SEED HEAT - TREATMENT AS PART OF AN INTEGRATED MANAGEMENT PLAN FOR CONTROLLING DISEASES CAUSED BY SEED-BORNE PATHOGENS

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Seed contaminated with a bacterial or fungal pathogen can be an important source of inoculum for diseases. Surface treatment with fungicide or hypochloride solution is effective for pathogens located on the seed surface. But some pathogens, notably bacteria, can be inside the seed.

Bacterial canker, caused by *Clavibacter michiganensis* subsp. *michiganensis* (*Cmm*), bacterial speck (*Pseudomonas syringae* pv. *tomato*), and bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*) are serious pathogens of tomatoes wherever they are grown. These diseases have been increasing in occurrence and severity in the northeastern United States. For many New Jersey tomato growers, bacterial canker is presently the most serious disease in the production system. A severe canker infection can result in complete loss of production, although losses when speck or spot are present in a tomato planting generally vary from none (minimal foliar injury) to total yield loss, and are dependent on source of the infection, weather conditions and cultural practices. To be effective, a management plan for bacterial diseases must integrate cultural and sanitary practices with chemical use. Seed heat-treatment is one cultural practice that prevents infected seed from resulting in losses to bacterial disease in the field.

Pathogen Survival and Spread

Infected seed is commonly named as the source of bacterial infections, and while the speck and spot pathogens can be present on the seed coat, plants that are infected with bacterial canker will produce seed that may contain the bacteria both on and within the seed coat. Bacterial pathogens have been detected on living and dead plant material in infected fields, and *Cmm* cells are reported to survive on tomato debris (including seed) for up to 5 years if the debris is undecomposed. Survival is influenced by the depth to which the inoculum is buried, and the degree to which infested debris breaks down. Cells of all three pathogens will survive for relatively short periods of time in soil without solid debris.

Bacterial pathogens can survive for up to a year on infested tomato stakes, and presumably on greenhouse benches and plant debris within the greenhouse. Perennial solanaceous weeds like horsenettle may serve as overwintering hosts, and *Cmm* has been isolated from roots of this weed growing in fields without tomatoes for up to 2 years. Debris from annual solanaceous weeds like our nightshades may harbor *Cmm* through the winter as well. Additionally, solanaceous weeds serve as asymptomatic hosts on which the pathogen can multiply during the course of a growing season.

A common and serious means of dissemination is through transplant production. In this case, even low numbers of infected seed can result in widespread infections, as seedlings are in close proximity to one another and are handled frequently. Seedlings are also at risk for infection if tools, benches, etc. have not been cleaned properly, or there are potentially infected weed hosts or debris present in the greenhouse. Infected seedlings then are put into the field, where the infection becomes severe. In-field infections can originate from infected tomato plants, infected weeds, or infested debris and stakes. Once individual or groups of plants are infected, dissemination through the field is aided by cultural practices that injure the plants including tying, pruning, and harvesting as well as wind driven rain. Even injury as slight as breaking of the hairs (trichomes) on leaves and stems has been implicated in disease spread. Infections are difficult to contain once they appear in a planting. The extent of the damage is largely related to the timing and method of initial of infection.

Management Strategies

Starting with pathogen free seed

Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments for the elimination of seed-borne pathogens. Heat treatment has the additional benefit of killing pathogens such as the bacterial canker organism of tomatoes that may be found within the seed coat. Heat treatment is particularly useful for tomatoes and other crops that are prone to seed-borne bacterial infections, including peppers and brassica crops. Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled water baths. Two baths are required; one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heat cycle is for 10 minutes at 100ºF (37ºC) followed by the effective temperature cycle. The following (from Dr. S.A. Miller of the Ohio State Univ.) are effective temperature protocols for several important crop groups:

Seed	Water temperature		Minutes
	°F	**°C**	
Brussels sprouts, eggplant, spinach, cabbage, tomato	122	50	25
Broccoli, cauliflower, carrot, collard, kale, kohlrabi, rutabaga, turnip	122	50	20
Pepper	125	51	30

Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper, and may be re-dusted with fungicide if desired. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current season.

Heat treatment of seeds will be demonstrated in this workshop, and other management strategies for bacterial pathogens including those for transplant greenhouses and field production will be discussed.