Cooperative Extension • Monterey County

Crop Notes

May/June 2012

In This Issue:

FOLIAR DISEASES OF APIACEAE CROPS IN COASTAL CALIFORNIA

Carolee Bull, USDA-ARS, Salinas
Steven Koike, UC Cooperative Extension, Monterey County

Plants in the Apiaceae (parsley family) are grouped together by virtue of their umbrella-like flower structure. This group includes a large number of important crop commodities. In Monterey County and surrounding coastal regions, significant acres are planted to carrot, celery, cilantro, fennel, and parsley. In addition, smaller plantings of specialty Apiaceae crops are also found and include the following: anise, celeriac, chervil, dill, parsnip. While not produced in coastal California, this plant family also includes caraway and cumin. From 2002 through the present, growers of Apiaceae crops in coastal counties have reported increased incidence of leaf spot diseases on these plants. Because related plants often are susceptible to the same plant pathogen, we conducted a series of studies of these foliar problems. Here we describe the bacterial diseases of this family and available management strategies.

Celery: Leaf spots are initially small, angular in shape, and water-soaked; multiple spots later coalesce and become necrotic and tan to brown in color. Lesions do not develop on the celery petioles. We confirmed that *Pseudomonas syringae* pv. *apii* causes northern bacterial blight of celery in central coast California, which is consistent with previous studies conducted in the region. Growers and pest control advisors continue to see this problem. The disease rarely has an impact on the final yield but primarily reduces the quality of transplants and may delay establishment of the transplant in the field. Field personnel must take care to not confuse bacterial blight with leaf spot diseases caused by fungal pathogens (*Septoria apiicola, Cercospora apii*).

Cilantro: Bacterial leaf spot of cilantro was documented in California in 1990. This disease begins with water-soaked leaf spots that later turn brown to black. Lesions do not develop on the cilantro petioles. The pathogen is *Pseudomonas syringae* pv. *coriandricola*. This disease is a chronic problem for growers and occurs every season. To our knowledge, this is the only foliar disease of cilantro in California.

Parsley: Symptoms of bacterial leaf spot of parsley are similar to the other Apiaceae bacterial diseases and consist of water-soaked, angular spots that later turn brown. Lesions do not develop on the parsley petioles. We found that both *P. syringae* pv. *apii* (the celery pathogen) and *P. syringae* pv. *coriandricola* (the cilantro pathogen) are the causes of this parsley disease. Of nine outbreaks studied, two were caused by *P. syringae* pv. *apii*, six were caused by *P. syringae* pv. *coriandricola*, and one consisted of both pathogens. Yet a third pathogen, *Pseudomonas viridiflava*, was found to cause a leaf spot on commercially grown parsley; studies are on-going regarding this additional bacterial agent. Bacterial leaf spot of parsley can be confused with leaf spot diseases caused by fungal pathogens (*Septoria petroselini, Stemphylium vesicarium*).

Fennel: Bacterial streak of fennel is the newest Apiaceae bacterial problem to be reported and was characterized in 2010. Initially, small dark brown to black lesions form on leaves. These lesions later expand and progress down the thread-like leaves and can eventually spread

(Cont'd to page 2)

University of California, U.S. Department of Agriculture, and County of Monterey cooperating

1432 Abbott Street • Salinas, CA 93901

phone 831.759.7350
fax 831.758.3018

http://cemonterey.ucdavis.edu

(Cont'd from page 1)

down into the main petiole and into the bulbs. The pathogen was shown to be *P. syringae* pv. *apii*. Bacterial streak is unlikely to be confused with the main fungal foliar disease, Cercosporidium blight (*Cercosporidium punctum*). However, bacterial streak can closely resemble damage to fennel foliage caused by frost and cold temperatures.

Celery, cilantro, parsley, and fennel are all subject to bacterial diseases of the foliage.

On-going research: We have initiated host range studies to determine if Apiaceae crops other than parsley, cilantro, and celery are susceptible to these pathogens. Under experimental conditions, all crops tested to-date are susceptible to these three pathogens (Table 1). However, only *P. syringae* pv. *apii* has been confirmed to be the cause of field disease epidemics on celery, cilantro, parsley, and fennel (Table 1). Our studies have indicated that the cause (etiology) of these various Apiaceae diseases is complex; we seek to further define the roles of these various bacterial species and pathovars on all crops from this plant family.

On cilantro, *P. syringae* pv. *apii* has only been isolated from symptomatic leaves from fields where *P. syringae* pv. *coriandricola* also caused disease. In a few cases both pathogens were isolated from the same lesion, suggesting that mixtures of these pathogens occur in fields and within lesions on plants. It is not yet known if one or both of these pathogens are associated with diseased cilantro grown outside of California. *P. viridiflava* has not been found again since the first isolation from parsley in 2008.

Management: (1) Use pathogen-free seed or seed that has been treated for bacterial pathogens. Seedborne inoculum has been confirmed for celery and cilantro, and it is likely that bacterial pathogens could be seedborne for parsley and fennel, as well. In the case of transplants, for example celery, use disease free transplants. (2) Avoid using sprinkler irrigation, since the bacterial pathogens are primarily spread plant-to-plant via splashing rain and water from overhead irrigation. (3) Practice crop rotation so as to minimize back-to-back plantings of Apiaceae crops. It is likely that these bacterial pathogens do not survive for long periods in the soil once crop residues are incorporated and completely decayed. However, it is possible that consecutive plantings of susceptible Apiaceae crops could result in some infection of the subsequent crop.

Researchers have some evidence that a complex of Pseudomonas bacteria may be involved.

The Bull/Koike research team continues to study these problems and welcomes samples and information regarding disease outbreaks.

Table 1. Susceptibility of major Apiaceae crops to three Pseudomonas pathogens found in California

	Natural (field) hosts				Experimental hosts			
Pathogen	Celery	Cilantro	Parsley	Fennel	Celery	Cilantro	Parsley	Fennel
P. syringae pv. *apii*	+	+	+	+	+	+	+	+
P. syringae pv. *coriandricola*	NF	+	+	NF	+	+	+	+
P. viridiflava	NF	NF	+	NF	+	+	+	+

+ = positive for disease on natural (in the field) or experimental (greenhouse inoculated) hosts
NF = not found naturally in the field

(Cont'd to page 3)

(Cont'd from page 2)

Bacterial blight of celery

Bacterial leaf spot of cilantro

Bacterial leaf spot of parsley

(Cont'd to page 4)

(Cont'd from page 3)

Bacterial streak of fennel

REVIEW OF SOILBORNE DISEASES OF COASTAL CALIFORNIA PEPPER

Steven Koike, Plant Pathology Farm Advisor
UC Cooperative Extension, Monterey County

Coastal peppers are susceptible to five soilborne pathogens.

Peppers (bell, Anaheim, jalapeno, wax, and other chili types) grown in the central coast region are subject to several soilborne problems that on occasion can cause poor growth, plant death, and yield loss. Symptoms of these diseases are briefly summarized here.

Transplant problems: Newly transplanted peppers can possibly be infected by a number of soilborne pathogens, including *Phytophthora, Pythium,* and *Rhizoctonia*. However, in general these pathogens are rarely found infecting peppers at this early stage and it is unusual for our UCCE diagnostic lab in Salinas to detect any of these organisms in transplants showing damaged crowns, lower main stems, or roots. Rather, transplants exhibiting darkened and shrunken tissues at or below the soil line were likely damaged during the transplanting process, were not properly planted, or were injured by elevated temperatures, sunburn, or excess water. The gray mold fungus, *Botrytis cinerea,* is often observed on and recovered from stems of injured transplants; in this case, the fungus is a secondary factor that is colonizing injured tissue but did not cause the original damage.

Phytophthora root and crown rot: Worldwide there are several soilborne *Phytophthora* species

(Cont'd to page 5)

(Cont'd from page 4)

that cause root rot, crown rot, foliar blight, and fruit rots of pepper. However, in coastal California we appear to only have root and crown rot caused by *P. capsici*. Symptoms of Phytophthora root and crown rot initially consist of water-soaked root lesions that later turn dark gray to brown. The discoloration can occur on both the fine feeder and larger taproots. As lesions expand, individual roots become girdled or entirely rotted. The discoloration and decay in the root can move up the main taproot and into the plant crown and lower main stem. Affected plant crowns can show both surface and internal discoloration. As disease progresses, foliage first turns dull gray green and then later wilts; often this wilting affects all leaves of an infected plant, in contrast with Verticillium wilt in which early in disease development only one side of the plant may be affected. Eventually the entire plant canopy can rapidly collapse and die.

Verticillium wilt remains the most important soilborne disease of pepper.

Southern blight: Southern blight is caused by the fungus *Sclerotium rolfsii*. On pepper, the early symptoms consist of a water-soaked discoloration on crown and lower stem tissue that is in contact with the soil. These infection sites turn light to dark brown and can rapidly girdle the entire crown. Above ground symptoms consist of wilting and a collapse of all foliage. If soil moisture conditions are suitable, the pathogen will form a white mycelial mat or layer on the crown and lower stem, and even on the soil surrounding the crown. Small (2 mm [approx. 1/16 inch] in diameter), spherical, tan to brown sclerotia form profusely on and in this white growth.

White mold: White mold, or Sclerotinia rot, is an occasional problem on peppers in our region. The types of symptoms depend on which species of *Sclerotinia* is involved and which stage of the pathogen is present. *Sclerotinia minor* only infects the pepper crown tissue that is in contact with the soil. *Sclerotinia minor* causes a water-soaked lesion to develop at the crown and lower stem. The lesion enlarges and can girdle the plant, resulting in the collapse of the canopy and foliage. With time the infected crown turns light tan to off-white in color. White mycelium and small (3-5 mm [approx. 1/8 to ¼ inch] in diameter), black, irregularly shaped sclerotia form around the decayed crown. This disease is rarely seen and is not of concern to growers.

White mold caused by *S. sclerotiorum* is the more important Sclerotinia disease, though it too is not a major concern for growers in our region. Sclerotia present in soil can also cause a crown rot similar to that caused by *S. minor*. In addition, airborne ascospores can cause infections in the pepper canopy. These above ground infections usually occur on damaged stems or petioles, or where a nutrient source, such as a senescent flower petal, falls onto stems or petioles. These infections are water-soaked lesions that gradually enlarge and encircle the stems. Older infections turn off-white, white gray, or tan in color and can show zonate rings. White mycelium and large black sclerotia (which can be larger than ½ long) can be observed on infected lesions or in the central hollow core of stems.

Verticillium wilt: Verticillium wilt is caused by the fungus *Verticillium dahliae*. This problem is a well-known disease that affects many different crops and is important on pepper throughout the world. Early symptoms consist of the slight yellowing of lower leaves. The chlorosis can progress until leaves are bright yellow; such leaves will later wilt and can fall off the plant. Plant shoots and the overall foliage will wilt, especially during the warmer times of the day. Inner, vascular tissue of the taproot, crown, and lower main stem show a tan to light brown discoloration; this coloring is most evident in the main stems closer to the crown and may not be evident in the upper, smaller stems. Symptom severity can be accentuated if the infected plant is bearing a heavy load of fruit or is stressed by some other factor.

Fusarium wilt: Caused by a form of *Fusarium oxysporum*, this disease has been detected in coastal California but has not been thoroughly investigated or documented. Foliar wilt and internal vascular discoloration symptoms are virtually identical to those caused by Verticillium wilt. Our UCCE group is collecting Fusarium isolates from pepper so that research may be conducted on this

(Cont'd to page 6)

(Cont'd from page 5)

disease.

Managing soilborne diseases of pepper: (1) The first step in managing these problems is to accurately identify which disease is affecting the crop. Histories of previous problems will be useful in diagnosing the current problem. Experienced personnel will be able to identify southern blight and white mold in the field; other diseases will require laboratory testing. Samples can be sent to the UCCE diagnostic lab in Salinas for analysis. (2) If possible, plant peppers in fields having no history of these problems. Alternatively, if fields are known to harbor these pathogens, then rotation to a non-host crop is advisable. (3) Pre-plant fumigation can effectively reduce soilborne pathogen inoculum. However, such a practice is very costly and available fumigants are dwindling. (4) Resistant pepper cultivars are the best means of managing these soilborne issues. However, acceptable pepper types having resistance traits are not yet available for coastal California growers. (5) Properly prepared beds that drain well can perhaps reduce disease severity, especially with Phytophthora root and crown rot. This disease is also managed with careful irrigation and avoiding over-watering. (6) Very critically, cultivation practices and movement of farm equipment should avoid, as much as possible, the spread of contaminated soil because all these pathogens reside in the soil; transport of infested dirt and mud on equipment will spread the fungi to clean fields.

Wilted pepper plants infected with Phytophthora.

(Cont'd to page 7)

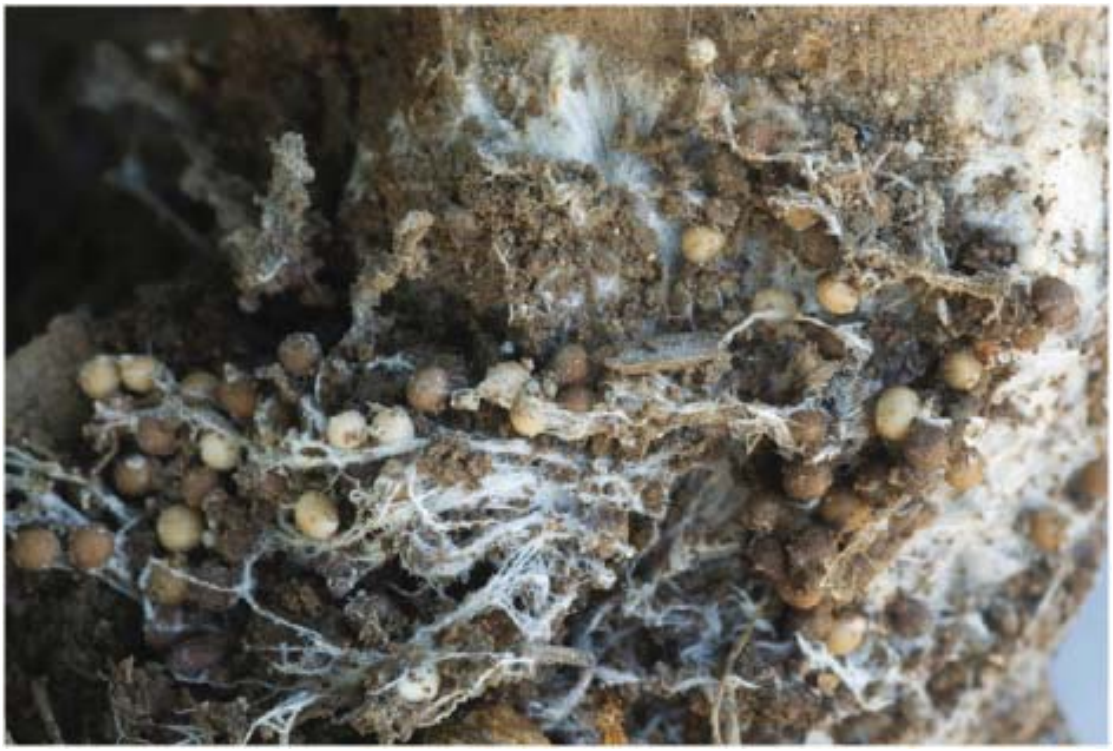
(Cont'd from page 6)

Healthy and diseased roots of plant infected with Phytophthora.

Southern blight crown infections cause plants to be severely stunted and wilted (healthy plant is on the left).

(Cont'd to page 8)

(Cont'd from page 7)



Mycelial growth and spherical sclerotia of the southern blight pathogen (Sclerotium rolfsii).

Sclerotinia infecting the crown tissue of pepper.

(Cont'd to page 9)

(Cont'd from page 8)

Verticillium wilt causes pepper plants to turn yellow and wilt.

Peppers infected with Verticillium will show brown streaking of the stem vascular tissue