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BLACK LEG IN BRASSICACEAE CROPS AND WILD CRUCIFERS

Cynthia M. Ocamb, Oregon State University
Lindsey du Toit, Washington State University

A widespread epidemic of black leg occurred on a diversity of crucifer oilseed, cover, forage, and vegetable seed crops in the Willamette Valley of Oregon in spring 2014. An outbreak of black leg also occurred in Bonner's Ferry, ID in 2011 in dryland canola crops. *Phoma lingam* (sexual stage: *Leptosphaeria maculans*) is the fungus that causes black leg. Black leg can be a significant problem for growers of fall- or spring-sown plantings of various crucifer crops, particularly under the favorable environmental conditions for this disease in the Pacific Northwest. In fact, black leg is a quarantine disease for five counties in northwestern Washington. Brassicaceae plants that can be infected include species of *Brassica* (e.g., broccoli, Brussels sprouts, cabbage, canola, cauliflower, various Chinese brassica vegetables, collard, kale, mizuna, mustard, oilseed rape, oilseed turnip rape, rutabaga, turnip, etc.), *Sinapis* (white and yellow mustard), and *Raphanus* (daikon and radish). Several wild species exist that may be infected by *P. lingam*

including *Descurainia* (tansymustard), *Sisymbrium* (hedge mustard), and *Thlaspi* (pennycress) (2).

The fungus survives and reproduces both sexually and asexually. Fruiting bodies of the sexual stage, *L. maculans*, are called *pseudothecia*, which form and survive on plant debris or live plants, and release the sexual spore type, called ascospores. Ascospores can be wind-blown up to several miles during cool, windy, and wet conditions. In fall-planted brassica crops or winter weeds, pseudothecia can form on infected plants the next spring or summer, prior to harvest, and can continue forming in plant residues that remain on the soil surface after harvest, releasing ascospores. Pseudothecia do not develop on residues incorporated into the soil, only on residues on the soil surface. For spring-sown crops, pseudothecia do not form until after harvest, and only on residues remaining aboveground. The asexual

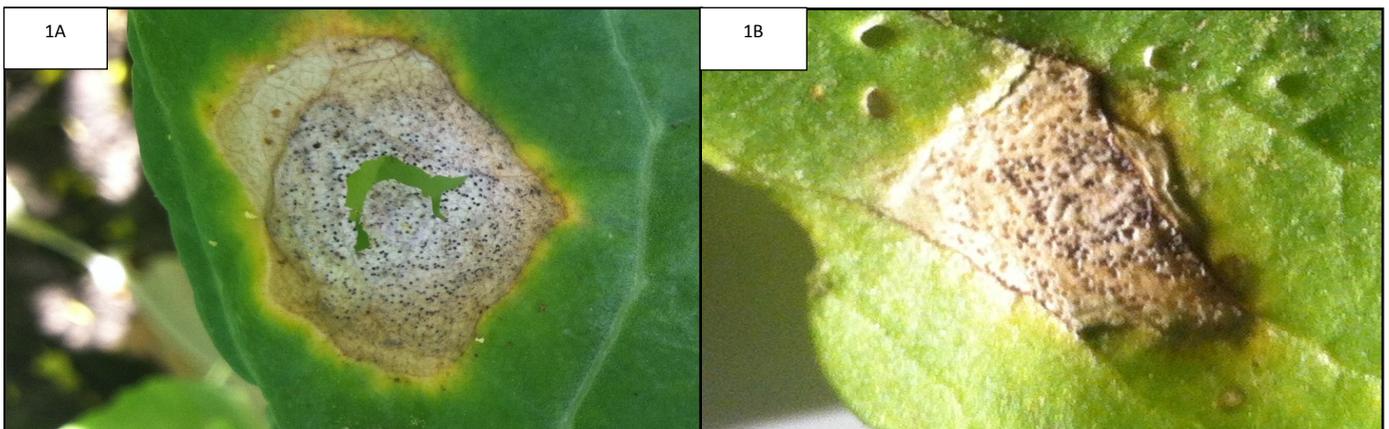


Fig. 1A and 1B. Phoma leaf spot symptoms incited by *Phoma lingam*. Phoma leaf spot lesions can resemble those caused by the ring spot pathogen, *Mycosphaerella brassicicola*.

stage develops on infected plants or residues, producing spores (pycnidiospores or conidia) that are dispersed by splashing water (rain or irrigation). Following wet or humid and cool conditions (46-60°F), spores are released from these fruiting structures on infected plants or residues on the soil surface. The fungus can survive in infected plant residues, potentially producing both spore types, until the debris decomposes fully (1 to 4 years). *Phoma lingam* can be seedborne, surviving for years in infested seed. Workers and equipment can spread spores by moving through a diseased crop during wet conditions.

Spots can develop on infected leaves, stems, petioles, or pods, and stem cankers can develop after the fungus spreads to the stems. The pale, irregular spots become ashy gray with scattered black dots (pycnidia) (Fig. 1A). Stem lesions usually develop near the soil line, are elongated and may have a purple border, and may extend below the soil surface, causing a black rot (black leg) of the lower stem (Fig. 2A). Severely affected plants can be stunted if infected early enough, and may wilt. As plants mature in seed

crops, they may fall over from poor root anchorage. Symptoms on seed pods are rare and inconspicuous, but can lead to infection of the developing seed. Infection can spread on crucifer vegetables in storage.

Control of black leg is critical for all crucifer crops including seed, vegetable (fresh market or processing), forage, cover, and oilseed crops, in order to avoid epidemics. It is imperative that all brassica growers, regardless of the type of Brassicaceae, practice the following to avoid introducing/spreading the pathogen:

- Only plant seed that has been tested and certified to be free of *P. lingam* (and the black rot pathogen, *Xanthomonas campestris* pv. *campestris*).
- Avoid planting in or adjacent to a site where black leg has occurred within the last 3-4 years.
- Eradicate susceptible Brassicaceae weeds and volunteer crucifers.
- Avoid planting seedbeds near crucifer crops and use a minimum 5-year rotation for seedbeds.

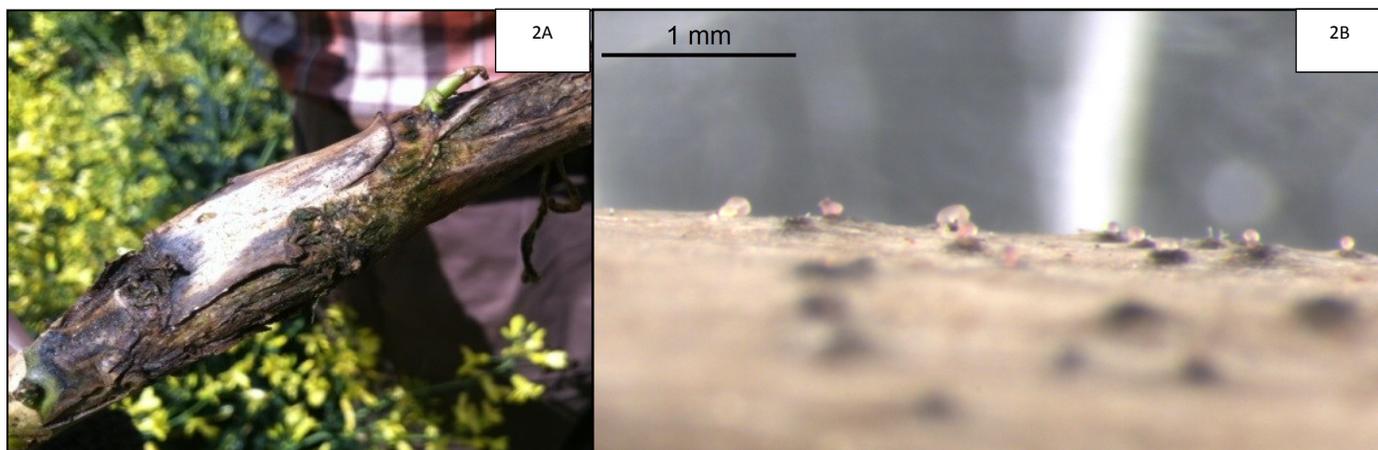


Fig. 2A and 2B. Black leg symptoms on brassica seed stalks incited by *Phoma lingam*. Small, black fruiting bodies (pycnidia and/or pseudothecia) form in the dead tissue. During wet conditions, each pycnidium imbibes moisture and produces a pink 'ooze' (cirrus) filled with conidia (2B) that are splash-dispersed.

- Do not dip transplants in water before transplanting.
- Inspect fields and seed beds for symptoms of black leg or leaf spot.
- Rid diseased fields of infested crop residues as soon as possible after harvest by propane-burning, intensive flailing with subsequent burial, deep plowing, or physical removal of plant debris.
- **Only plant seed treated with fungicides and/or hot water (15 to 30 min at 122°F). The following products are registered for use on crucifer seed crops:**
 - ◆ Coronet fungicide seed treatment (Fungicide Resistance Action Committee (FRAC) Groups 7+11). Not registered for use on radish. Studies at WSU showed Coronet is very effective for seedborne *P. lingam* & other fungi (1).
 - ◆ Dynasty (Group 11) at 0.1 to 0.38 fl oz/100 lb seed (0.1 to 3.75 fl oz /100 lb seed for canola).
 - ◆ Maxim 4FS (Group 12) at 0.08 to 0.16 fl oz/100 lb seed. Not registered for use on canola.
 - ◆ Rovral 4 Flowable (Group 2) at 16 fl oz in 6 gal water applied as a seed soak (24 hours at 30°C) or as a slurry. Washington (SLN WA-070001) only.
 - ◆ Thiram 50WP (Group M3) at 8 oz/100 lb seed (not labeled for Oregon) or 42-S Thiram (FRAC Group M3) at 8 fl oz/100 lb seed (6.4 fl oz for canola).
- If leaf spots develop early, **foliar sprays** help reduce disease development. Spring-planted crops may warrant protective sprays because of the potential for ascospore release and dispersal. The following foliar sprays are labeled for crucifer crops, unless otherwise noted:
 - ◆ Cabrio EG (Group 11) at 12 to 16 oz/A (8 to 16 oz in radish). Not for use on canola or rapeseed.
 - ◆ Quadris Flowable (Group 11) at 6 to 15.5 fl oz/A is labeled for other fungal diseases on crucifers and can be used in Oregon to help control *P. lingam*.
 - ◆ Priaxor Xemium Brand (Groups 7+11) at 4 to 8 fl oz/A for use on canola only.
 - ◆ Proline 480 SC (Group 3) at 4.3 to 5.7 fl oz/A is labeled only for use on canola to control *Sclerotinia*, and can be used in Oregon to control black leg in canola.
 - ◆ Rovral 4F (Group 2) at 2 to 4 pints/A. For *Brassica* and *Raphanus* seed crops, except canola/rapeseed, in Oregon (SLN OR-130001) and Washington (SLN WA-960027) only.

References

1. du Toit, L.J., and Derie, M. L. 2005. Evaluation of fungicide seed treatments for control of black leg of cauliflower, 2004. Fungicide & Nematicide Tests 60:ST011.
2. Rimmer, S.R. and van der Berg, C.G.J. 2007. Black leg (Phoma stem canker). Pp. 19-22 in: Compendium of Brassica Diseases. S.R. Rimmer, V.I. Shattuck, and L. Buchwaldt. (eds.), APS Press, St. Paul, MN. 117 pp.

FROM FLOWER TO FRUIT - A BRIEF OVERVIEW ON HOW TO PROMOTE YIELD AND BERRY QUALITY

Lisa Wasko DeVetter, Small Fruit Horticulturist
WSU Mt. Vernon Research and Extension Center

Strawberry season has arrived, which is an indication that the cascade of berries contributing to the agricultural vitality of Whatcom County will start its annual flow! Producing an excellent crop of high-quality berries is a tremendous investment on the part of a grower. Although



Figure 1. Honey bee pollinating a blueberry flower.

many of the factors contributing to production are beyond the control of a grower (e.g., temperature, precipitation, light, etc.), there are cultural management practices that optimize conditions and help promote the success of a crop. The objective of this article is to provide a brief explanation about the rationale behind some of these practices, with an emphasis on the periods encompassing flowering, pollination, berry development, and floral bud induction in blueberry, raspberry, and strawberry.

Flowering and Pollination

Spring is a beautiful time of the year, but it can also be among the most stressful for growers producing some of our early-flowering crops, such as blueberry. This is partly because flowers become increasingly sensitive to cold temperatures as they open (more discussion on that topic will come in a future newsletter article). Wind machines, propane heaters, and overhead irrigation for frost control are some of the main tools growers can utilize to protect



Figure 2. Flowering and fruit development in red raspberry.

buds and blossoms from frost injury and these tools are commonly utilized in cold-climate areas. Selection of later-flowering cultivars and/or placement of such cultivars at cooler locations in the landscape may also be an option depending on site conditions and grower preferences.

In addition to protecting buds and blossoms from abiotic elements of the environment, growers should also be aware of biological threats. Open flowers are susceptible to infections, such as the fungus botrytis, and this is particularly aggravated under cool and humid-moist conditions. Thus, it's important to start preparing and implementing a robust fungicide program at bloom and under conditions favorable for infection. Rotating fungicides with different modes of action within a spray program is also critical for effective and long-term management, particularly in the prevention of developing resistance and enhancing the longevity of currently available products.

The arrival of flowers on our berry crops also marks the arrival of honey bees (*Apis mellifera*). Rented colonies of honey bees are primarily used for pollination, which can serve an important role in promoting fruit set, berry size, and yield in the absence of sufficient native pollinators. Unfortunately, honey bees have some major challenges that directly impact berry growers. One issue particularly important for western Washington blueberry growers is that weather conditions are often unfavorable for honey bee activity during typical bloom times. In general, honey bees are most active at or above 55 °F, with low wind and full-to-partial sun conditions. Unfortunately, cool and wet conditions often prevail during the flowering period experienced by Whatcom County blueberries, which does not favor honey bee activity

and has been attributed to poor fruit set and yields during some seasons. Another large issue is the potential for poor health among honey bees due to a number of factors including mites, viruses, exposure to pesticides, poor nutrition, and inferior genetics. Recent research has raised more concern about some of the negative impacts fungicides (such as pyraclostrobin and chlorothalonil) and additives (surfactants, adjuvants, etc.) have on honey bee health. More research is needed to determine the extent of the relationship between honey bee health and agrichemical exposure, particularly to products commonly used in production. Of course, growers do not want to apply insecticides during bloom, as they are the most fatal to honey bees and other pollinators. No matter what, it is becoming increasingly important for growers to communicate with their bee keepers about how to manage a planting when bees are on site so not to compromise their health.

Another interesting issue related to pollination is the general attractiveness of flowers to pollinators. Raspberry flowers are very appealing to honey bees, in part because of the open morphology of flowers and easy accessibility to pollen and nectar. Blueberry flowers, in contrast, are not as attractive to honey bees. Honey bees even exhibit preferences for flowers from certain cultivars of blueberry. For example, 'Duke' has been found to be more appealing relative to 'Draper' and this is likely due to the shape of each cultivar's flowers. The general flower structure of blueberry is also such that it's difficult for honey bees to land and access pollen that would help contribute to pollination and fruit set. These issues are why some growers try to saturate plantings with honey bees and stocking rates

can be as great as eight hives per acre (typical is two-to-three hives per acre). Attractants that are labeled as synthetic bee hormones that stimulate foraging behavior and subsequent pollination have also been developed by various companies, but little is known about their efficacy. Some interest has also been expressed in utilizing alternative and/or native pollinators that are more adapted for pollinating blueberry and other difficult-to-pollinate crops. Both bumblebees (*Bombus* spp.) and mason bees (*Osmia* spp.), as well as different genetic strains of bees have been suggested. Yet, little is known about their overall effectiveness in berry crop production and if their incorporation will be cost effective.

Fruit Set and Berry Development

After successful pollination comes fruit set, a complex process whereby plants execute a decision about what berries to and not to develop. Much depends on having effective fertilization of seeds, which is aided by good pollination. If poor fruit set is a concern, synthetic plant hormones may be applied, which can stimulate development of seedless berries. Proper nutrition and provision of adequate water through irrigation is also critical for good berry development, fruit sizing, and quality. Drip/trickle irrigation is becoming increasingly commonplace in berry crop production due to this system's ability to target application to the root system and minimize canopy wetness, which can reduce disease incidence and promote fruit quality. Mulching can also help maintain soil moisture and has several other benefits, such as reducing weed pressure. As berries develop, it is also important for growers to regularly survey fields for pests, diseases, and any other problems that warrant intervention.



Figure 3. Fresh strawberries mark the beginning of berry season!

Floral Bud Initiation

As we transition into late summer and fall, our plants begin transitioning themselves into developing a crop for next year. This process is called floral bud initiation (or FBI), whereby microscopic flowers develop inside select buds. These immature flowers overwinter, grow the following year, and will produce next season's crop. Shortening day lengths and cooler temperatures are the main environmental signals plants use to begin the process of FBI. Age of plant tissue, nutritional status, and overall health also play important roles, with well-established plantings having higher rates of FBI. Environmental factors are difficult to optimize, but growers can help usher plants into FBI mode by encouraging the appropriately timed transition to this type of growth from summer vegetative growth. Practices that stimulate flushes of vegetative growth, such as heavy late-season nitrogen applications and pruning, are unadvised because they delay and/or interrupt the process of FBI and can have negative implications on yield the following season. Another issue with encouraging too much late season growth is that it interrupts the process of acclimation and can

lead to more cold injury because plants haven't prepared themselves physiologically to withstand cold temperatures. Unless there are special circumstances, it is best for growers to naturally allow plants to undergo FBI, begin transitioning into dormancy, prune after leaf drop, and fertilize earlier in the growing season.

Conclusion

Berry crop production is complex and subject to so many variables seemingly beyond the control of a grower. However, understanding some of the principles of crop growth and development, as well as the rationale behind various management practices, can better serve growers in how to successfully manage their crops in the face of all this complexity. Much research remains on how to develop and refine sustainable approaches to berry crop management, which is where my new program and the great team of small fruit scientists in the PNW are immersed in!

WHATCOM COUNTY PRODUCERS PARTICIPATING IN NAHMS DAIRY 2014 STUDY

Susan Kerr

WSU Regional Livestock and Dairy Extension Specialist

Several Whatcom County dairy producers are participating in the National Animal Health Monitoring System's (NAHMS) Dairy 2014 study. Every year, this branch of the USDA's Animal and Plant Health Inspection Service looks closely at a particular animal industry--beef cattle, sheep, goat, dairy cattle, swine, equine, poultry and catfish. The last comprehensive study of the dairy industry was in 2007; there have been a total of five dairy studies.

The Dairy 2014 study will be an in-depth look at U.S. dairy operations, which will provide the industry with new and valuable information regarding trends in the dairy industry from 1991 to 2014. This year's study will focus on key areas important to dairy producers and consumers alike, including lameness, calf health, animal welfare and food safety. Each farm's information will be kept confidential, but aggregated data collected from U.S. dairy farms will be released in NAHMS reports and be very valuable to the dairy industry in establishing performance benchmarks and opportunities for improvement.

Phase One: Determining the Study's Focus

For the study, NAHMS asked dairy producers, industry stakeholders and government officials to provide input and define the information needs of the dairy industry. During this process, six study objectives were identified:

- Describe trends in dairy cattle health and

management practices

- Describe management practices and production measures related to animal welfare
- Estimate the prevalence of lameness and evaluate housing and management factors associated with lameness
- Evaluate calf health from birth to weaning
- Describe antibiotic use and residue prevention methods used to ensure milk and meat quality
- Estimate the prevalence and antimicrobial resistance patterns of select foodborne pathogens

Surveying Producers

Selected dairy producers throughout the U.S. were given the opportunity to participate in the NAHMS Dairy 2014 Study. Operations were selected so dairies of various sizes and locations could be involved. After an initial intake survey to identify specific details of each dairy, an extensive on-farm questionnaire was conducted with producers who decided to participate. The questionnaire included questions about animal health and management practices focusing on the objectives listed above.

After analysis of their survey, each participating dairy will receive customized reports describing animal welfare measures, heifer-calf growth and productivity, the risks of drug resi-

dues in meat and milk and how to address these risks. Based on questionnaire responses, these reports will allow producers to compare their practices and productivity measures with those of other dairies. Best management practices/industry goals will also be included.

Optional Calf Component

Dairies that participated in the initial survey and questionnaire were also invited to participate in a year-long calf health study. This component will focus exclusively on U.S. dairy heifer calves from birth to weaning. Specifically, it will:

- Describe practices related to colostrum management, milk feeding and calf housing
- Evaluate colostrum quality and passive transfer
- Estimate the incidence of disease in calves and its relationship with management factors
- Evaluate calf growth rates based on different milk feeding approaches
- Test calves for persistent infection with bovine viral diarrhea virus.

Benefits of the NAHMS Dairy 2014 Study

The dairy industry will benefit from the study's results, which will include current and scientifically-valid estimates of management practices, disease prevalence and other information important for trade and the health of the dairy industry (e.g. benchmarking). Researchers and educators will examine reports generated from the study to identify areas that need additional investigation and/or educational outreach to achieve desired outcomes. The public will also benefit from the process itself, knowing the industry takes an in-depth look at itself on a regular basis to see where it can continue to improve, particularly in the areas of animal welfare and product safety.

For more information about the NAHMS Dairy 2014 study, visit <http://tinyurl.com/lubytpt>.

"The NAHMS process for many years identified industry benchmarks that provided a snapshot of industry practices that other producers could use to see where they stand relative to their peers. The NAHMS 2014 dairy study provides an opportunity for today's producers to be part of this proud process."

—Dr. Cassandra Tucker
Department of Animal Science
University of California, Davis

—Drs. Dan Weary and Nina von Keyserlingk
Animal Welfare Program
University of British Columbia, Canada

NEW 1000 FT² ORGANIC FERTILIZER AND COVER CROP CALCULATOR AVAILABLE ONLINE

Nick Andrews

Senior Instructor, Small Farms Extension Agent, Oregon State University

The [OSU Organic Fertilizer and Cover Crop Calculator](#) is available on the Small Farms website. It is a downloadable Excel spreadsheet that allows farmers and gardeners to estimate nitrogen release from organic fertilizers and cover crops. The calculator makes it easy to compare the cost of nutrients from cover crops and fertilizers, and develop a fertilizer plan. It can help you to select the most cost-effective fertilizers, and supply enough nutrition for your crops without over-fertilizing. This can help you save money, optimize yield and reduce the risk of water pollution on your farm.

In March 2014 we launched a new “small farms and gardens” version of the calculator that makes calculations on a 1000ft² basis. The original calculator for larger farms that was launched in 2010 makes calculations on a per acre basis (*Oregon Small Farm News*, vol. 5(2), spring 2010). Most small scale farmers and gardeners manage their fields in units that are less than 1 acre. This new version is designed to be easier to use on smaller scale operations. The new “small farms and gardens” version includes all of the features of the “larger farms” calculator. Both calculators predict nitrogen (N) mineralization from organic fertilizers, compost and cover

crops and allow cost comparisons between cover crops and fertilizers.

In November 2012, Dan Sullivan and Nick Andrews published PNW 636: “[Estimating plant-available nitrogen release from cover crops](#)”.

This 23 page publication describes the science used to predict N-mineralization from cover crops, and answers many common questions about N release and immobilization from cover crops.

How much nitrogen can you get from a cover crop?

Figure 1 presents findings from Amy Garrett and John Luna’s research at OSU. The graph on the left shows that the vetch cover crop supplied about 110 lbs of plant-available N (PAN) to the broccoli. In this example, a farmer could reduce supplemental N fertilizer by about 110 lbs PAN/ac and save \$500/acre or more in fertilizer costs. The graph on the right shows that an oat cover crop immobilized about 50 lbs of plant-available N when it was decomposing. This farmer would have to supply more N fertilizer to maintain crop yield.

How can you estimate cover crop PAN?

To estimate cover crop PAN you first need to measure or estimate cover crop biomass, dry

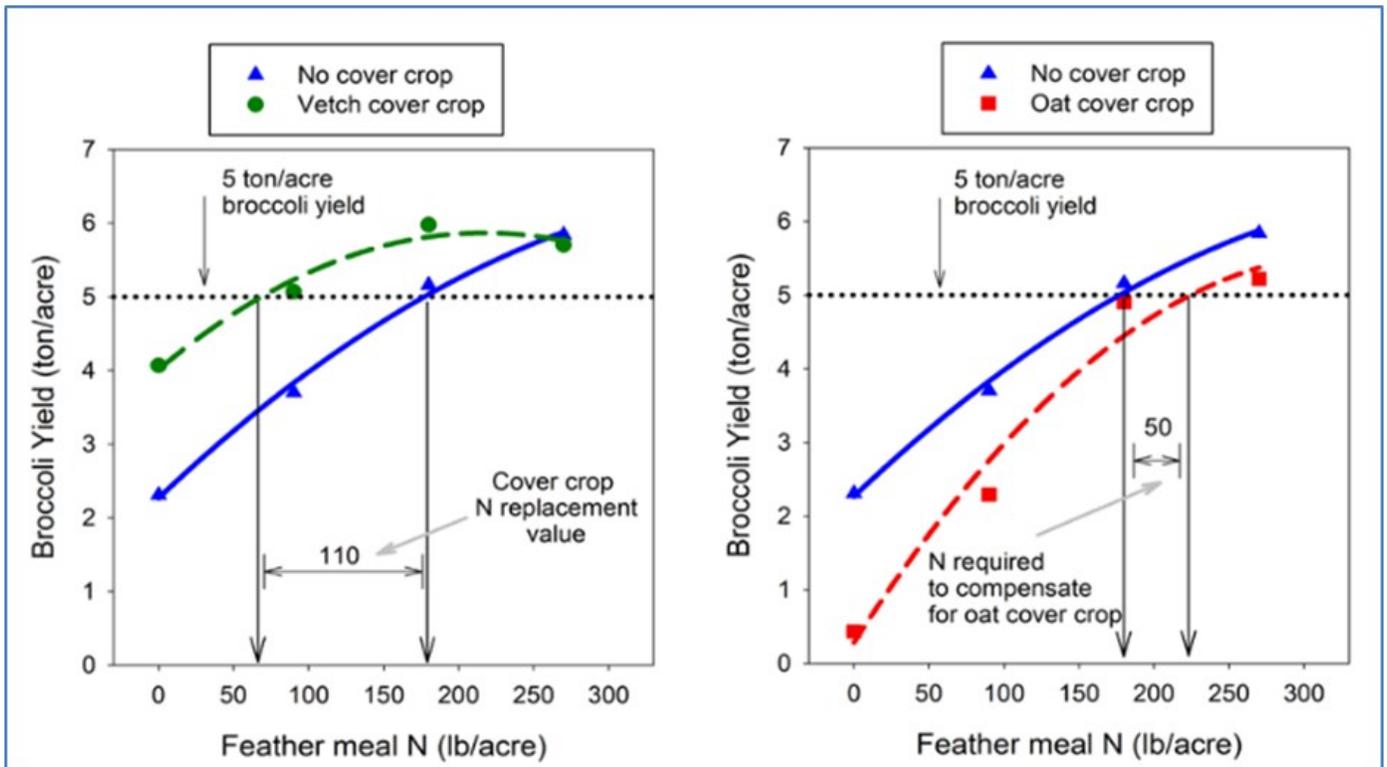


Figure 1. A vetch cover crop reduces the N requirement for broccoli (left). An oat cover crop increases N required for broccoli (right). Fertilizer equivalency is estimated at a broccoli yield of 5 ton/ac.

matter and total N content. The most accurate on-farm method is to harvest cover crop foliage from a known area and measure the fresh weight (figures 2-3). Mix the complete field sample thoroughly for a few minutes and shred large plants by hand (figure 4). Collect a small (i.e. 1 lb) sub-sample and send it to a soil and plant laboratory in a paper bag ([see Laboratories Serving Washington](#)). Make sure you don't send any soil with the sample, and that the lab is willing to dry and grind your whole sample before measuring % dry weight and total % nitrogen.



Figure 2. Harvesting cover crop biomass from a known area (4 ft² quadrats in this picture) in order to estimate plant-available N release. This is usually done from at least four areas of the cover cropped field.

When you have results back from the lab, you can use the OSU [Organic Fertilizer and Cover Crop Calculator](#) to estimate PAN on a per acre scale, or per 1000ft². We periodically hold workshops to show people how to sample cover crops and use the calculator. It generally costs less than \$20 for postage and lab fees to analyze cover crops. It is not uncommon for farmers to save \$200 or more per acre by including cover crop N in their fertilizer plans. If you prefer not to send cover crop samples to the lab, you can estimate cover crop PAN by measuring cover crop biomass and using typical values to predict PAN, instructions for using this shortcut method are in [PNW 636](#) (page 9). After a couple years' experience measuring cover crops and using the calculator, some farmers feel comfortable estimating cover crop PAN visually based on their experience.

Please contact Nick Andrews via [email](#) or (503) 678-1264 x149.



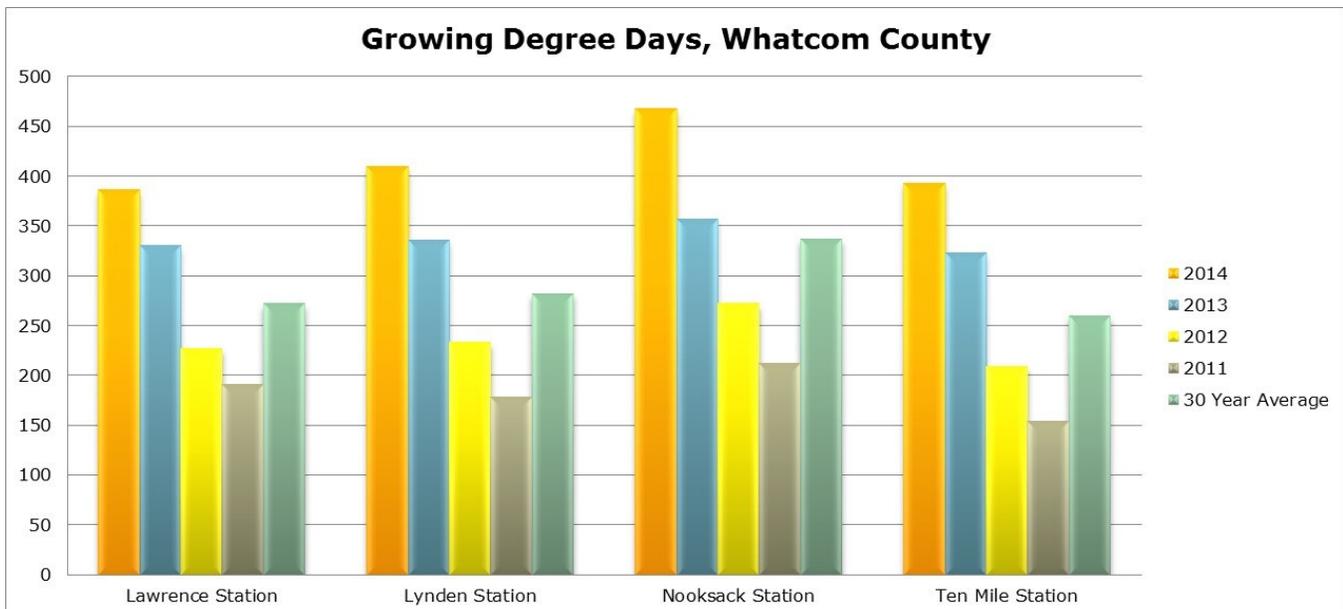
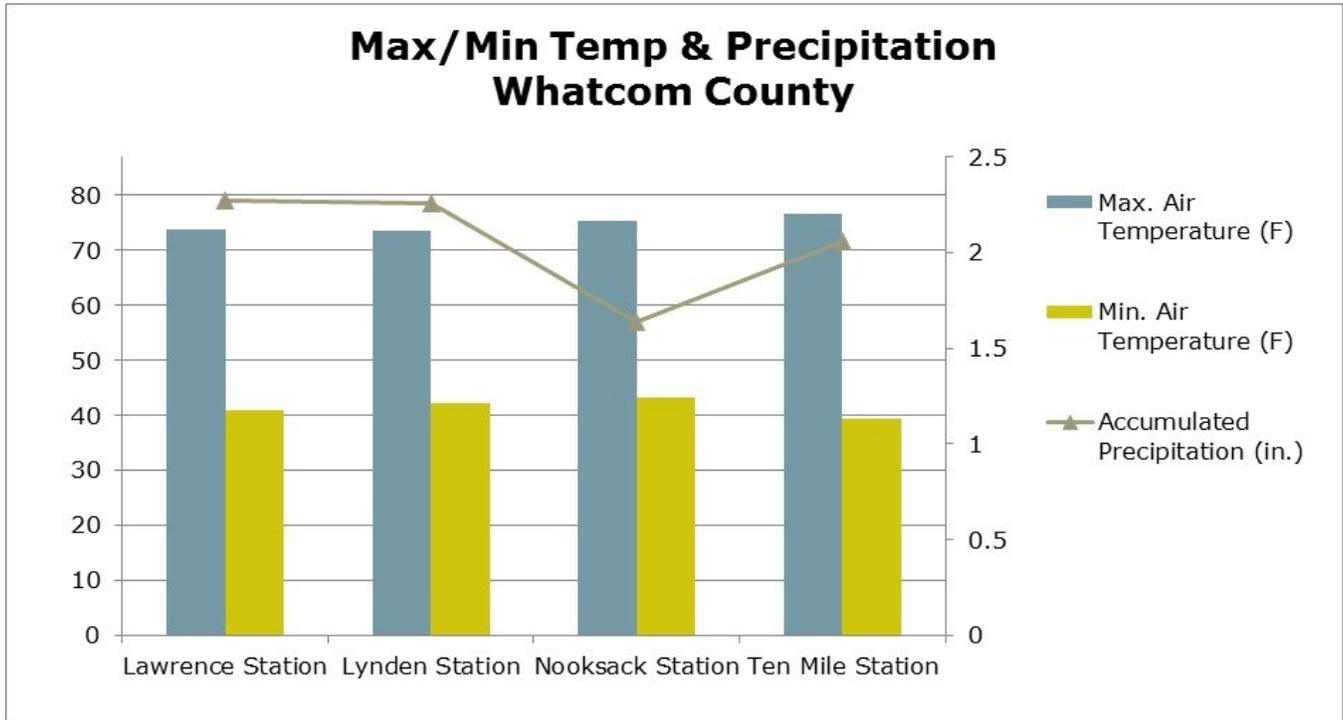
Figure 3. Weighing the cover crop biomass from the complete field sample. Samples from all four areas of the field are combined.



Figure 3. Mixing the harvested cover crop to weigh total fresh weight from the 16 ft² sample we take from each field. Submit about a 1 lb sub-sample to the lab to measure percent dry weight and total percent nitrogen.

WEATHER UPDATE

All information here is derived from the four weather WSU AgWeatherNet stations (<http://weather.wsu.edu/awn.php>) in Whatcom County. Current weather conditions can be found at: <http://whatcom.wsu.edu/ag/currentdata.html>. Station information can be found [here](#).



Chris Benedict

Editor

WSU Whatcom County
Extension
(360) 676-6736, ext. 21

Colleen Burrows

Assistant Editor

WSU Whatcom County
Extension
(360) 676-6736, ext. 22

Jessica Shaw

Assistant Editor

WSU Whatcom County
Extension
(360) 676-6736, ext. 23

Vincent Alvarez

Designer

WSU Whatcom County
Extension
(360) 676-6736

Cover Image:

Silage Corn

Web site:

whatcom.wsu.edu/ag

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Upcoming Events

June

[Annual Maximum Residue Limit \(MRL\) Harmonization Workshop](#)

June 18th - 19th
San Francisco, CA

The interactive seminar will address critically important issues for stakeholders with interests in exporting agricultural products. Growers, packers, shippers, PCAs, registrants, regulators, trade experts, and other stakeholders in international trade are strongly encouraged to attend.

[WSU Vegetable Seed Field Day](#)

June 20th
8:00 am - 12:00 pm
WSU NWREC, Mt. Vernon, WA
The tour will include visits to entomology, plant pathology, and weed science plots as well as discussion of preliminary results from our 2014 vegetable seed crop experiments.

[WSU Small Grains Field Day](#)

June 25th
3:00 pm - 6:00 pm
WSU NWREC, Mt. Vernon, WA
This tour will visit research fields to discuss the production of small grains such as wheat, oats, rye and barley in Western Washington for food, feed and malt.

[Orchard Management for Direct Retail Sales](#)

June 30th

12:30 pm - 4:00 pm
Chelan, WA

Attendees will learn about organic orchard management, pest and weed management, packaging of fruit, and marketing strategies for wholesale and direct co-op sales.

July

[OSU Caneberry Field Day](#)

July 9th
1:00 pm - 5:00 pm
Aurora, OR

A focus on the breeding program & research on conventional and organic production systems for commercial growers.

[WSU Mount Vernon Field Day and Tour](#)

July 10th
3:30 pm
This tour will visit current research projects at WSU Mt. Vernon. Followed by barbecue cookout.

[OSU Blueberry Field Day](#)

July 16th
1:00 pm - 5:00 pm
Aurora, OR

A focus on research for commercial growers; A focus on the breeding program & research on conventional and organic production systems for commercial growers.