

Managing Bacterial Disease in Vegetables

Delaware Ag Week: Fresh Market Vegetable Session 2024

Dr. Alyssa Koehler Betts
Assistant Professor and Extension Specialist,
Field Crops Plant Pathology





Acknowledgements

Thank you to Dr. Andy Wyenandt



Dr. C. Andrew Wyenandt
Rutgers Agricultural Research
and Extension Center (RAREC)
📍 121 Northville Road, Room
146

Bridgeton, NJ 08302

📞 856-391-7644



wyenandt@njaes.rutgers.edu

Bacterial Leaf Spot (BLS)

- BLS is one of the most destructive and common diseases on pepper and tomato in the eastern United States
- Favored by warm weather (75-86 F) and high precipitation
- Bacteria spread easily through water splash
- Infected pepper leaves drop early and can increase sun scalding on fruit

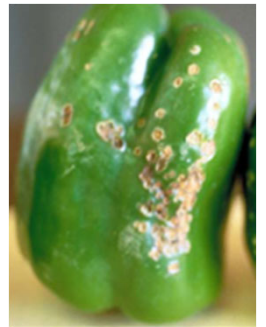


BLS Symptoms

- Symptoms of water-soaked lesions that progress to circular necrotic spots
- Lesions can be on leaves, stems, or fruits
- Spots often have a yellow halo
- Water soaking around the lesions will not be present in diseases from fungal pathogens



<https://vegcropshotline.org/bacterial-spot-of-pepper/>



<https://plantpathology.ca.uky.edu/files/ppfs-vg-17.pdf>

Similar Symptoms

Early Blight

- *Alternaria solani*
- Brown to black leaf spot
- Target pattern
- Spots on older leaves first



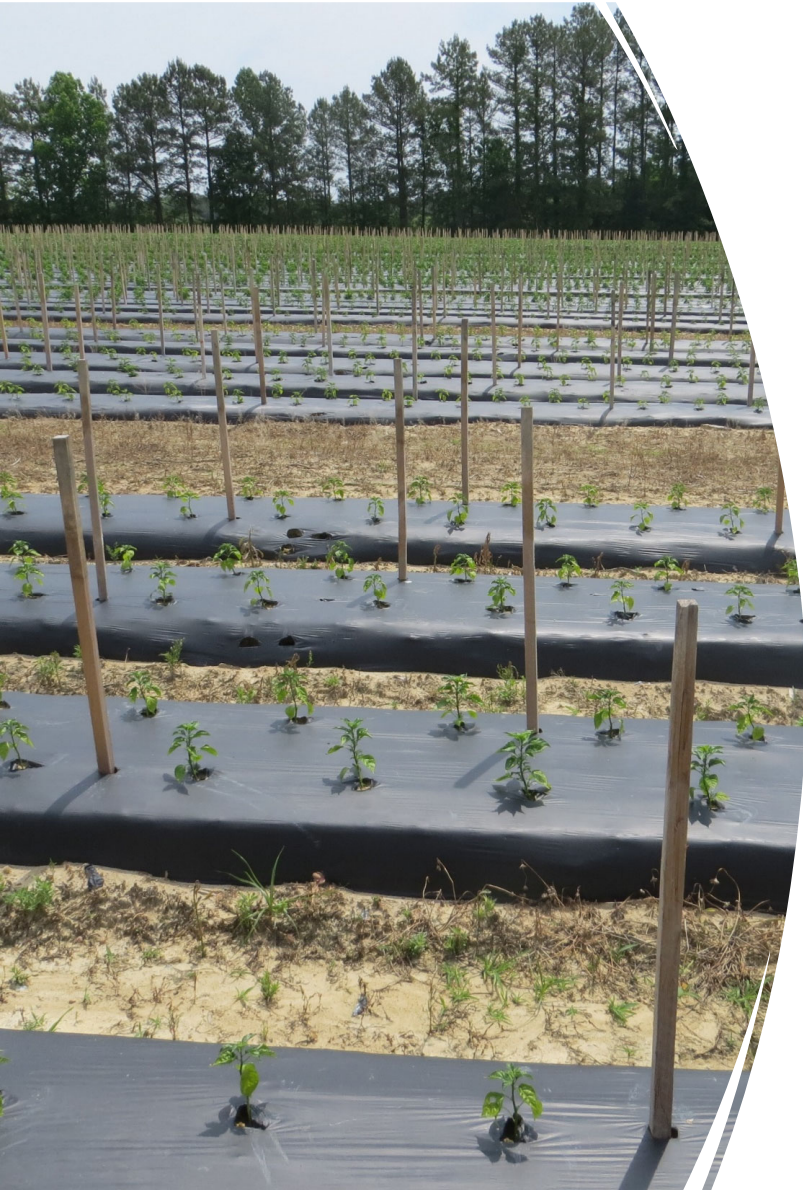
<https://content.ces.ncsu.edu/early-blight-of-tomato>

Septoria leaf spot

- *Septoria lycopersici*
- Small dark spots with a halo
- Shows up on lower leaves first
- Fungal structures in the center of the leaf spots and no water soaking



<https://content.ces.ncsu.edu/septoria-leaf-spot-of-tomato>



Inoculum Sources

- Infected seed or transplants (only takes 1)
 - Purchase clean seed
 - Treat with hot water or dilute bleach solution
- Greenhouse or Field materials (pots/trays, stakes, string, equipment)
 - Start with clean equipment
 - Remove weeds

Movement

- Wind-driven rain, irrigation, handling wet plants
- Water driving rate of spread
- Within 1 week can move >13' from a symptomatic plant
- In the greenhouse can spread 6.5' within 3 weeks by overhead irrigation splash



Management

- Pathogen-free certified seed and disease-free transplants
- Sanitation (remove old debris, remove affected foliage when possible)
- Increase air circulation, avoid prolonged leaf wetness
- Crop Rotation to a non-solanaceous crop
- Select Resistant Varieties
- Chemicals and Antibiotics (*Streptomycin sulfate*)



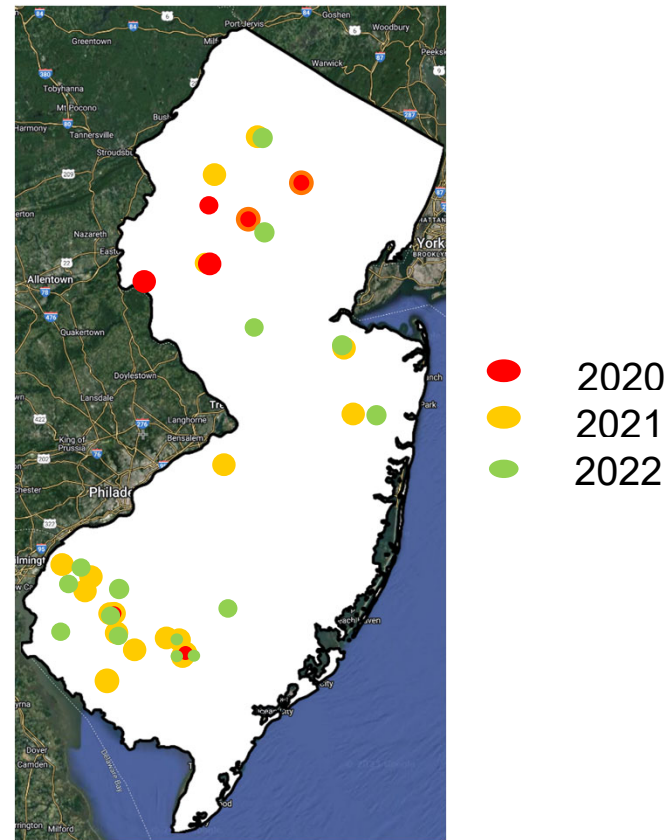
Causal Organisms

- At least 4 *Xanthomonas* species cause BLS on pepper and tomato
 - *X. euvesicatoria*, *X. perforans*, *X. vesicatoria* (warmer temps)
 - *X. gardneri* (cooler temps)
- 11 pathogenic races of *Xanthomonas* identified on pepper, all 11 races present in NJ



Bacterial Leaf Spot in NJ

- NJ Survey 2020-2023
 - Which of the 4 *Xanthomonas* species are causing BLS?
- Is this data we need for DE?



Do *Xanthomonas* species have preferential host ranges?

- In NJ, *Xanthomonas euvesicatoria* and *Xanthomonas perforans* are found on peppers and tomato at different rates

	BLS on Pepper	BLS on tomato
<i>X. euvesicatoria</i>	55%	0%
<i>X. perforans</i>	45%	100%

- On tomato, only finding *X. perforans* (same finding in NC)
- On pepper, about 50-50 split between two species!
- In Florida, the host range of both pathogens is mixed as well

Can *X. euvesicatoria* and *X. perforans* both exist on the same farm?

- Most farms have only one bacterial species, with a few exceptions
 1. *X. euvesicatoria* and *X. perforans* was found on 2 varieties of pepper
 2. *X. euvesicatoria* on bell pepper and *X. perforans* on tomato
- Conclusion: It is possible to have both bacterial species causing disease on the same farm.



Resistance in Pepper

Variety/Line	Phyto R	BLS resistance	BLS rating	Total boxes/A
Paladin	R	none	4.00	164
Turnpike	IR	1-5,7-9	2.00	933
Camelot X3R	none	1,2,3	1.75	585
Mercer	IR	1,2,3,7,8	1.00	1130
Aristotle X3R	IR	1,2,3	1.00	849
Revolution	IR	1-3,5	1.00	823
1819	IR	1,2,3,4,5	0.75	1047
Captain	IR	X10R	0.75	614
3964	none	0-4,7-9	0.50	950
9325	none	X10R	0.00	851
9386	IR	X10R	0.00	678
Antebellum	none	X10R	0.00	786
Enza 301	IR + TSWV	X10R	0.00	699
Enza 302	IR	X10R	0.00	878
J-2101	IR	X10R	0.00	728
Nitro	IR	X10R	0.00	763
Sailfish	IR	X10R	0.00	651



Products

Tomato

Bacterial Speck and Bacterial Spot

When producing transplants, use Clorox or heat-treated seed as described above under Seed Treatment. Apply streptomycin sprays (Agri-Mycin 17, Agri-Strep, 1.0 lb/100gal, 1.25 tsp/gal) when the first true leaves appear and continue every 45 days until transplanting. Streptomycin cannot be used after transplanting. Limit handling of plants and keep greenhouse moisture levels low.

Rotate to allow 2 -3 years between plantings. Use only certified transplants. Cultural practices discussed in the bacterial canker section will also suppress levels of Bacterial Speck and/or Spot. Bacterial Speck and/or Spot occur more often on southern-produced transplants. Strains of copper resistant Bacterial Spot are common in some areas of the mid-Atlantic particularly on the Eastern Shore of VA. Use Actigard alone or in conjunction with copper-containing materials. Where disease is present or anticipated, do not work in fields when plant surfaces are wet.

Code	Product Name (*~Restricted Use)	Product Rate	Active Ingredient(s)	PHI (d)	REI (h)	Bee TR
Tank mix the following beginning shortly after transplanting and repeat every 7 days.						
M01	copper (OMRI)	1.0 lb ai/A	copper	0	see label	N
M03	mancozeb 75DF	1.5 lb/A	mancozeb	5	12/24	N
And rotate with or apply the following:						
M01+M03	ManKocide 61WP	2.5 to 5.0 lb/A	copper hydroxide + mancozeb	5	48	N
The following is a plant defense activator and preventative applications should begin prior to the onset of symptoms.						
P01	Actigard 50WG ¹	0.33 to 0.75 oz/A (see label)	acibenzolar-S-methyl	14	12	N

¹Use in areas where copper resistance is known. See label for rates and times of use.

Pepper

Field sprays to help reduce spread: If growing susceptible varieties or varieties showing symptoms of the disease, apply a fixed copper + mancozeb at labeled rates. If necessary, begin preventative fungicide applications shortly after transplanting and repeat every 7 to 10 days, especially if symptoms of BLS are present during transplant production.

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¹Copper-based OMRI listed products for suppression of BLS are available; see labels for rates.

²Copper can be tank mixed with mancozeb to also help reduce Anthracnose Fruit Rot.

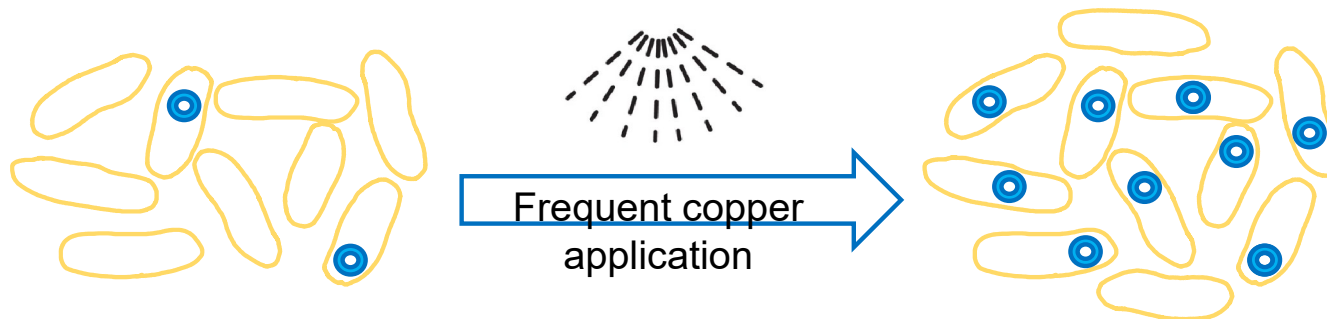
³Copper resistance has been detected in the mid-Atlantic region.

Mid-Atlantic Commercial Vegetable Production Recommendations

<https://njaes.rutgers.edu/pubs/publication.php?pid=e001>

Copper Resistance in pathogens

- Copper has been the most widely used method to control bacterial diseases for many years
- Increased applications of copper sprays increases the probability of bacterial populations acquiring copper resistance
- Copper resistance can develop and spread rapidly



Plasmids



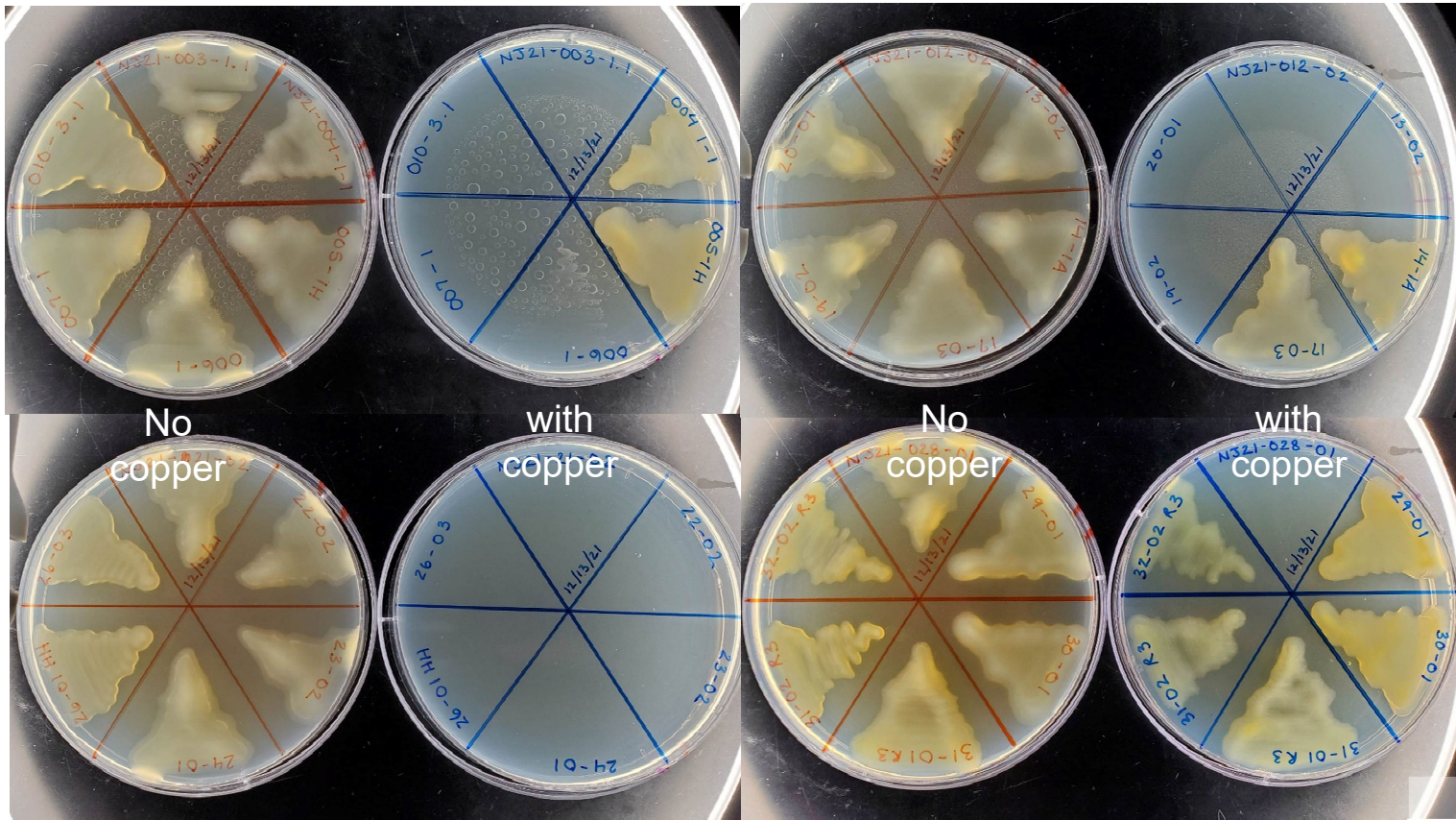
- Circular DNA that are distinct from the cell's main chromosomal DNA
- Replicate independently
- Usually give the bacteria some sort of genetic advantage - Copper Resistance
- Bacteria can share this resistance with their neighbors



METHODS FOR EVALUATING COPPER RESISTANT *XANTHOMONAS* POPULATIONS ON TOMATO AND PEPPER:

1. Growth on agar plate containing copper
2. Molecular analysis for the presence of copper resistance genes





How prevalent is copper resistance?

- Pooling data from 2020-2022, copper resistant bacteria were identified from ~60% of all farms in NJ study
- Recent studies in NC revealed >95% of strains were copper tolerant (many also streptomycin tolerant)
- Copper Resistance reported in Eastern Shore of Virginia
- Conclusion: Copper resistance is prevalent in the mid-Atlantic and highly likely to be present in DE



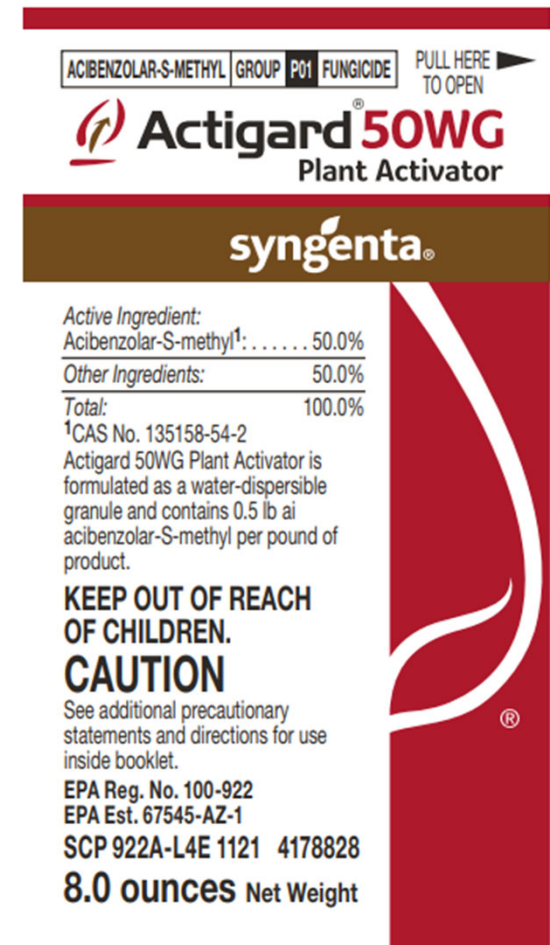


Summary of recent regional work

- It is possible to have both *X. euvesicatoria* and *X. perforans* causing disease at the same farm
- *X. euvesicatoria* limited to tomato in NJ and NC
- Copper resistance is prevalent in surrounding regions
- Regardless of species, all *Xanthomonas* populations can become copper resistant!

Actiguard

- Turns on host defense reactions (Systemic Acquired Resistance, SAR)
- Need to use before problems arise
- Can be used in combination with copper-based products



Management Take Aways

- *Preventative control measures*
 - Start clean, stay clean
 - Plow debris soon after harvest
- In pepper, use resistance when possible
- Rotate to other hosts
- Copper application may have limitations due to copper resistance, can combine with Actiguard



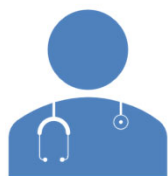
Fig. 1 Row on right had fungicides and Cu applied, row on left same fungicides and Cu plus Actigard.

Updated: September 16, 2021

By Gerald (Jerry) Brust

<https://extension.umd.edu/resource/tomato-problems/>

Discussion



How prevalent are your bacterial issues?



Do you think you have copper resistance?



Would sampling for copper resistance be helpful?



Questions?

Alyssa Koehler Betts

akoehler@udel.edu

302-242-9056

@UDPlantPath

