Celery Pathology Update

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Fusarium Yellows. Growers have observed symptoms of root and crown rot leading to wilting and plant death and call these symptoms "meltdown". Communication with growers and others indicate that "meltdown" includes more than one symptom type. Fusarium yellows is caused by the soilborne pathogen *Fusarium oxysporum* f. sp. apii (*Foa*) and causes stunting, chlorosis, and plant death. Development of tolerant/resistant cultivars has limited Fusarium yellows in Michigan celery. Resistant cultivars provide the best control for Fusarium yellows.

Sampling and Identification. Fungal isolates were isolated from symptomatic celery plants collected in Michigan fields. Preliminary sampling indicated that *Fusarium* spp. was the most common organism associated with diseased plants; isolation focused on crown and vascular tissue. Isolates (258) across 2018-19 were identified by sequencing as primarily *Fusarium oxysporum* (45%) and *Fusarium solani* (52%).

Diagnostic Primers and Pathogenicity Testing. *F. oxysporum* can act as a pathogen (resulting in disease) or live saprophytically in plant tissue (no disease). *Fusarium* isolates must be tested for pathogenicity to see if they can cause disease. Diagnostic primers published by researchers at UC-Davis (Henry et al. 2020) allow DNA of *Fusarium* isolates to be tested to determine if it matches the genetic characteristics of *Foa* race 2 (historically, the primary race causing Fusarium yellows in Michigan celery) or *Foa* race 4 (cause of recent disease outbreaks in California celery). Isolates collected in both 2018 and 2019 tested positive for *Foa* race 2 using these diagnostic primers (25% of 2018 and 17% of 2019 *F. oxysporum* isolates, respectively). *Foa* race 4 was NOT detected. *Foa* race 2 was detected using primers across sampling years and locations/farms.

A subset of the *F. oxysporum* isolates with preliminary identification of *Foa* race 2 and *F. solani* were tested for virulence. Plant were allowed to grow and examined for symptoms of root and crown discoloration 7-8 weeks after inoculation. Results show that some *F. oxysporum* isolates identified using *Foa* race 2 primers can cause disease and that *F. solani* isolates are less capable of causing disease. Pathogenicity testing is challenging and results have not been consistent among studies.

Pythium Root Rot and Damping Off. Celery production begins with transplants produced in plug trays using peat-based media in greenhouses. Root rot caused by *Pythium* spp. can be a sporadic problem for celery transplants in the greenhouse resulting in stunted or uneven stands, yellow foliage, and water-soaked red-brown root discoloration. Pythium root rot can be controlled through sanitation and application of preventive fungicides.

Fungicide Efficacy Test. To test fungicides for control of Pythium root rot in the greenhouse, 5-6 week old seedlings ('CR-1') were inoculated by transplanting into soil mixed with millet colonized with *Pythium* isolates. Fungicides were applied as a drench (Table 1). Symptoms of stunting and root rot were compared between an inoculated untreated control and plants treated with fungicide. The *Pythium* fungicide trials (Table 1) showed that Kphite (phosphorous acid salts) controlled *Pythium* in two trials and Actinovate (*Streptomyces lydicus*) controlled disease in one trial but not the other (Table 2). Results also indicate that unregistered fungicides with varying modes of action may have a fit in the greenhouse and could be pursued for eventual registrations through the USDA IR-4 Program.

Virulence of Pythium Species. *Pythium* isolates collected in Michigan celery greenhouses were used to test virulence of *Pythium* spp.. Isolates collected in 2014-15 were primarily *P. mastophorum* and *P. intermedium* (55% and 16% is isolated respectively). However, in the virulence test, *P. sulcatum* and *P. sylvaticum* caused stunting and root rot while other species tested did not cause symptoms. Only 3 of 37 *P. mastophorum* isolates were recovered from storage so isolates used may not be representative of the population initially observed in Michigan greenhouses. Isolates of other species were easily recovered from storage.

Table 1. List of products evaluated for Pythium root rot control of celery seedlings cv. CR-1

Product	Active ingredient	FRAC code	Rates/100 gal	Interval	Labeled for greenhouse use
Actinovate	*Streptomyces lydicus*	-	6 oz	14-day	Yes
Kphite	phosphorus acid salts	33	1.5 quarts	14-day	Yes
SubdueMaxx	mefanoxam	4	1 fl oz	14-day	No
Ranman	cyazofamid	21	2.75 fl oz	14-day	No
Elumin	ethaboxam	22	8 fl oz	14-day	No

Table 2. Effect of drench applications of fungicide treatments on plant and root health cv. CR-1

Treatment/100 gal	Active ingredient	Plant health (1-10)		Root disease severity (1-5)
		Trial 1	Trial 2	Trial 2
Uninoculated untreated	-	1.00 a	1.00 a	1.09 a
Inoculated untreated	-	6.00 b	3.00 a	2.84 c
Kphite	phosphorous acid salts	1.33 a	1.00 a	1.42 ab
Elumin	ethaboxam	1.16 a	2.50 a	2.08 bc
Actinovate	*Streptomyces lydicus*	1.00 a	2.50 a	2.50 c
Ranman	cyazofamid	1.16 a	2.50 a	1.91 abc
SubdueMaxx	mefanoxam	1.00 a	1.90 a	1.33 ab

*Column means with a letter in common are not significantly different

Henry, P., Kaur, S., Pham, Q. A. T., Barakat, R., Brinker, S., Haensel, H., Daugovish, O., and Epstein, L. 2020. Genomic differences between the new *Fusarium oxysporum* f. sp. *apii* (*Foa*) race 4 on celery, the less virulent *Foa* races 2 and 3, and the avirulent on celery f. sp. *coriandrii*. Bmc Genomics 21:23.

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