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Research, Education and Economics
Agricultural Research Service

August 26, 2014

Robert F. Morrissey, Jr.
Executive Director
National Watermelon Association
190 Fitzgerald Road ~ Suite 3
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Dear Bob,

A grower watermelon grower wondered about the potential of using chicken manure to manage Phytophthora. Plus literature search revealed that bio-fumigation using mustard cover crops could also help reduce Phytophthora populations in soils. However, such long-term experiments have not been conducted with watermelon before. Using NWA provided funding we conduct one trial, however, to be able to conclusively say if these strategies will work or not the experiments need to be repeated. Hence we propose to re-evaluate a combination of these two strategies in the proposal we are submitting in response to the NWA RFA. Successful completion of this proposal should help answer the following questions that several growers asked us:

- Will bio-fumigation with a mustard cover crop help reduce Phytophthora fruit rot?
- Will Chicken manure help manage fruit rot?
- Will the combination of chicken manure and mustard cover crop be more useful for managing Phytophthora fruit rot?
- Do other cover crops such as red clover harbor Phytophthora?

Along with this letter we are submitting a proposal entitled "**Will bio-fumigation with a mustard cover crop combined with chicken manure help manage Phytophthora fruit rot of watermelon?".**

We are submitting several proposals under the NWA priority area Phytophthora. The reason for several proposals is because we will conduct different experiments with the ultimate goal of finding ways to manage Phytophthora fruit rot under extreme conditions as observed in GA and NC. These different strategies can then be integrated to manage the disease from a long term perspective.

The total funds requested for completion of the project is $11,654 with $7,654 for research to be conducted by USDA-ARS in Charleston, SC and $4000 for research to be conducted in NY. Our ultimate goal is to help the U.S. watermelon growers make a successful crop year after year.

Thank you very much for your time and for considering this proposal.

Sincerely,

Shaker/s/

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Proposal for Evaluation by the National Watermelon Association

Will bio-fumigation with a mustard cover crop combined with chicken manure help manage Phytophthora fruit rot of watermelon?

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Severe Phytophthora fruit rot of watermelon in a GA field. The grower lost his entire crop despite applying fungicides.

Time Line: February 1, 2015 to January 31, 2016. Duration: 1 Year

Funds requested for USVL, USDA-ARS Charleston, SC: $7,654
Funds requested for Cornell University, Long Island, NY: $4,000
Total funds requested: **$11,654**

NWA Priority area of Proposal: Phytophthora Fruit rot caused by *Phytophthora capsici*

Objective: Conduct field trials in northern and southern parts of the U.S. to determine if bio-fumigation utilizing a mustard cover crop combined with chicken manure will reduce Phytophthora fruit rot of watermelon?

Brief Summary: Phytophthora fruit rot of watermelon has become a serious problem for growers in most states in the Southeastern U.S. (FL, GA, SC, NC and VA), and has caused significant yield losses to growers before and after harvest of the crop. Fungicides are most commonly used to manage fruit rot however they do not always provide adequate protection. In the proposed research we will conduct field trials in Charleston, SC, to determine if bio-fumigation with mustard cover crop variety 'Caliente 199' combined with chicken manure will help manage Phytophthora fruit rot. In Long Island, NY we will mainly evaluate the effects of bio-fumigation on Phytophthora fruit rot of watermelon. Soil samples will tested before and after planting the cover crops to determine the effect of the various cover crop treatments. A seeded (pollinizer) and a seedless watermelon variety will be planted in these plots in the summer of 2015 to determine if bio-fumigation and chicken manure help manage Phytophthora fruit rot. Results from 2014 suggest that bio-fumigation may have potential for managing fruit rot of watermelon.

Project details

Introduction: Phytophthora fruit rot of watermelon caused by *Phytophthora capsici* is a prevalent disease particularly in the southeastern states (FL, GA, SC, NC and VA) and other parts of the U.S. (eg. MI, DE, MD). About 50% of the US watermelons are grown in the southeastern states where conditions for development of fruit rot are very common. Identifying solutions to manage Phytophthora fruit rot is considered as a high priority by the National Watermelon Association. A meeting with several growers in 2013 and 2014 also indicated that research to find solutions to manage *P. capsici* on watermelons are sorely needed. Some growers also suggested using chicken manure as a possibility which led to the development of this proposal.

For the past few years (2006-2014) we have conducted research in NC and SC, and identified several new chemicals (Revus, Presidio, Ranman, Zampro, QGU-42) to manage Phytophthora fruit rot (Kousik et al., 2011). However, fungicide applications were not effective in 2013 because of heavy rainfall. Therefore it is necessary that we continue to identify other strategies and develop an integrated program to manage this serious production limiting factor for watermelon growers.

Chicken manure: Chicken manure has been evaluated for managing various Phytophthora species in tree and other crops with positive results (Aryantha et al., 2000; Kurt and Emir, 2004; Nunez-Zofio, 2012). Similarly, chicken manure was also found to reduce crown rot of peppers caused by *P. capsici* (Alao et al., 2013; Moises et al., 2001; Zinati, 2005). Chicken manure applications have also shown to reduce viability of *P. capsici* oospores (Nunez-Zofio et al., 2011) and thus reducing crown rot of pepper. However, others have found no significant effect of chicken manure on crown rot of peppers (Meyer and Hausbeck, 2012). No long-term studies to date on the effect of chicken manure on Phytophthora fruit rot of watermelon have been conducted.

Cover crop and bio-fumigation: Cover crops are known to improve soil quality by improving physical and chemical properties. They also help suppress weeds. Some cover crops especially those belonging to the Brassica family (mustard etc) are used in bio-fumigation which is the application of plant residues to the soil to manage nematodes and fungal pathogens. Bio-fumigation occurs due to the release of chemical exudates from plants into the soil when the plants are disked in and kill other organisms. These mustard cover crops have been especially bread for high glucosinolate content for bio-fumigation. Mustard cover crops have been shown to reduce *P. capsici* oospore density under field condition (Ppoyl, 2011) and also reduce crown infection of pumpkins in a greenhouse (Ppoyl, 2011) and blight of squash in the field (Ji et al., 2012). Similarly mustard cover crop was shown to reduce Phytophthora fruit rot of acorn and pumpkin under field conditions (McGrath and Menasha, 2013).

Outline of Specific Research to be conducted:

Field experiments using mustard cover crop will be conducted in the south in Charleston, SC and in the north at Riverhead, NY.

Field preparation and inoculation in Charleston, SC: In Charleston, we propose to combine the benefits of bio-fumigation with a mustard cover crop and chicken manure to manage fruit rot

of watermelon. We have *P. capsici* infested fields (ca 2.5 acres) at the US Vegetable Laboratory farm in Charleston, SC that we have successfully used for the past several years (2006-2014). These same infested fields will be used for conducting the proposed experiments. Soil samples will be collected from the field prior to inoculation to determine soil characteristics and the base level of Phytophthora inoculum. Fields will be disked in early spring 2014 and inoculated with a mixture of *P. capsici* isolate belonging to mating types A1 and A2. For inoculation an A1 isolate and A2 isolate will be paired and allowed to grow in 500-ml glass flasks containing 30 ml of V8-CaCO3 medium (Kim et al., 2009). We will use sufficient flasks to produce enough oospores to inoculate the field. Once abundant oospores are produced they will be separated as described before (Babadoost and Pavon, 2013) using sieves and quantified and mixed with vermiculite. The vermiculite oospore mix will be spread in the field using a fertilizer spreader. After spreading the oospores, the field will be lightly tilled with a roto-tiller and soil samples will be collected to determine the actual oospore density.

Cover crop planting and chicken manure (Spring 2015): The experiment will be a split-split plot design with the cover crop being the main treatment and the chicken manure treatment the sub-plot. The mustard 'Caliente 199' will be used as the bio-fumigation cover crop (planted at 10 lb/A rate), Red clover as the conventional cover crop and a fallow treatment. Each cover crop or fallow plot will be an area of 80 ft long and 20 ft wide. Within the 80 ft, 30 ft will be cover crop planted on soil treated with chicken manure (2 t/A) and the other 30 ft will be untreated cover crop with a 20 ft buffer between the two sub plots. Each plot will be have four replications. There will be a total of 24 sub-plots (3 cover crops/fallow x 2 manure x 4 reps). Fertilization of the cover crop plots will be standardized depending upon the soil fertility and nutrition provided by Chicken manure. We have sufficient space to conduct this experiment. If necessary we can increase the space required.

Bio-fumigation and planting watermelon (Summer 2015): At flowering, the cover crops will be flail chopped and immediately incorporated into the soil to help release the lethal glucosinolates. The soil will be packed with a culti-packer and irrigated. Two rows of 18-inch beds on 6 ft centers and covered with silver plastic mulch will be prepared using a super-bedder in each cover crop plot. Two weeks after bio-fumigation the beds will be planted with 4 week old transplants of seedless watermelon variety 'Wonder' (Dark colored). After every three plants of the seedless variety a plant of the seeded variety 'Mickey Lee' (light colored) will be planted to serve as the pollenizer. Plants will be spaced 2 ft apart in the beds for a total of 30 plants per plot. The watermelon plants will be grown according conventional practices suggested for SC and allowed to grow and produce fruit on the soil. Plants will be sprayed for managing insects and diseases such as gummy stem blight and anthracnose. However, the plots will not be sprayed for managing Phytophthora fruit rot.

Fruit rot rating and data analysis (late summer 2015): Plants will be overhead irrigated if necessary to enhance fruit rot development. Total number of fruit and rotted fruits will be recorded every week for each plot after fruit reach 4-inch diameter. All data will be analyzed using SAS proc mixed procedures and means will be separated using LSD (α=0.05).

Soil testing: Soil samples will be collected from each of the 16 sub-plots before and after bio-fumigation and sent to Clemson University for determining other soil characteristics such as

CEC, organic matter, bulk density, *pH*, nitrogen analysis, other micro and macro nutrients, and total nematode population.

Quantification of Phytophthora in soil: Pathogen populations will be quantified using real-time PCR techniques that we have developed in our laboratory (Kousik et al., 2012). Soil samples will also be collected from all the plots to fill 50 cell trays in the greenhouse. These will be planted with 25 seedlings each of a crown rot susceptible variety of watermelon 'Ojjakyo' and pepper 'Jupiter' to determine the effect of cover crop and chicken manure treatments on crown rot (seedling blight). The seedling trays will be kept water saturated for 3 days to enhance disease development. Watermelon and pepper seedlings will be evaluated 3 weeks after planting for symptoms of crown rot. Data will be analyzed using proc mixed procedures of SAS.

Bio-fumigation experiment in Long Island, NY: This part of the trial will be conducted at the Cornell University's, Long Island Long Island Horticultural Research & Extension Center farm in New York where *P. capsici* has been a problem for the past several years. Bio-fumigation experiments to manage Phytophthora fruit rot of pumpkins have been conducted here before (McGrath and Menasha, 2013) and the same pathogen also causes fruit rot of watermelon. The main cover crop treatments in NY will be Caliente 199, Clover and Fallow. Plots will be similar to the ones in Charleston, SC. The experiment will be a randomized complete block design (RCBD) with five replications for each treatment. Thus there will be a total of 15 plots. Soil will be tested before and after the cover crop or fallow treatments. Chicken manure will not be evaluated in NY.

Projected accomplishment: Successful completion of this project will help develop an integrated management strategy for managing Phytophthora fruit rot of watermelon from a long term perspective. It will also provide watermelon growers with knowledge regarding use of cover crops and chicken manure in GA, SC, NC, and northern states who are aware of their fields being infested with both mating types (A1 and A2) of *P. capsici*.

Publication of results: Data obtained from these trials will be published in the NWA's online magazine "Vineline". Data will also be presented at various state chapter meetings of NWA.

Cost for research to be conducted in Charleston, SC

A. Salaries and wages for part time student worker	$ 4,220
B. Materials and Supplies (Soil test, PCR reagents, field supplies etc.)	$ 3,434
Funding requested for USDA-ARS Charleston, SC:	**$ 7,654**
Funding requested for research at NY for part time worker:	**$ 4,000**
Total funding requested:	**$11,654**

How funds will be used:

Funding is requested for one student aid and for supplies essential for this research. The supplies and other costs will include soil testing at Clemson University, qPCR reagents, soil DNA extraction kits, petri-dishes, reagents for media, field supplies, such as plastic mulch, drip tape, etc. A part time student aid will assist the USDA-ARS Research Plant Pathologist and Technician (GS7) for six months (spring and summer) in Charleston, SC. Funding is requested mainly for a part-time worker to help Dr. McGrath conduct the bio-fumigation experiment in NY.

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A beautiful watermelon field near Tifton, GA. All the vines look good and healthy. However, most of the watermelon fruit under the crop canopy in this field were rotting due to *Phytophthora capsici* infection. The grower had to abandon this field because of fruit rot. Fruit rot also occurred after harvest during transport for the July 4th market resulting in a complete loss for the grower.

Addendum to NWA proposal (Interpretive / Simple summary)

Will bio-fumigation with a mustard cover crop combined with chicken manure help manage Phytophthora fruit rot of watermelon?

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Severe Phytophthora fruit rot of watermelon in a GA field. The grower lost his entire crop despite applying fungicides.

Duration of Project: 1 year (Feb 2015-Jan 2016)

Funds requested for USDA, Charleston, SC: $7,654
Funds requested for Cornell University, NY: $4,000
Total direct funds requested: **$11,654**

NWA Priority area of Proposal: *Phytophthora*

Objective: Conduct field trials in northern (NY) and southern (SC) parts of the U.S. to determine if bio-fumigation utilizing a mustard cover crop combined with chicken manure will reduce Phytophthora fruit rot of watermelon? Studies on bio-fumigation and chicken manure need to be repeated to ensure they are truly effective or not.

Brief Summary: A watermelon grower wondered if chicken manure might help manage Phytophthora fruit rot? Plus literature search revealed that bio-fumigation using mustard cover crops could help reduce Phytophthora populations in soils. Hence we propose to re-evaluate a combination of these two strategies for managing fruit rot of watermelon to answer some of the grower questions. In our 2014 trials bio-fumigation showed the potential to reduce fruit rot.

Projected accomplishment: Successful completion of this proposal should help answer the following questions:

- Will bio-fumigation with a mustard cover crop help reduce Phytophthora and thus fruit rot?
- Will Chicken manure help manage fruit rot?
- Will the combination of chicken manure and mustard cover crop be more useful for managing Phytophthora fruit rot?
- Do other cover crops such as red clover harbor Phytophthora?

Our ultimate goal is to integrate different management strategies such as use of cover crops, chicken manure, fungicides and rotation schemes, field drainage, clean irrigation for managing Phytophthora fruit rot of watermelon.