (fast pyrolysis increases temperatures over 1000 ^{o}C/second). Fast pyrolysis rates require small feedstock particle sizes (less than 2 mm diameter). In contrast, a feedstock such as dry, cut firewood can be converted to charcoal with slow pyrolysis. The two processes lead to quite different proportions of end products. Slow pyrolysis may yield 35 mass % gas (35% by mass), 30 mass % charcoal, and 35 mass % liquid, whereas fast pyrolysis might lead to 15 mass % gas, 15 mass % charcoal, and 70 mass % liquid (final pyrolysis temperature: 500 ^{o}C). In both processes, the gas is often combusted during the process itself to provide a large portion of the energy input. The gas can also be collected and used as an energy source. The liquid fraction, called bio-oil, is generally of higher quality from fast pyrolysis than from slow pyrolysis and is easier to refine into finished transportation fuel. While the liquid fraction collected in a fast pyrolysis reactor typically consists of a single phase liquid called bio-oil, the liquid fraction collected in a carbonization reactor (slow pyrolysis) has two parts: an aqueous phase called pyrolygneous water and an oily phase known as tar. The tars from slow pyrolysis processes and the bio-oils from fast pyrolysis can be hydrotreated to produce 'green' gasoline and 'green' diesel. The Pacific Northwest National Laboratory (PNNL) in Richland, Washington, and Universal Oil Products (UOP) are scaling up the first bio-oil refinery based on the hydrotreatment of bio-oils. Recent studies conducted by PNNL estimated the cost of 'green' gasoline (made from bio-oil from fast pyrolysis) at about $2 per gallon. This technology is able to convert 28 mass % of the original biomass into green gasoline and green diesel. This process produces more energy content than and equivalent amount of ethanol.

Although fast pyrolysis is an excellent technology to produce transportation fuel, slow pyrolysis would provides the better choice for maximizing biochar production for soil amendment. It is a simpler technology than fast pyrolysis and there are designs on the Internet for home or farm-scale units. However, these can lead to undesirable airborne emissions if not carefully managed. The lack of research and development to develop carbonization (slow pyrolysis) prototypes compliant with current environmental regulations is the most important hurdle to deployment of this technology in North America.

WSU Biochar project

Recently, the Washington State University Center for Sustaining Agriculture and Natural Resources (WSU CSANR) completed a study of biochar potential in Washington State agriculture which was funded by the Washington State Dept. of Ecology Beyond Waste Organics Initiative. The project team consisted of Manuel Garcia-Perez (WSU biosystems engineer), Hal Collins (USDA-ARS soil scientist), Jonathan Yoder and Suzette Galinato (WSU economists), and David Granatstein and Chad Kruger (CSANR faculty). The project looked at three aspects: biochar production; effects of biochar additions to soil; and economic analysis. The final report for the project is on line. Key findings from this project are described below.

Biochar feedstocks

Most organic materials can be used in pyrolysis. However, the following characteristics are desirable: dry (10 mass % moisture); lignocellulosic materials with low content of proteins (less than 2 mass %); waste products (a material currently not being used or that is being disposed of through open burning); and proximity to the processing unit to minimize transport cost and energy. WSU conducted a statewide biomass inventory in 2005 to identify underutilized biomass that could be used for various purposes, including pyrolysis. This inventory

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identified nearly 19 million tons of underutilized biomass available yearly in the state. Results are provided by type of biomass at the county level.

The characteristics of the feedstock influence the final characteristics of the biochar (see section below). Pyrolysis tests have been conducted with many materials, including animal manure. Results show that most of the nitrogen in manure is lost during the pyrolysis process; manures are likely more valuable as a nutrient source than as a pyrolysis feedstock. Feedstocks with high contents of proteins should be processed by biological conversion technologies (e.g., anaerobic digestion and composting).

Tabel 1: Feedstock, C, N, S Concentrations

Feedstock	C (g kg-1)	N (g kg-1)	S (g kg-1)	C:N	C:S
Swtichgrass	432	23.5	1.2	18	360
Digested fiber	480	20	3.3	24	145
Softwood bark	470	3.3	0.3	142	1567
Wood pellets	477	1.2	0.3	398	1590

Use of Biochar from the Pyrolysis of Waste Organic Material as a Soil Amendment, July 2009. Washington State University, Center for Sustaining Agriculture and Natural Resources, David Granatstein, Chad Krueger and Hal Collins, USDA ARS, page 18.

Making biochar

As part of the WSU biochar project, a laboratory scale auger pyrolysis unit was built at WSU Pullman. This unit was used to pyrolyze four different feedstocks available in the state (softwood bark, softwood pellets, switchgrass straw, and digested dairy manure fiber from an anaerobic digester). The characteristics of the biochar can be influenced by the type of feedstock, the moisture content, the rate of heating, and the final temperature. In the WSU project, biochar was made at four different temperatures: 350, 425, 500, and 600 ^{o}C. The yield of biochar (as a percent of the original feedstock mass) ranged from 50 to 30 mass % and declined with increasing temperature. With fast pyrolysis, biochar yields would be more in the 10 to 20% range. Fast pyrolysis researchers are working to reduce biochar formation since it is considered a waste product that detracts from the yield of the desired bio-oil. A target yield for biochar using slow pyrolysis at 500 ^{o}C is 30 mass %.

At the beginning of this project, little data existed on the potential for the pyrolysis process to form undesirable compounds such as polyaromatic hydrocarbons (PAHs) and dioxins. A review of the published literature showed no evidence that leachable PAHs and dioxins were present in the biochars that would be used as soil amendments. Samples of biochar from different feedstocks made at different temperatures were subjected to qualitative analysis with a gas chromatograph at WSU Pullman. None of the samples indicated the presence of PAHs or dioxins. Six samples were then subjected to quantitative analysis for dioxins and furans (in parts per billion), and leachable PAHs (in parts per million). The only detectable chemical was the PAH phenanthrene, but at levels 10 to 100 times lower than the level of concern for environmental cleanup. All dioxin levels were similar to background levels previously determined by Ecology. These results confirms the extremely low likelihood of undesirable toxins being formed during the slow pyrolysis of lignocellulosic materialsis.

Biochar characteristics

The woody feedstocks produced biochar with a higher percent carbon (C) than the herbaceous feedstocks and the percent C increased with increasing pyrolysis temperature. Feedstocks lost 60-70% of their nitrogen during the pyrolysis process and the nitrogen in the biochar was essentially not biologically available. Increasing pyrolysis temperature led to an increase in the pH of the resulting biochar, which increases its value as a liming agent on acidic soils. The biochars were subjected to acid hydrolysis to determine the fraction of very stable C in them. Biochar from herbaceous feedstocks lost 6-8% of their C after acid treatment, while biochar from woody feedstock was essentially unchanged. The C remaining after acid hydrolysis is estimated to have a mean residence time in soils of hundreds to thousands of years, and this is the key property for biochar to be used for long-term carbon sequestration in soil.

Influence of biochar on soil properties

Biochar was added to five different soils from around Washington State to see how it would influence them. Soils included a sandy soil from the Columbia Basin (irrigated crops), silt loams from the Palouse (dryland grains), and a silt loam from western Washington (forages on a dairy farm). Biochar was added to the soils at rates equivalent to 0, 5, 10, and 20 tons/acre. The highest rate of the herbaceous biochar raised soil pH 1.0 unit, while the woody biochars raised pH by 0.5-1.0 unit. Soil cation exchange capacity (CEC) was not changed by biochar amendment. Soil CEC is a key property of interest, since it represents the soil's ability to retain and provide a range of nutrients (e.g., calcium, potassium, ammonium) for plant growth. Soil water holding capacity was increased by biochar amendment in two instances. Biochar amendment increased total soil C the most on the sandy soil, doubling it at the highest rate for all biochars, due to the small overall pool of stable organic matter in this soil. Long-term mineralization studies (>200 days) showed essentially no difference in CO_2 emission between amended and unamended soils, providing more evidence of biochar C stability in

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soil. A study of carbon isotopes with biochar derived from switchgrass confirmed that the initial flush of CO_2 shortly after biochar amendment was from the biochar and not the native soil organic matter.

Increasing biochar application rate led to a decrease in soil nitrate, perhaps due to ammonium (NH_4^+) ions being adsorbed by the biochar and not available to microorganisms for conversion to nitrate. This could benefit plant growth if the ammonium is available to plant roots over time as a slow release nitrogen source. However, the N in the biochar itself is not biologically available. Initial observations of reduced nitrous oxide (N_2O) emissions after biochar amendment are being explored further. This property could be as valuable as the stored carbon for a carbon credit, since nitrous oxide is some 300 times more potent than CO_2 as a greenhouse gas. Research also continues on the ability of biochar to remove phosphorus from dairy manure wastewater and provide it to soils in a plant-available form.

Auger slow pyrolysis reactor at WSU.

A greenhouse study of wheat growth in soil amended with different rates of biochar (equivalent to 0, 5, 10, and 20 tons/acre) was also conducted. No significant growth differences were measured, although low biochar rates (10 tons/acre) tended to stimulate growth compared to the zero biochar soil, while the highest rate tended to depress growth. A field study of corn on biochar-amended soil at WSU Prosser was conducted during 2009 as part of a national USDA effort and data from the study will add to our knowledge of biochar effects on temperate climate soils and crop growth.

Biochar economics

When the project started, there were no commercial pyrolysis facilities operating in Washington State. Availability of biochar was extremely limited, making it difficult to source enough for field trials. The project economists developed a prototype enterprise budget for fast pyrolysis of forest thinnings (for forest health and fire reduction) and looked at how the size of pyrolysis unit (mobile, transportable, relocatable, or stationary) influenced cost of production and breakeven prices. They also modeled how the ratio of biochar to bio-oil would affect the revenues, based on differing prices for these products. Finally, they estimated the potential return on investment of biochar application to a dryland wheat field, based on the biochar substituting for lime to raise soil pH to a more optimal level, and on the potential value of the biochar as a salable carbon credit.

With a stationary fast pyrolysis facility, the breakeven price for biochar was \$87 per metric ton. The few existing biochar suppliers have suggested pricing at \$200/ton; if the market would support such a price, this would be a profitable enterprise. If breakthroughs in fast pyrolysis occur that produce bio-oil at prices competitive to petroleum, then the allocated cost to the biochar (a by-product) might be much lower than \$87. If carbon credits were trading at \$31 per metric ton (the historic high on the European market), all scales of pyrolysis facilities modeled in the study would be profitable. Without salable carbon credits, only the stationary facility is profitable. The mobile (producing 10 dry tons per day), transportable (producing 100 dry tons per day), and relocatable (producing 500 dry tons per day) facilities become profitable at carbon credits worth \$16.44, \$3.39, and \$1.04 per MT CO_2, respectively. Biochar represents a gross carbon offset of 2.93 MT CO_2 per MT biochar applied to the soil (MT: 1 metric ton = 2200 lb). Initial calculations show that biochar provides net C sequestration even after accounting for processing energy.

Next steps

The WSU biochar project established that biochar is likely free of unwanted contaminants amd provides very stable C when added to soil, but it is not a source of available nutrients for plants. How biochar in temperate soils changes over time as it “weathers” remains an unanswered question and longer term studies are needed to understand whether observable benefits to plant growth will occur. The current high cost of biochar (and its application), the absence of clear crop growth responses, and the lack of available supply for use on farms, suggest that widespread field application will not occur in the near future. Rather, biochar may find a niche as a carrier for microorganisms and specific nutrients (e.g., blending biochar and compost tea), or in uses to remove excess nutrients from water (e.g., drainage water, livestock effluent) that can be returned to farmland. “Designer” biochar may also be possible through process modification that can target specific end uses. If fast pyrolysis becomes widely deployed for producing renewable fuels, then biochar as a by-product of this process may be more available and affordable.

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Continued research is underway and planned to better understand the issues of making and utilizing biochar. For more information on biochar, visit the International Biochar Initiative or the USDA Agriculture Research Service biochar initiative. Also, the PNW Biochar Group and the Sea-Char group are active in the region.

Management of Damping-off in Organic Vegetable Crops in the Pacific Northwest

Ana Vida Alcala & Lindsey du Toit, Vegetable Seed Pathology, WSU Mount Vernon NWREC

Damping-off is a concern to growers involved in conventional and organic vegetable production. The pathogens causing the disease are commonly soil borne and can be difficult to control. Seed and drench treatments with proven efficacy are sometimes used for managing pathogens that cause damping-off. However, products allowed on certified organic farms are limited to those compliant with the USDA National Organic Standards. In 2007, Jaime Cummings (graduate student) and Dr. Lindsey du Toit, faculty lead of the vegetable seed pathology program at the WSU Mt. Vernon NWREC, evaluated various seed and drench treatment products that either were approved or were being developed for certified organic production to manage damping-off. Jaime used spinach as a model crop and demonstrated that some products showed promising results against Pythium ultimum and/or Rhizoctonia solani under greenhouse conditions. Jaime's project was funded by the WSU Center for Sustaining Agriculture & Natural Resources. Dr. du Toit received additional funding to continue evaluating organic seed and drench treatments for efficacy against soil borne damping-off pathogens of vegetable crops in organic production systems in the maritime coastal region of the Pacific Northwest as well as the semi-arid, irrigated Columbia Basin of central Washington. In spring 2009, graduate student Ana Vida ('Avi') Alcala started research on this stage of the project.

To gain a greater understanding of organic vegetable growers' needs to manage damping-off, Avi and Lindsey made personal farm visits and completed phone interviews to learn whether damping-off is considered a disease of immediate concern in their vegetable crops and what practices they have tried for managing this disease. Surveys included nine growers and production managers involved in organic vegetable production in central and western Washington. The information gathered is being used to formulate the objectives and experiments for Avi's research. The interviewees work with diverse production systems, ranging from five acres of organic vegetable crops to a 6,000 acre certified organic operation in central Washington. Survey responses were very informative and helped redirect the original focus of Avi's project. Highlights of the stakeholder feedback included the following:

- Two main types of organic vegetable production exist in Washington State, based on market type: those producing primarily for fresh markets and those producing for processing markets. Organic production for fresh produce markets is generally smaller scale (a few acres to ~400 acres) and exhibits significant diversity in crops as well as flexibility in production practices on individual farms. Conversely, organic production for processing markets typically involves large areas (up to 6,000 certified acres on one farm) focused on three to five different crops with processing contracts largely dictating production practices and the cultivars grown.
- The respondents have been involved in certified organic vegetable production for periods from five years to several decades. Most of the fresh produce market growers interviewed have operations that are 100% organic, while some growers producing for processing markets still devote a significant part of their land to conventional production.
- Generally, organic growers targeting processing markets have experienced losses to damping-off, sometimes economically significant especially during early season planting (typically late February to early March in the southern Columbia Basin). Some have sought assistance for pathogen identification when damping-off occurred in their crops. Interestingly, several growers stated that it is not uncommon to replant entire fields or plant seeds at a higher population than normal due to damping-off. On the other hand, growers for fresh markets stated that they either never, or rarely, encounter significant damping-off in their fields when using appropriate management recommendations. When they have encountered damping-off, the disease caused minimal

Spinach damping-off (roots washed).

Spinach damping-off in-situ.

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impact and was managed readily by adjusting production practices (e.g., modifying crop rotations, selecting field sites and/or planting dates for specific crops and/or cultivars).

Pythium ultimum black hypocotyl - 13

- An early planting date was almost unanimously associated with poor stands in organic vegetable crops. Several reasons growers of processed vegetables plant so early include: (1) to avoid weed problems (e.g., nightshade is very problematic in pea crops because the berries are toxic and difficult to separate from peas in the processing plant, but this weed typically is only a problem in crops planted later in the spring or summer); (2) to ensure harvest earlier than conventional crops so that processors can complete the run of organic products before conventional products, thus avoiding the effort and expense of cleaning out the processing facility after conventional crops; (3) to meet market demands; and (4) to enable double-cropping (e.g., pea crops planted early can be followed by sweet corn, which must be planted no later than the first week of July in the Columbia Basin).
- Growers found using high quality, vigorous seed lots very important for ensuring good stands and minimizing losses when planting vegetable crops early in the season, particularly for sweet corn and pea crops. For example, some stakeholders observed mechanical damage to pea seed resulted from bulk loading/unloading using augers instead of manually loading pea seed packaged in bags. This damage can contribute significantly to poor seed quality and poor stands.
- Organic growers capitalize significantly on building "healthy soil" through practices that help ensure healthy crops and minimize disease problems, such as crop rotation, incorporation of green manure crops and various composts, fallow, etc.
- Respondents indicated they do not commonly use organic seed treatments. Those who have completed on-farm evaluations of commercially available, organic-compliant seed and/or drench treatments (mostly microbial products) usually encountered inconsistent effectiveness (if any) of the products under field conditions, thus not warranting the expense of the treatment. Several growers indicated they would pay up to \$100 (even \$150) per acre for a seed or drench treatment if the treatment consistently provided significant control of damping-off (at least 30% improvement in stands) under their production practices.
- Vegetable crops requiring the most attention for managing damping-off are pea and sweet corn, especially super sweet cultivars of sweet corn and sugar snap pea cultivars planted early in central Washington for processing markets.
- Seed treatment products effective at controlling damping-off in cold, wet soils (freezing temperatures, or even slightly below freezing) will be most beneficial to growers in the Columbia Basin because of their need for early season planting. Exacerbating the problem is the very cold water used to irrigate these crops in early spring (≤5˚C), which increases damping-off problems. In addition, most commercially available organic seed/drench treatment products have better efficacy against damping-off pathogens under warmer soil conditions.

Based on these interviews, organic vegetable growers with large areas of production of a few crops (mostly farms located in central Washington) for processing markets are the primary growers who encounter significant losses to damping-off in vegetable production. Developing management practices and organic-compliant products that effectively control damping-off will be of greatest benefit to these growers. The most urgent need is for early season plantings, especially pea and sweet corn processing crops.

Pythium GH Trial 2 - Plots

Pea and sweet corn crops grown for processing markets comprise the largest acreage of organic vegetable production in Washington State and will be the focus of Avi's research. Based on the survey results, Avi will investigate management of damping-off in organic vegetable production during early season planting under low soil temperatures (0 to 10°C) and high soil moisture, which favor many Pythium species pathogenic on vegetables. She will investigate the biology of Pythium species in certified organic fields in central Washington, including the prevalence and distribution of species in this region. Other factors contributing to damping-off in field conditions will be investigated. These include electrolyte leakage of seed lots used by growers as a possible predictor of damping-off risk, and cultural production practices

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that may contribute to damping-off. Microbial and non-microbial products approved for certified organic production will be evaluated in greenhouse trials and in farmer's fields for efficacy at controlling damping-off in pea and sweet corn.

Physiological Leaf Roll of Tomato

A Fact Sheet prepared by The Pacific Northwest Vegetable Extension Group

The PNW VEG includes specialists from the University of Idaho, Oregon State University, Washington State University and USDA-ARS who contribute expertise in plant pathology, horticulture and entomology to help identify and offer solutions to vegetable problems in Idaho, Oregon and Washington.

Many areas in the PNW experienced unusually hot and dry conditions during the 2009 growing season, including record dry and warm conditions west of the Cascade Mountains. PNW VEG members in Idaho, Oregon, and Washington have received many reports of moderate to severe leaf rolling on tomato plants in home gardens and commercial fields this season (see photos). Although the leaf roll symptoms are similar to those caused by certain viruses (curly top and tomato yellow leaf curl, for example), the symptoms noted in the PNW in 2009 were likely the result of a disorder on tomatoes called 'physiological leaf roll.'

Physiological leaf roll starts with upward cupping at the leaf margins followed by inward rolling of the leaves (Figure 1A). Lower leaves are affected first, and can sometimes recover if environmental conditions and cultural factors are adjusted to reduce stress. If the conditions favoring leaf roll are prolonged, affected leaves may not recover. In severe cases, whole plants can be affected. If environmental conditions and cultural factors are adjusted after prolonged leaf rolling, new growth that develops may not exhibit leaf roll symptoms (Figure 1B).

Many university extension publications (listed below) provide information about this physiological condition. Several causes are reported. The severity of leaf roll appears to be cultivar dependent. High production-potential cultivars tend to be most susceptible. Staking cultivars of tomato are reported to be more sensitive to this disorder than bushy cultivars. In some cases, the condition is believed to occur most commonly when plants are staked and pruned during dry soil conditions. In other cases, causes listed include growing high-producing cultivars under high nitrogen fertility programs, phosphate deficiency, or extended dry periods. Also, the disorder has been attributed in some areas to excess soil moisture coupled with prolonged high temperatures.

In a study in Florida, removal of young vegetative shoots and fruit hands caused rapid and severe rolling of the lower leaves of 'Floradel' tomato plants, and symptoms progressed to the upper leaves. Sugar and starch accumulation in the lower leaves was positively correlated with the degree of leaf rolling, and overhead shading decreased the severity of leaf roll. A report from Kansas indicated that when spring weather is mild at planting, top growth may be more vigorous than root growth. If drier summer weather follows, the foliage may transpire water faster than the root system absorbs water from the soil, and the plant compensates by rolling the leaves to reduce transpiration surface area of the foliage. This situation may reflect PNW tomato growing conditions in 2009.

Regardless of the cause of physiological leaf roll, the symptoms are generally the same in that the margins of the leaves roll up and in (Figure 1). Leaf roll symptoms first appear on the older (lower) leaves, and may be temporary, disappearing after a few days. Not all leaves on a plant may exhibit rolling, but eventually the rolling can involve most leaves on a plant and persist through the season. The margins of adjacent leaflets may touch or overlap. Rolled leaves become rough and leathery but are otherwise normal in size and appearance. There is no discoloration of leaf veins associated with this condition. Plant growth, fruit yield, and fruit quality are not believed to be affected (Figure 1C).

Some management strategies recommended for physiological leaf roll include: (i) planting bushy type cultivars, (ii) planting in well-drained soils and maintaining uniform, adequate soil moisture (~1 inch per week during the growing season depending on the area of production), (iii) being careful not to over-fertilize especially with nitrogen fertilizers (iv) providing adequate phosphorus

Figure 1A: Severe physiological leaf roll symptoms on a tomato plant.

Figure 1B: Tomato plants with physiological leaf roll on the older (lower) leaves with normal new (top) growth that developed after air temperatures cooled.

Figure 1C: Some tomato cultivars are less susceptible to physiological leaf roll than others.

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fertilizer, (v) avoiding severe pruning, and (vi) maintaining temperatures below 95°F by using shading or evaporative cooling. Follow closely the fertilizer programs recommended for specific regions of production and specific tomato cultivars.

Accurate plant diagnosis is essential before management practices are initiated. Some tomato pathogens can cause symptoms very similar to physiological leaf roll, so it is important not to confuse a non-infectious problem like physiological leaf roll with infectious diseases of tomato. For example, curly top virus causes upward leaf rolling but leaves are typically also yellow, thickened and crisp. Tomato mosaic virus can cause prominent leaf roll but mostly during early growth stages and accompanied by mosaic symptoms. Tomato yellow leaf curl virus causes leaves to cup down or up depending on the plant growth stage at the time of infection. Aster yellows phytoplasma can cause leaf roll on upper leaves. Informative photos on tomato diseases are on several university websites. The Compendium of Tomato Diseases sold and published by APS Press has valuable information and photos on tomato problems.

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Tidbits

WSDA Organic Food Program (OFP)

For those interested in the changes going on at the WSDA Organic Food Program (OFP), and at the National Organic Program (NOP), read their Quarterly reports.

Oregon Department of Agriculture Launches Organic Certification

Oregon's Department of Agriculture is now accredited to certify farms as organic. For years, farmers who wanted to market their produce as grown under the National Organic Program, had to turn to private organizations like Oregon Tilth or to other states, like Washington and Idaho. But now, says Jim Cramer of the state Department of Agriculture, Oregon will be able to do its own certifications. Oregon is the 16th state accredited for the national program.

New Food Systems Planning and Evaluation Resource Available

The Community Food Security Coalition has released Whole Measures for Community Food Systems: Values-Based Planning and Evaluation (PDF/909KB). This new planning and evaluation tool provides a lens for community food projects to dialogue about how their work affects whole communities. It includes a set of six core fields of value-based practices against which projects can measure the impact of their work.

Oregon Small Farms News Features Clark County Farm

Learn about the Conway Family Farm in Camas, WA. This diverse operation also participated in the National Association of Agriculture Agents annual meeting tours.

Resources

Researchers to Develop Crop Varieties for Organic Production

Growers of organic crops in North Carolina and across the Southeast will get some much needed help as plant breeders at North Carolina State University launch an effort to develop corn, peanut, soybean and wheat varieties adapted to being grown organically. A $1.2 million U.S. Department of Agriculture grant will be used to develop corn, soybean, peanut and wheat varieties with traits identified by farmers as necessary for organic production.

On-Farm Energy Use Publication Available

How much energy is being used by Iowa's agricultural producers? A new Iowa State University Extension publication answers that question.

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Farm Energy: How Much Energy Is Being Used on Your Farm? offers initial steps that help farmers analyze their farm energy use. This publication is part of a series of farm energy conservation and efficiency educational materials being developed through the Farm Energy Conservation and Efficiency educational initiative.

Economic Research Service Releases Organic Dairy Report

USDA's Economic Research Service (ERS) has released a report, Characteristics, Costs, and Issues for Organic Dairy Farming (PDF/1.2MB). This report addresses size, regional differences, and pasture use in organic milk production. Economic forces have pressured organic dairies to operate more like their conventional counterparts and take advantage of economies of size.

Report Discusses Impact of Health Insurance on Farmers

The Social Responsibility Initiative at Ohio State University has just released a new topical report examining how the cost of health insurance affects farmers at the rural-urban interface. The report, The Persistence of Agriculture at the Rural-Urban Interface: Does the Cost of Health Insurance Make a Difference? (PDF/861KB), states that the cost of health insurance is a serious concern of farmers operating at the Rural-Urban Interface (RUI) across the United States.

Need More Pollinators?

Want to develop habitat that will attract native pollinators to your crops? Or increase your populations of beneficial insects to improve pest control? Or improve the forage available for your commercial bees?

The Natural Resources Conservation Service (NRCS) can assist in developing habitat for beneficial insects and pollinators on your farm by helping you design flowering buffers, hedgerows and other practices, and through the Wildlife Habitat Incentives Program can offer incentive payments to help in planting these areas for pollinator habitat. To learn more about farming for pollinators, visit the Xerces Society website.

To learn more about the Natural Resources Conservation Service and the Wildlife Habitat Incentives Program visit the NRCS website. Contact your local NRCS planner to learn more about how NRCS can help, find your local service center.

Study Reveals Economic Benefits of Local Foods

Iowa State University economist David Swenson worked with Hometown Harvest, a local food group in southeast Iowa to examine several scenarios for increased local food production, processing and consumption in Davis, Jefferson, Keokuk, Mahaska, Van Buren and Wapello counties. His study, Investigating the Potential Economic Impacts of Local Foods for Southeast Iowa, funded by a competitive grant from the Leopold Center's Marketing and Food Systems Initiative, showed that the region could benefit from the addition of 50 to 75 production, retailing and enhanced processing jobs divided between rural areas and local communities. "A relatively small amount of land generates enough produce to feed a large number of people," Swenson explained. "In this case, 528 acres of production would yield 25 percent of 22 fresh fruits and vegetables consumed annually for 100,000 people in the region... [yet] the scenarios produce net farm and regional income gains of almost $1 million."

Conservation Markets for Farmers and Ranchers

AFT. We are launching a new project to help create markets for ecosystem services provided by agriculture. Farmland can provide environmental services such as carbon sequestration and wildlife habitat; however, farmers are not always compensated for the benefits their conservation efforts provide. This new project seeks to create markets for these services so farmers and ranchers can supplement their farm incomes while providing much needed services to the rest of society at a reasonable cost. We will be working with the agriculture community to create a *Farmers and Ranchers Guide to Conservation Markets*, which will serve as the basis for a series of workshops, presentations, and best practices for agriculture.

Community Gardening Publication Available

A new guide to community gardening, developed by three North Carolina Cooperative Extension specialists, a nutritionist with the state's Division of Public Health and two graduate students from the University of North Carolina at Chapel Hill - will provide communities with tools to increase access to fresh fruits and vegetables, strengthen neighborhood groups and increase physical activity through gardening. The gardening primer, Growing Communities through Gardens, was published by Eat Smart, Move More North Carolina and the North Carolina Community Garden Partners, a coalition of agencies seeking to promote community gardening. The primer provides information on how to find or develop a garden and how to prepare, preserve and store produce.

Continued on next page

Forestry

Got Wild Forest Goods?

Do you have a business that buys, sells, processes, or harvests Christmas boughs, cones, wild mushrooms, floral greens, medicinal herbs, mosses, berries, or other products from forestlands? The Oregon Forest Industry Directory (OFID) is a free, on-line business directory operated and maintained by Oregon State University's Wood Innovation Center for businesses that buy and sell a variety of forest products and services. The directory is currently expanding its nontimber forest products section to include a diverse array of products and services. The site currently lists over 1,500 businesses and receives over 200,000 hits per month. To register, go to the OFID site. If you need assistance registering on OFID, contact Scott Leavengood at OSU Extension (541-737-4212) or Lita Buttolph at the Institute for Culture and Ecology (503-331-6681).

Funding to expand the nontimber forest products section of OFID was provided by a grant from the USDA Cooperative State Research, Education and Extension Service (now the National Institute of Food & Agriculture, or NIFA) to develop and expand markets for nontimber forest products. The grant was awarded to the Institute for Culture and Ecology, and Oregon State University Forestry Extension. The Institute for Culture and Ecology is a non-profit organization whose mission is to conduct research and education that leads to a better understanding of the social aspects of natural resources management. Visit IFCAE for more information about this project, or contact Lita Buttolph at (503) 331-6681.

Submitting articles: Submit articles electronically to Doug Stienbarger in MS Word or RTF formats. Photos and graphics are encouraged.

Views: The views expressed in this newsletter reflect those of the author(s) and not necessarily those of the sponsoring institutions.