REPORT TO THE SMAL FRUIT CONSORTIUM
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TITLE: Importance of Pathogens Associated with Roots of Strawberry Transplants

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OBJECTIVES: To characterize fungi associated with roots of strawberry plants that have originated from various nurseries to understand the potential level of risk associated with such plants. To initiate disease management strategies.

Justification: A fundamental challenge facing the Southeastern Strawberry industry is the ability to get "clean" plants. Healthy plants translate into productive yields and programs with long-term missions to develop healthy plants should have direct and substantial economic benefits for the strawberry growers in the Southeast.

Currently the majority of strawberry transplants originate from nurseries in Canada or as locally produced plug plants, with the remainder originating as bare root plants from mountain nurseries in North Carolina and California. While it is clear that anthracnose, (bacterial) angular leaf spot and some of the foliar diseases are imported on infested plant material, more recently we have documented that soil-borne pathogens that cause root and/or crown rot may also be associated with these plants. These pathogens pose a serious threat to the industry especially as we face the loss of methyl bromide as a soil fumigant, an effective management tool that limited losses due to many of these soil-borne pathogens. For example, we have isolated *Phytophthora cactorum* and other (as of yet) unidentified *Phytophthora* species associated with strawberry transplants. These pathogens cause a crown rot that leads to plant collapse and reduced crop productivity. Once introduced to soils, *Phytophthora* species have a notorious capability to persist in soils for years. We do not know about the survival capabilities of the strawberry pathogens but we desire to limit the introduction of these pathogens in our farming systems and thereby reduce risk of disease.

The success of the strawberry industry is highly dependent on the success of the nurseries that supply us our plants. Therefore our initiatives are not intended to point out problems at any particular supplier but to develop programs and research initiatives that are supportive of both the nursery supplier, plug-plant producers and our fruit producers. At times this challenges us to walk a fine line but it is also consistent with our vision for enhancing the health and strength of our industry.

We have implemented an aggressive and broad program to evaluate methyl bromide alternatives and management of soil-borne pathogens. However, research advances and crop productivity associated with alternative fumigants will be limited if "clean" plants are not used. The first step to determine the level of risk and prior to implementing disease management strategies is to characterize the pathogens associated with strawberry roots. Currently there is insufficient knowledge about the level of infestation and types of pathogens associated with strawberry transplants. During the past year we initiated this study and isolated *Rhizoctonia fragariae, Pythium* species, and *Phytophthora.*

DESCRIPTION AND MATERIALS AND METHODS:
We extended our work that was initiated last year through the Southern Region Small Fruit Consortium. We sampled plants collected from various sources and associated with our field trials. The plants were analyzed for the presence of fungi associated with the roots. For isolation, crown and root systems were washed thoroughly with tap water and dried in paper towels. For isolation of root-associated fungi, localized lesions from individual roots and crown portions were excised, dried in paper towel, and transferred into X plates containing acidified water agar AWA or PARP (*Pythium/Phytophthora* selective) media. Alkaline-water agar (AWA) was used for the isolation of *Rhizoctonia*, *Fusarium*, *Cylindrocarpon* species and other fungi. Difco Corn-meal agar (CMA) + antibiotics (PARP) for the isolation of *Pythium, Phytophthora* species and other related fungi. Selected colonies observed in both media were transferred under a block of AWA or PARP media to assure the production of pure cultures free of bacterial contamination. Colonies growing in AWA were transferred to Difco Potato Dextrose Agar (30 g/l) (PDA 30), and colonies growing in PARP were transferred to CMA for identification and further characterization.

We used several of the isolates to initiate trials where chemical and biological control agents were screened for efficacy against the most common pathogens we encounter. These trials were geared towards the plug production of plants.

RESULTS: We had a productive year and have made significant progress. We isolated fungi from tips, plug plants and bare root plants (not shown here) from multiple sources including commercially sourced plants produced locally or elsewhere. We also evaluated plants that have been produced through tissue culture and then propagated in the field or in the greenhouse. A challenge we found was the difficulty to find plants that do not have Rhizoctonia or Pythium associated with the roots prior to going into the field. Of serious concern, we also isolated *Phytophthora cactorum* (up to 22% infection rate in plug plants; Table 3) and *Colletotrichum acutatum* (up to 53% infection rate in plug plants; Table 3) from commercially sourced plants. We also characterized a new species of *Phytophthora* associated with strawberry plants. The isolation of Colletotrichum has been particularly concerning since this pathogen is so destructive. We noted extensive plant stunting in plantings with this pathogen and this represents a newly identified problem. Preliminary work on selected strains demonstrated many isolates are pathogenic on strawberry plants.

Summary Table 1 for Fungal Isolations from Grower Trial Tips		
Frequency of fungal isolation (% of total crowns or roots plated)		
Fungal Genus	Crowns (n=10)	Roots (n=40)
Phytophthora	0.0	0.0
Pythium	0.0	0.0
Rhizoctonia	10.0	0.0
Fusarium	20.0	0.0
Alternaria	60.0	40.0
Trichoderma	10.0	0.0
Botrytis	20.0	0.0
Epicoccum	10.0	2.5
Nigrospora	10.0	0.0

Summary Table 2 for Fungal Isolations from Plymouth Trial Tips		
Frequency of fungal isolation (% of total crowns or roots plated)		
Fungal genus/species	Crowns (n=10)	Roots (n=42)
Pythium spp (total)	20.0	9.6
P. dissotocum	10.0	4.8
Phytophthora cactorum	10.0	7.1
Rhizoctonia	0.0	0.0
Fusarium	60.0	47.6
Alternaria	50.0	16.7
Colletotrichum	0.0	2.3
Gnomonia	0.0	2.3
Pyrenochaeta	0.0	2.3

Frequency of fungal isolation (# of plants/32 and % infected)		
Fungal genus/species	# plants	% plants tested
Colletotrichum acutatum	17	53
Rhizoctonia	1	3
Fusarium	13	41
Pyrenochaeta	10	31
Alternaria	4	13
Phoma	2	6
Idriella lunata	2	6
Coniothyrium	2	6
Epicoccum	1	3
Phialophora	4	13
Bipolaris	1	3
		0
P.cactorum	7	22
Pythium spp	11	34

Summary Table for Fungal Isolations from Greenhouse Tips		
Frequency of fungal isolation (# of plants and % infected)		
Fungal genus/species	# plants	% plants tested
Fusarium	18	67
Alternaria	16	25
Aspergillus	6	4
Pestalotia	1	13
Epicoccum	3	8
Phoma	2	4
Bipolaris	1	0

We also initiated a large trial to look at biological and chemical products that may limit the amount of root rot in plug plants in cooperation with Vollmer Farm. Regretfully our commercially sourced plants had a high level of anthracnose (*Colletotrichum acutatum*) and this has affected our data. Nevertheless we went ahead with the trial (Table 4). Treatments were applied in the transplant mix 31 Aug and 2 days prior to setting tips in trays on Labor Day (2 Sep). Plugs were field set 2 Oct in a Latin square design. Disease data and plant growth data were measured at this time.

The results were complicated. All biologicals tended to increase plant growth with Rootshield producing a larger plug plant than the control (Table 4). Ironically, these plants also tended to have the highest level of discolored roots. Data analysis from

isolations could not directly relate the discoloration to pathogens or the biological control agent. BioYield and PrimaStop tended to increase the % plants with anthracnose. These plants were also greener (although this was not quantified) and such plants are typically more susceptible to anthracnose. These biologicals do not appear to hold promise to manage anthracnose and need to be re-evaluated in the absence of this disease. A follow-up test to evaluate Trichoderma strains/formulations demonstrated the Trichoderma strains had excellent suppressive activity against Pythium and/or Phytophthora.

Table 4: Transplant mix treatments on plant growth and disease incidence.

Treatment	Leaf Area/Plant (cu. cm)	Root Rot Severity (% rot)	Anthracnose (% plants)
Control	64.6 a	28.3 ab	9.1 ab
BioYield	67.2 ab	21.5 a	17.1 bc
PrimaStop	67.1ab	29.0 ab	20.3 c
RootShield	79.5 b	33.6 b	3.7 a
System 3	63.3 a	30.0 b	6.6 a

Values followed by the same letter are not significantly different.

CONCLUSIONS AND IMPACT:

The evaluations of tips and plug plants demonstrated that there is a significant level of colonization of strawberry tips and transplants with fungal pathogens that may lead to disease problems in the fruiting field. This work has helped us understand the nature and complexity of the problem we face to minimize disease risk from root crown rot pathogens.

Evaluation of chemicals and biologicals needs to be pursued in future research and these products hold promise as one component of an IPM program growers can utilize to suppress disease and maximize economic returns.