Integrated Pest Management
University of Missouri

NOVEMBER 2018

Missouri Produce Growers *Bulletin*

This Fall's On Farm Readiness Reviews

Patrick Byers

'On Farm Readiness Reviews' (OFRR) were discussed in the July MPG Bulletin and have concluded for this year. To recap, these farm visits are a partnership between Missouri Department of Agriculture (MDA) and MU Extension specialists. An OFRR is requested by the grower, and takes place on the farm. The only other requirement is that someone with that farm must have attended a FSMA training *(see back page on upcoming FSMA workshops)*. The format is similar to future FSMA inspections; it consists of a walk-through of the farm's production and produce handling areas. The OFRR team will ask extensive questions of the farmer, and the farmer is encouraged to ask questions as well. Following the walk through, the OFRR team leaves a short report to help the grower correct any problems and prepare for an eventual inspection. A booklet to assist in understanding the report is also provided.

About 10 OFRR visits took place at Missouri farms, with at least five that market at produce auctions. Many of the host farmers invited neighboring produce growers to follow along. This is completely up to the farmer if they are comfortable with it, and it certainly increased awareness in those communities. As an overall comment, all are trying to follow safe production and handling practices and largely doing so. However, each farm had several areas where improvement was needed. Among these areas of improvement, the following were noted:

- Animal management in production fields and at harvest. Animals should be clearly separated from the harvested part of covered crops. Any manure issues, especially in production fields, must be treated as a contamination situation. Care must be taken to prevent cross contamination when handling animals and then handling produce.
- Record keeping requirements. A wide range of records are required for farms subject to the FSMA PSR, and growers were generally starting the process. Growers are encouraged to use templates which are available from your local Extension office.
- Training programs for workers. All persons working on the farm must receive training in safe production and handling practices, including children. Training materials must be appropriate for the audience, which can be a challenge given the wide range of ages among people working with produce on a typical farm.
- Policies for farm visitors. Visitors to the farms, both family and strangers, were common. All visitors to the farm must understand farm policies relative to food safety. Commercially available signage can meet this requirement.
- Sanitation of harvest gloves. Most farms did not have policies in place relative to glove use. Farms using gloves for harvest and handling must launder the gloves when soiled.
- Cleaning and sanitation of harvest containers. Harvest containers must be cleaned when visibly soiled, and then sanitized.
- Water quality profiles for agricultural production water and harvest/postharvest water. Most farms are at the beginning of developing water quality profiles. The FSMA PSR has allowed additional time to meet the requirement to develop a water quality profile. All water sources other than public water must be tested. If multiple wells are used for production water, each well must be tested. Growers were interested to learn about the water quality standards for agricultural water used for production. Growers were equally interested to learn that water used during harvest and postharvest handling must be potable. Finally, growers were interested in locating a convenient testing lab that offered the approved water testing protocol. Kansas State University is currently offering free water testing. Check with Kenny Struemph for details.
- Managing sanitizing solutions used to wash produce. Farms generally did not have protocols in place to validate the concentration of sanitizers in water for batch or multiple pass use. Several growers were interested in ways to reduce the use of harvest/postharvest water.
- Design of storage areas relative to rodent control. FSMA PSR mandates control of rodents in places where produce is handled, as well as storage areas for containers and tools. A common recommendation was to allow a clear area around the interior perimeter of buildings, to observe any rodent activity. A second recommendation was to place and check rodent monitoring traps (not baits).
- Cross contamination risks. As animals are commonly used in crop production and manure is a common soil amendment on farms, cross contamination was discussed in depth. Designated clothing for animal handling, lining wagons and carts with plastic tarps, using aprons or coveralls over clothing, and proper glove use were practical solutions to this risk.

OFRR visits will continue in 2019 and start earlier in the season. The OFRR is most effective when scheduled during production and harvest. To schedule an OFRR, contact Kenny Streumph at MDA (Kenny.Struemph@mda.mo.gov or 573-751-1134). Editor's note: Patrick Byers is now assigned ½ time to food safety due to grant support by MDA.

Also In This Issue

Cole crops harmed by hot weather

David Trinklein

For lovers of cole crops or those relying on their production for income, 2018 has been a disappointing year thus far. The combination of a late spring and early summer has resulted in reduced yield and quality or, in certain cases, no yield at all. Commercial growers and home gardeners alike have been left wondering what went wrong this spring.

The term "cole crop" is derived from *kohl*, the German word for cabbage, and given to a number of cultivar groups of *Brassica oleracea*. In its uncultivated form, the latter is commonly known as wild cabbage. Significant cultivar groups of *B. oleracea* include *Acephala* (kale and collard greens), *Botrytis* (cauliflower and Romanesco broccoli), *Capitata* (cabbage), *Gemmifera* (Brussel sprouts). *Gongylodes* (kohlrabi) and *Italica* (broccoli). All likely were derived by artificial (human) selection from phenotypic variations of *B. oleracea* that appeared throughout antiquity. Today, cabbage, broccoli and cauliflower represent the three most economically important cole crops in the United States.

The cole crops are classified as "cool season" vegetables which grow best under cool, moist conditions. For example, cabbage carries on the greatest amount of photosynthetic activity (growth) at temperatures in the 59-68 degree F range. Properly hardened, many of cole crops can withstand temperatures well below freezing for short periods of time. Young plants tend to be more cold tolerant than older plants.

Conversely, cole crops do not respond well to hot weather. For example, cabbage totally stops growth at temperatures above 77 degrees F. Broccoli and cauliflower are even more sensitive to high temperatures. Any condition that causes stress on cole crops during their period of active vegetative growth can lead to crop failure. At our latitude, temperature stress is a frequent cause.

Because of their ability to withstand frost but their aversion to hot weather, cole crops typically are planted (outdoors) in Missouri in March or early April. Exact planting date depends largely upon latitude and local conditions. The hope is for plants to have sufficient cool weather to make significant growth before warm weather ensues. Cool temperatures provide the plant with an environment conducive for growth that results in the formation of heads, spears or curds in cabbage, broccoli and cauliflower, respectively.

In most years, this production regime results in an adequate crop spring crop for Missouri growers. In 2018, it did not. Most of Missouri was subject to a combination of climatic events this past spring that rarely, if ever, were experienced before. Borrowing from a movie title, it was the "perfect storm" for cole crop failure.

Weather data collected at Sanborn Field on the University of Missouri campus revealed that April 2018 was the second coldest on record. The abnormally cold temperatures resulted in below average growth during a period when cole crops usually make significant growth.

April was followed by much warmer weather in May and June. Again at Sanborn Field, weather data revealed May to be the warmest on record with an average high of 84 degrees F. The latter is well beyond the point cole crops stop growth. Additionally, there was no respite to high temperature stress in May. Every day the recorded high daily temperature was above the historical average.

The abnormally warm temperatures continued into June when the average high temperature at Sanborn Field was 89 degrees F and the average low 69. The latter is significant, since warm night temperatures result in elevated rates of respiration which depletes the meager amount of food manufactured by plants during the day.

This transition from being somewhat "behind schedule" (growth-wise) at the end of April to the stifling temperatures of May and June resulted in widespread cole crop failure during spring 2018. At best, yields were greatly reduced and quality was poor.

Additional temperature-related disorders that can reduce cole crop value include "riciness" and curd bracts in cauliflower and knuckling in broccoli, Ricing occurs when cauliflower flower buds develop, elongate and separate. Curd bracts are leaves that develop between curd segments. Both are caused by high temperatures. Knuckling, caused by fluctuating temperatures, occurs when broccoli makes uneven growth leading to a bumpy appearance.

The question arises then, "What can be done to improve the likelihood of a successful crop"? Cultural practices that allow for earlier planting in the spring so that cole crops can make significant growth before the advent of hot weather should be explored. These include the use of floating row covers, plastic mulch or high tunnels.

Depending upon thickness, row covers can provide from 4 to 8 degrees F of frost protection. At our latitude, this would allow cole crops to be planted three to four weeks earlier in the spring. The result would be longer exposure to cooler temperatures favored by cole crops before high temperatures slow growth.

Plastic mulch tends to warm the soil earlier in the spring. Research has demonstrated black plastic mulch increases soil temperature about 5 degrees F at a depth of two inches, when compared to bare soil. The combination of warmer roots along with favorable cool spring weather has been shown to hasten the maturity of cole crops from between one and three weeks. Thus, the crop has been harvested before temperatures get too warm. Clear plastic does an even better job of warming soil than black plastic, however, it does not suppress weed growth.

Finally, high tunnels are rudimentary, unheated greenhouses covered with a single layer of polyethylene plastic. Although they do represent an added production expense, their use has been demonstrated to increase day temperatures by 10 to 30 degrees F and offer up to four degrees of frost protection. The latter allows for the planting of most crops two to four weeks earlier than normal. Passively cooled, high tunnels provide ideal growing conditions for cole crops very early in the season. Once the crops have been harvested, warm weather vegetables can be planted to make additional use of the valuable space. For an extra early start, a combination of floating row covers placed over plants in a high tunnel has proven to be workable. Additional information about high tunnels can be found at **http://hightunnels.org/**.

Spotlights: MU Plant Diagnostic Clinic

Josephine Mgbechi-Ezeri

The following are highlights about samples and disease issues diagnosed at the Plant Diagnostic Clinic in the month of September.

Soft rot of cabbage

Soft rot, caused by *Pectobacterium carotovorum* subsp. *carotovorum* is a widespread destructive disease of vegetables worldwide. The bacteria infects succulent plant parts such as tubers, fruits, bulbs, corms, rhizomes, buds, petioles and leaf stalk tissues. Soft rot losses can occur during cultivation in the field and after harvest in storage. The bacteria attacks several vegetable crops including cabbage, broccoli, onion, potato, pepper, melon, cucumber, bean, and beet. Symptoms of infection appears as small, water-soaked areas that rapidly enlarge. Affected tissue becomes soft and mushy with foul odor. The affected plant part may decay and collapse within a few days.

The bacteria overwinters in soil and infected debris, and infect plants through wounds caused by frost damage, insect injuries, harvesting and handling. The bacteria is spread by affected plant tissue, irrigation water, rain, insects and infested pruning tools. Soft rot disease development is favored by warm [25-30°C (77-86°F)], humid conditions with prolonged periods of wet weather.

Control of soft rot involves multiple measures. Minimizing wounding during cultivation, harvesting and handling can help to reduce spread in the field or storage. Start plants with disease free seeds and transplants. Select well drained site for planting. Control frequency of irrigation, avoid overhead irrigation and using stagnant water source. Grow resistant crops in rotation with susceptible vegetables. Harvest crops during dry weather condition. Store and ship produce in clean and cool conditions.

Soft rot on cabbage caused by *Pectobacterium carotovorum* subsp. *Carotovorum*

Diseases of cucurbits

Anthracnose of Cucumber

Anthracnose is a widely distributed fungal disease of cucurbits. The MU Plant Diagnostic clinic received a sample of cucumber with leaf spots caused by the fungus *Colletotrichum orbiculare* (syn. *Colletotrichum lagenarium*). Anthracnose can cause serious losses of cucumbers, melon, watermelon and muskmelon whenever susceptible cultivars are grown but rarely infects pumpkin and squash. Warm, humid, and frequent rain favors disease development and spread. Infection can occur on seedlings, leaves, petioles, stems, and fruits.

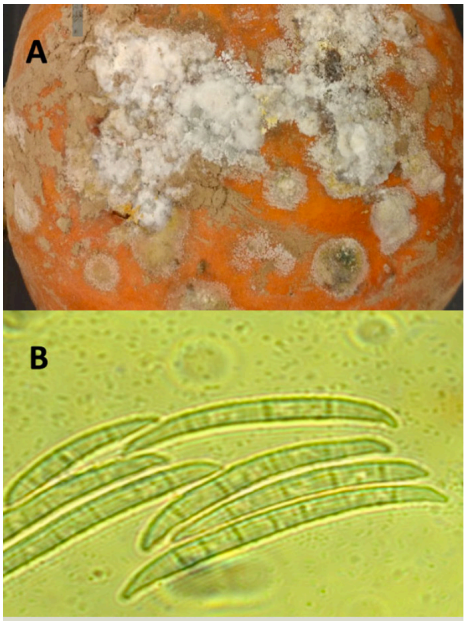
leaf spots on cucumber

Leaf symptoms start as a small water soaked lesion with yellowish appearance. As the disease progresses, the lesion expands and turns into brown spots which may coalesce resulting in leaf blighting. Lesions on the leaf petiole and stem are shallow, elongate and tan. Severe infection of the petiole, stem, fruit and pedicel can cause extensive defoliation, lower fruit quality and yield loss. The fungus survives between crops on seeds, volunteer weeds and on infected crop residues. Spread of the fungus occurs by splashing rain, overhead irrigation, insects, field workers and tools.

Leaf spots on cucumber caused by *Colletotrichum orbiculare*

Effective management of anthracnose disease involves an integrated pest management strategy. Start with certified clean seeds to reduce disease incidence on the field. When purchasing transplant seedling, carefully inspect plants for disease symptoms before transplanting. Scout plants regularly for signs of disease. Control volunteer cucurbit weeds and alternate host around the field. Plow down deeply all infected debris immediately after harvest. Practice crop rotation for at least two years with crops other than cucurbits. Regular fungicide application as soon as disease is detected can help to reduce disease severity. Information on chemicals registered for anthracnose disease on cucurbits is available in the Midwest Vegetable Production Guide for Commercial Growers.

Fusarium fruit rot



Fusarium fruit rot caused by *Fusarium* species. **A** Pumpkin fruit with lesion, **B** macroconidia of *Fusarium* species

Fusarium fruit rot, a common pre and post-harvest disease of many cucurbits, can severely affect fruit quality. The disease is more destructive on pumpkin and squash. Fruit rot losses can occur in the field or in storage after harvest. Several *Fusarium* species including *F. equiseti*, *F. acuminatum*, *F. graminearum*, *F. avenaceum*, and *F. solani* are associated with fruit rot in cucurbits. The pathogen is seed borne and can survive as chlamydospores in the soil for 2-3 years.

Symptoms develop on fruit surfaces in contact with soil as firm, dry, sunken lesions of varying sizes covered with white or gray fungal growth. Disease symptoms can vary with host, plant age, environmental conditions, soil moisture, pathogen population in the soil, and the aggressiveness of the strain.

Effective management of this disease involves an integrated pest management strategy. Plant resistant cultivars, start with disease free seeds and do not save seeds from the infected fruit. Practice rotation with non-cucurbits for 4 years. Avoid planting in fields with history of disease. Providing physical barrier between the fruit and the soil can help to minimize the disease and avoid wounding of the fruit during handling.

FSMA Trainings for Winter 2018-19

The Food Safety Modernization Act (FSMA) trainings are in full swing this year. Besides one each being held in Lamar (Oct. 29th) and Windsor (Nov. 7th) there are four more scheduled. And we expect additional trainings in other communities as well (e.g. Clark and Rich Hill). Consider one of the trainings below if you are interested or needing this training. Attendance is limited to 50; please reserve in advance.

$20 per person*, lunch is included and all participants will receive a training certificate along with a PSA Training Manual.

December 4th	8 AM to 5 PM
260 Brown Rd.	St. Peters, MO 63376
636-797-5391	MU Extension in Jefferson County
December 7th	8:30 AM to 5:30 PM
1002 Greatwest Dr.	Kennett, MO 63857
573-686-8064	MU Extension in Popular Bluff
December 12th	8 AM to 5 PM
18761 Kelsay Rd.	(Morgan County Seeds) Barnett, MO 65011
573-378-5358	Morgan County Extension Center
December 14th	8 AM to 5 PM
State Hwy. Short P	(C Highway Produce Auction) Seymour, MO 65746
417-859-2044	Webster County Extension Center
January 10th, 2019	8 AM to 5 PM
Fulkerson Center	(Great Plains Growers Conference) St. Joseph, MO 64507
816-279-1691	Buchanan County Extension Center**

(cost is $55 with a $35 rebate)**

MU and LU Extension are pleased to offer the Food Safety Modernization Act Produce Safety Alliance training, open to fruit and vegetable growers and others interested in learning about produce safety. The Food Safety Modernization Act (FSMA) Produce Safety Rule training meets the requirement for farms subject to the FSMA Produce Safety Rule,outlined in §112.22(c) that requires "At least one supervisor or responsible party for your farm must have successfully completed food safety training at least equivalent to that received under standardized curriculum recognized as adequate by the Food and Drug Administration."

**** The Missouri Department of Agriculture is providing generous support to offset the costs of this training so it is available at a reduced price for Missouri growers.***

WHO'S WHO

MU Extension

James Quinn
Editor
573-634-2824
quinnja@missouri.edu

Dave Trinklein
State Floriculture Specialist
573-882-9631
trinkleind@missouri.edu

Jared Fogue
MU IPM Program
Media Specialist
foguej@missouri.edu

MU Extension County Specialists

Adair: Jennifer Schutter
660-665-9866

Daviess: Tim Baker
660-663-3232

Greene: Patrick Byers
417-881-8909

Henry: Travis Harper
660-885-5556

Morgan: Joni Harper
573-378-5358

Vernon: Pat Miller
417-448-2560

Webster: Patrick Byers
417-859-2044

The Missouri Produce Growers (MPG) bulletin is published by the University of Missouri with funding support from both the Missouri Department of Agriculture (MDA) Cooperative Agreement to Enhance Produce Safety from the US Food and Drug Administration (FDA) and the USDA NIFA (National Institute of Food and Agriculture) CPPM – Extension Implementation Program.

UNIVERSITY OF MISSOURI Extension

Issued in furtherance of the Cooperative Extension Work Acts of May 8 and June 30, 1914, in cooperation with and funded in part by the U.S. Department of Agriculture. Director, Cooperative Extension, University of Missouri, Columbia, MO 65211. • MU Extension provides equal opportunity to all participants in extension programs and activities, and for all employees and applicants for employment on the basis of their demonstrated ability and competence without discrimination on the basis of race, color, national origin, ancestry, religion, sex, sexual orientation, gender identity, gender expression, age, genetic information, disability, or protected veteran status. • 573-882-7216 • extension.missouri.edu