Proposal number/Title/PI: 4E, Efficacy of Biofungicide Product at the Early Stage of Development for Downy Mildew in Cucumber, McGrath

The following criteria were established to assist the reviewers in selecting biopesticide projects for funding that: (1) in an exploratory or early stage of development (2) have a high probability of being registered/marketed in a reasonable period of time; and (3) will be useful in meeting pest control needs involving minor crops (uses), including minor uses on major crops.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score</th>
<th>(0 to 10 or 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Adequacy of investigators and facilities.</td>
<td></td>
<td></td>
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<tr>
<td>2. Experimental design, work plan and preliminary research.</td>
<td></td>
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<tr>
<td>3. Evaluation of budget.</td>
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<td>4. Time to completion and probability of attaining objectives in the proposed time frame.</td>
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<tr>
<td>5. Relevance of the proposal toward the development of data for registration or label expansion of the biopesticide.</td>
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<tr>
<td>7. Probability of biopesticide being used by growers (factors such as effectiveness and economics of use rates should be considered).</td>
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<tr>
<td>8. Adverse environmental risks including crop safety, safety to beneficials, safety to ecosystems, and stability.</td>
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<td>9. Other control measures currently available to control target pest.</td>
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<tr>
<td>10. Probability of biopesticide being registered, time to registration, and if label expansion, time to market.</td>
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<tr>
<td>11. Availability of a potential registrant. Likelihood of developing a formulated commercial product.</td>
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<td>TOTAL*</td>
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</table>

Funding Recommendation

(Choose appropriate line)

YES

NO

MAYBE

Note: Attach a comment page, should you have specific comments related to the proposal not covered in the above criteria.

* There is a possibility of 10 points per criteria (except efficacy=20) for a total of up to 120 points. A rating of 0 means that the proposal does not meet the criteria at all, while a rating of 10 means it is ideal.
**IR-4 BIOPESTICIDE GRANTS COVER PAGE**

2014

<table>
<thead>
<tr>
<th>Proposal Number (For IR-4 Use):</th>
<th>Principal Investigator: Dr. Margaret Tuttle McGrath</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposal Title:</strong> Efficacy of Biofungicide Product at the Early Stage of Development for Downy Mildew in Cucumber</td>
<td></td>
</tr>
<tr>
<td>Institution: Cornell University</td>
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<tr>
<td>Total dollars Requested (Year 1 of project only) $6,500</td>
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</tr>
</tbody>
</table>

Enter each biopesticide /crop/ pest combination

<table>
<thead>
<tr>
<th>No.</th>
<th>Biopesticide and/or Conventional Product</th>
<th>Crop</th>
<th>Pest (Weeds, Diseases, Insects)</th>
<th>PR No. (For IR-4 Use)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MBI-110</td>
<td>Cucurbit Group</td>
<td>Downy mildew</td>
<td></td>
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<tr>
<td>2</td>
<td>Regalia</td>
<td>Cucurbit Group</td>
<td>Downy mildew</td>
<td></td>
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<tr>
<td>3</td>
<td>Actinovate</td>
<td>Cucurbit Group</td>
<td>Downy mildew</td>
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<tr>
<td>4</td>
<td>Sporatec</td>
<td>Cucurbit Group</td>
<td>Downy mildew</td>
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<tr>
<td>5</td>
<td>Badge X2</td>
<td>Cucurbit Group</td>
<td>Downy mildew</td>
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<tr>
<td>6</td>
<td>Bravo</td>
<td>Cucurbit Group</td>
<td>Downy mildew</td>
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## Biopesticide Grants Contact Information Form

**Proposal Title:** _Efficacy of Biofungicide Product at the Early Stage of Development for Downy Mildew in Cucumber_

<table>
<thead>
<tr>
<th>Name</th>
<th>Address</th>
<th>Phone Number &amp; Fax Number</th>
<th>E-mail Address</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Director (Principal Investigator):</strong> Margaret Tuttle McGrath</td>
<td>3059 Sound Avenue LIHREC, Cornell University</td>
<td>631-727-3595 (Ph) 631-727-3611 (Fax)</td>
<td><a href="mailto:mtm3@cornell.edu">mtm3@cornell.edu</a></td>
</tr>
<tr>
<td><strong>Administrative Contact:</strong> Tracy Holdridge</td>
<td>330 Plant Science Building Tower Road</td>
<td>607-255-5474</td>
<td><a href="mailto:tlk2@cornell.edu">tlk2@cornell.edu</a></td>
</tr>
<tr>
<td><strong>Financial Grant Officer:</strong> Ilene Lambiase</td>
<td>Division of Financial Affairs 341 Pine Tree Road</td>
<td>607-255-0875</td>
<td><a href="mailto:iml22@cornell.edu">iml22@cornell.edu</a></td>
</tr>
<tr>
<td><strong>Authorized Grant Official:</strong> Linda Griswold</td>
<td>Office of Sponsored Programs 373 Pine Tree Road</td>
<td>607-255-7280 607-255-5058</td>
<td><a href="mailto:lag13@cornell.edu">lag13@cornell.edu</a></td>
</tr>
<tr>
<td><strong>Individual Responsible for Invoicing:</strong> Tracy Holdridge</td>
<td>330 Plant Science Building Tower Road</td>
<td>607-255-5474</td>
<td><a href="mailto:tlk2@cornell.edu">tlk2@cornell.edu</a></td>
</tr>
</tbody>
</table>

**NOTE:** THIS IS FOR INFORMATIONAL PURPOSES ONLY. THIS IS NOT MEANT TO BE SIGNED. DO NOT DELAY SUBMITTING YOUR PROPOSAL BY ATTEMPTING TO GET THIS SIGNED. THIS IS NOT MEANT AS A REPLACEMENT FOR ANY INSTITUTIONAL APPROVAL PAGES.
Principal Investigator: Margaret Tuttle McGrath
Department of Plant Pathology, Cornell University,
Long Island Horticultural Research and Extension Center,
3059 Sound Avenue, Riverhead, NY 11901. mtm3@cornell.edu
Phone: 631-727-3595 Fax: 631-727-3611

All research work will be conducted by Research Support Specialist Karen A. LaMarsh, with the assistance of a team of temporary seasonal employees, under the guidance of the principal investigator.

I. Grant Stage

- Early – Biopesticide not yet registered and has not completed the Tier I toxicology data requirements.
- Advanced – the biopesticide is registered or at least has completed the Tier I toxicology data requirements.

II. Introduction (objective, description of pest problem and justification).

The objective of this proposed study is to test a biopesticide for downy mildew in cucumber alone and within an integrated program. The integrated aspects of the program consist of 1) using Dasher II, one of the varieties that performed relatively well in NC variety trials in which susceptibility to downy mildew was assessed and 2) using disease and weather forecasts as well as disease occurrence to determine when to make applications.

Downy mildew is a potentially very devastating disease that can begin to develop at any time during cucurbit crop development. Young seedlings are especially susceptible. This disease use to occur sporadically in the northeastern US, usually appearing late enough in the growing season that yield was not impacted. However, since 2004 this disease has appeared earlier and has caused extensive leaf death when not adequately managed. Also, QoI fungicides are no longer highly effective and cucumber crops have been severely affected although genetic resistance is a common feature of both slicer and pickling varieties marketed today. These changes indicate that a new strain of the pathogen has developed. The downy mildew fungus exists as pathotypes varying in ability to infect the various cucurbit types. Cucumber is susceptible to all pathotypes and thus usually is the first crop affected in an area. Premature death of leaf tissue results in reduced fruit quality and quantity. Loss can be quite extensive in cucumber as fruit production declines substantially in severely affected plants, much of the fruit produced is misshapen, and plants die prematurely.

Impact has been great especially for organic producers because their customers want a continuous supply of cucumbers into the fall, which they have not been able to do because downy mildew has been killing their plants. Marketing their own produce is especially important for organic growers, thus they very rarely purchase produce to compensate for what they cannot produce themselves. Other cucurbit crops are also very important for organic growers, especially winter squashes which enable them to market into the winter. Long Island organic growers have identified downy mildew as one of the top problems needing to be
addressed especially in cucumbers because of the impact it has been having on production of a crop that their customers want into fall. Both slicer and pickle types are in demand.

Presently the only established management tool for organic growers is copper fungicides, but these have provided limited control in fungicide efficacy experiments conducted with highly susceptible varieties. Most cucumber varieties have resistance to the old strain of the pathogen, which was a very high degree of resistance approaching immunity. This resistance provides limited suppression of the new strain; however, variety evaluations conducted in NC over the past three years have documented variation among varieties in downy mildew severity. While the best varieties are not adequately resistant to be used as a sole management practice, they could be a valuable component of an integrated program. Search for a new resistance gene has so far been unsuccessful, thus new resistant varieties unfortunately are not on the horizon.

Downy mildew control on cucurbits is an IR-4 priority for 2014. Results obtained with cucumber would be relevant to other cucurbit crops.

### III. Experimental Plan

#### 1. Numerical list of all treatments.

**A. Applied to cucumber variety ‘General Lee’:**
- 1. Nontreated.
- 2. MBI-110 (1 qt/A)
- 3. MBI-110 (2 qt/A)
- 4. MBI-110 (4 qt/A)
- 5. MBI-110 (8 qt/A)
- 6. MBI-110 (2 qt/A) + Regalia (2 qt/A)
- 7. Regalia (2 qt/A) alt MBI-110 (4 qt/A)
- 8. Organic Biopesticide standard:
  - Regalia (2 qt/A) alt Actinovate (12 oz/A) alt Sporatec AG (3 pt/A)
- 9. Organic Non-biopesticide standard (copper fungicide): Badge X2 (0.5-1.25 lb/A) *
- 10. Conventional Fungicide STD: Bravo Ultrex (1.4 – 1.8 lb/A) *

**B. Applied to cucumber variety ‘Marketmore 97’:**
- 12. MBI-110 (2 qt/A) + Regalia (2 qt/A)

* low rate will be used for initial applications when there is a forecasted risk of downy mildew infection at the ipmPIPE website. Higher rate will be used when downy mildew is present.

Treatments will be applied as needed, which is anticipated to be on a 5- to 7-day schedule. Initiation of applications will be determined by monitored the NC forecast web site as well as the local weather forecast. The first application will be made just before the first rain event is forecast to occur after plant emergence or transplanting unless downy mildew has not started to develop in the greater northeastern US and thus there is no source of inoculum at that time, which is not likely based on disease development in recent years. Timing of subsequent applications will depend on weather and disease occurrence in the region. An application will be made when the forecasted risk for downy mildew to occur on LI is high. Once downy mildew is
present on LI, applications will be made once a week, or sooner when rain is forecast, with a minimum spray interval of 5 days. Treatments will be made using a backpack CO₂ sprayer with a 2-nozzle boom.

The biopesticide MBI-110 will be compared to 1) a program with OMRI-listed biopesticide labeled for this disease 2) an OMRI-listed copper fungicide, because this continues to be commonly used for managing disease in organic vegetables, and 3) a conventional fungicide program of Bravo. Only a protectant fungicide will be used for the conventional fungicide standard because conventional growers would use a biopesticide demonstrated to be effective for downy mildew in place of the protectant fungicide they are tank mixing with the mobile fungicides that have targeted activity for downy mildew.

All treatments will be applied to ‘General Lee’, a cucumber variety grown by organic growers on Long Island. One of the MBI-110 treatments will also be tested on ‘Marketmore 97’, a variety reported to be less susceptible to downy mildew than other varieties also bred to be resistant to the previously dominant strain(s) of the pathogen.

2. Crop and experiment location.

   Cucumber. Field-grown plants
   Cornell University Long Island Horticultural Research and Extension Center in Riverhead, NY.

3. Statistical aspects of the experiment.

   Experimental design - Randomized Complete Block.
   plot size – single 27-ft rows with 18 plants.
   number of replications - four
   statistical test – multiple comparison using Fisher’s Protected LSD and planned comparisons for certain treatments. Data will be transformed when needed to obtain constant variance before analysis.

4. Locations.

   The experiment will be conducted in one location, which is a field of Haven loam soil at LIHREC (Cornell’s research facility in Riverhead NY) that has been in use for research evaluating products for organic vegetable production. There will be four replications.

5. How this proposal is designed to provide information on how biopesticides fit into an integrated pest management program.

   The integrated aspects of the program consist of 1) using disease and weather forecasts as well as disease occurrence to determine when to make applications, 2) testing MBI-110 in combination with Regalia, another biopesticide with a different mode of action, and 3) testing MBI-110 plus Regalia on ‘Marketmore 97’, a variety reported to be less susceptible to downy mildew than other varieties also bred to be resistant to the previously dominant strain(s) of the pathogen.

6. Data collection.

   Plants will be scouted routinely for evidence of downy mildew. Disease severity (percentage of leaf tissue infected) will be rated weekly on individual leaves and the entire plot. Defoliation will be rated as disease progresses.
Fruit will be harvested weekly as it reaches marketable size. Culls and marketable fruit will be counted and weighed.

7. Description of disease to be controlled.

Downy mildew is a common, potentially very devastating disease of cucurbit crops. It develops in most cucurbit production areas in the US each year. It is caused by the obligate fungus *Pseudoperonospora cubensis*. This pathogen only attacks leaf tissue, but it can begin to develop at any time during cucurbit crop development, in contrast with powdery mildew, with young seedlings being especially susceptible. When leaves are not protected by fungicides, the leaf blade can be killed quickly, leading to premature crop death. Chemical control is the main management practice. Resistance was bred into cucumbers and provided excellent control until the pathogen evolved to overcome this resistance, which was evident in 2004. Resistant varieties still provide some suppression, but not adequate to be used as the only management practice.

8. Source of the target pest.

*Pseudoperonospora cubensis* has occurred every year where the experiment will be conducted since the new strain was detected in 2004. This pathogen survives over winter in FL where cucurbits are grown during winter months. It is capable of moving long distances in wind, and moves northward each year affecting other production areas as the year progresses. This pathogen has also survived over winter in greenhouses in southern Canada, and from there moved eastward and southward during the field growing season. There are no plans to inoculate plants.


June. Order seed and other supplies. Communicate with registrant about quantity of product needed.

Early July. Prepare field for planting. Seed cucumbers in trays in the greenhouse.

Mid-July. A combination of 5-3-4 and 8-2-8 organic fertilizers each at 50 lb/A N will be applied over rows, incorporated, and then black plastic mulch with drip tape will be laid. Holes will be cut at 18-in spacing with a waterwheel transplanter that will also be used to apply an organic starter fertilizer into the holes. Plots will be staked and marked with flags. Cucumber seedlings will be transplanted by hand into the holes.

July – September. The downy mildew forecast system will be monitored. The PI will also utilize information gained from being a cooperator on the IPM pipe project to determine when downy mildew is a sufficient risk to initiate applications. Plants will be inspected routinely for downy mildew symptoms and cucumber beetles.

Cucumber beetles will be controlled with the organic insecticide Pyganic.

Weeds between plastic strips will be managed with cultivation and applying the organic herbicide Axxe. Weeds will be removed by hand if they are not managed by the other practices and when they grow in the transplant holes.

Treatments will be applied as needed based on disease occurrence and disease and weather forecasts.
Disease severity and defoliation will be assessed. Plants will be inspected for phytotoxicity. Fruit will be harvested at least once a week.

**October to December.** Clean up experiment site. Plant cover crop. Enter and analyze data, write reports. Write a report for Plant Disease Management Report.

**January to March.** Extend results to growers if the project is successful. Present results at grower meetings. Write grower newsletters. Contact editors with The Vegetable Growers News, American Vegetable Grower, and Organic Gardening who have worked with the principal investigator on previous articles about the results of projects. Post report on-line.

10. **Description of the test facilities.**

   Cornell University’s Long Island Horticultural Research and Extension Center (LIHREC) in Riverhead, NY, has a state-of-the-art greenhouse with a room dedicated to research on vegetable diseases. Transplants will be produced here.

   LIHREC has 68 acres with irrigation (overhead and drip) for field research, laboratory facilities, and two modern greenhouses. The land was recently enclosed in a deer fence to protect experiments. Farm equipment is available for all aspects of vegetable production, including tractor sprayers designed for research. The field support staff of three has extensive experience with vegetable research.

   Two two-acre fields at LIHREC have been designated to be used exclusively for applied research in cultural practices and pest management within an organic farming framework. In one field non-organic products are permitted, thus allowing testing of products not approved for organic production.

11. **Budget Form.** (follows proposal)

12. **Description of need for the biopesticides to be tested and alternative treatments.**

   There is a great need for a product that can effectively suppress downy mildew in organically-produced cucumber and other cucurbit crops. The product proposed to be tested, MBI-110, performed well in evaluations conducted on cucumber and grape downy mildew in 2013. MBI-110 combined with Regalia (MBI-10605) was more effective than MBI-110 alone at any of the rates tested for cucumber downy mildew, providing 51% control based on AUDPC values. Three treatments in this experiment with conventional fungicides (Ranman plus either Manzate, Bravo, Presidio and/or Tanos) provided 51% to 55% control. MBI-110 plus Regalia provided 76% control of grape downy mildew based on average leaf area affected; however, in this experiment significantly better control was obtained with MBI-110 alone at all 3 rates tested (up to 96%).

   Several biopesticides are labeled for downy mildew in cucurbit crops: Actinovate AG, Double Nickel, Organocide, OxiDate, MilStop, Regalia, Optiva (replaced Serenade), Sonata, Sporatec AG, and Trilogy. Those evaluated to-date have not been as effective. Actinovate and Sporatec were evaluated on LI in 2008. In the experiment conducted in 2009, six biopesticides controlled downy mildew based on both the 8 Sep and the 23 Sep canopy severity values, providing 43-82% and 26-51% control, respectively: Actinovate, K-Phite, Organocide + NuCop, Sonata, Taegro, and Timorex Gold. These were as effective as the organic standard based on at least one of these assessments. K-Phite, Organocide + NuCop, and Sporatec had the lowest severity values at the last three assessments. These treatments provided 39-45% control based on AUDPC, which was not significantly different from the conventional standard (53% control).
However, no biopesticides were effective in a similar experiment conducted in 2010 when downy mildew onset was late in the growing season.

Conventional growers are increasingly interested in alternatives to conventional fungicides. A biopesticide could be a suitable alternative to the conventional, protectant fungicide being used.

References:
Appendix 1  
**PCR Form**

Appendix 2  
**Labels of the biopesticides to be evaluated.**  
A draft label has not been prepared yet by the registrant, Marrone Bio Innovations, Inc. See letter in Appendix 6.

Appendix 3  
**Supporting preliminary data.**  
Data tables from Kelly Ivors and Wayne Wilcox who conducted evaluations for downy mildew on cucumber and grape, respectively, in 2013.

Appendix 4  
Resume for Principal Investigator

Appendix 5  
Progress Report on 2013 Biopesticide project. A third project funded in 2013 had to be postponed until 2014.  
*Efficacy of Biofungicide Products at the Demonstration and Advanced Stages of Development for Foliar Diseases in Organically-Produced Tomato.*  
(combination of two separately-funded experiments with products at the advanced stage of development and at the demonstration stage of development)

Appendix 6  
**Registrant support.** Questionnaire form and letter.  
**Letter in support of the project from a grower.**  
James Russo, Golden Earthworm Organic Farm
**BIOPESTICIDE PROJECT BUDGET**

**Project Period:** From: 6/1/2014  
To: 5/31/2015

<table>
<thead>
<tr>
<th>Funds Requested</th>
<th>Matching Funds</th>
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<tr>
<td><strong>Totals ($)</strong></td>
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</table>

| A. Senior/Key Person | $0.00 | $ |
| B. Other Personnel   | $2,995. | $ |

| Number, Other Personnel | 2 |

| C. Fringe Benefits | $1,754. | $ |
| Total Salary, Wages and Fringe Benefits | $4,749. | $ |

| D. Equipment | NOT ALLOWED | $ |

| E. Travel | $0.00 | $ |
| 1. Domestic | $0.00 | $ |
| 2. Foreign | NOT ALLOWED | $ |

| F. Participant Support Costs | $0.00 | $ |
| 1. Travel | $0.00 | $ |
| 2. Other | $0.00 | $ |

| G. All Other Direct Costs |                |                |
| 1. Materials and Supplies | $754.00 | $ |
| 2. Publication Costs | $90.00 | $ |
| 3. Consultant Services | $0.00 | $ |
| 4. Computer Services | $0.00 | $ |
| 5. Subawards/Consortium/Contractual Costs | $0.00 | $ |
| 6. Equipment or Facility Rental/User Fees | $817.00 | $ |
| 7. Alterations and Renovations | NOT ALLOWED | $ |
| 8. Other 1 | $ | $ |
| 9. Other 2 | $ | $ |
| 10. Other 3 | $ | $ |

| Total Direct Costs | $6,500.00 | $ |

**Each budget item requires documentation**

**IMPORTANT**

On a separate sheet provide the following information:  
- Project title, PI name and one paragraph statement of work  
- Identify each budget item individually - provide cost and a written description and/or purpose for the cost.  
- For rentals and fees: identify type of rental or fee and provide rental rate & purpose for the cost  
- Any contractual work will require a separate budget and statement of work including rate and purpose  

The Other category **MAY NOT** include construction or indirect overhead. These costs are not permitted, under any circumstances, under this grant. 

*Indicate in a footnote if the matching funds are monetary or in kind and their source

*Please enter all values to the nearest hundred dollars.
Budget Narrative:

Principal Investigator: Dr. Margaret Tuttle McGrath
Proposal Title: IR-4

The goal of this study is to evaluate a new biopesticide for downy mildew in cucumber. This is the most important disease for this important crop. Downy mildew is challenging to control, especially in organic production systems. Yield is reduced because affected plants produce fewer and misshapen fruit, and die prematurely. Total yield loss can occur when disease starts developing early. While organic growers will benefit the most from the results of this project, conventional growers are increasingly interested in inherently safe products like biopesticides. A replicated experiment will be conducted in a research field at LIHREC, a Cornell University applied research facility on Long Island. Procedures for producing the crop, applying treatments, assessing disease, and measuring yield will be similar to those used in previous experiments conducted with cucumber in LIHREC fields.

Budget Items:

A. Senior/Key Person: No funds are requested.
B. $2,995 Labor cost for technical and seasonal personnel. Funds are requested for the Research Support Specialist (Karen LaMarsh) who will be conducting all technical aspects of the experiment including treatment applications, assessing and supervising disease evaluations, and analysis of data. Funds requested also include wages for a temporary summer research assistant at $11.50/hr, average of 8 hr/week, for 12 weeks from June through September to do maintenance activities (such as seeding, transplanting, establishing plots, weeding, running irrigation, and cleaning up field site at experiment end) and assist Karen with data collection and entry.
C. $1,754 Fringe benefits are calculated at 61.3%.

Total Salary: $4,839

D. $0.00 Equipment
E. $0.00 Travel cost
F. $0.00 Participant support costs
G. $1,661 All other direct costs. Funds requested include $754 in expendable items for growing the crop, marking plots, and making treatment applications, including seed, fertilizer, plastic mulch, drip tape, and flags for marking plots; personnel protective equipment (chemical resistant gloves, respirator cartridges, and tyvek suits) for making applications. The other funds requested in this section are $817 charge for facility user fees ($250/A for 1 A of field space, $27 for greenhouse space, and $30/hour for farm crew labor) at the Long Island Horticultural Research and Extension Center (LIHREC) and $90 to cover publication costs in the annual Plant Disease Management Report and an abstract for a presentation at a meeting of the American Phytopathological Society.

Total Costs: $6,500

Matching Funds (in-kind): $0.00
IR-4 Minor Use Biopesticide (*Required Fields)  
Project Clearance Request (PCR) Form

1. *Requestor:  Margaret Tuttle McGrath  Affiliation:  Cornell University  
   *Address:  LIHREC, 3059 Sound Avenue  
   *City:  Riverhead  *State/Territory:  NY  *Zip:  11901-1098  
   *Telephone:  (631) 727-3595  FAX:  (631) 727-3611  
   *E-mail address:  mtm3@cornell.edu

2. *Pest Control Product (Active Ingredient {a.i.}):  Bacillus amyloliquefaciens  
   *Trade Name/Formulation:  MBI-110  
   Registrrant (manufacturer):  Marrone Organic Innovations, Inc.  
   Method of Production (Fermentation, in vivo, extraction from plants):  Fermentation

3. *Commodity (one crop or crop group per form):  Cucurbits  
   *Use Site (e.g., field, greenhouse, post-harvest):  field  
   Parts Consumed:  fruit  Animal Feed By-Products:  Yes  No X  
   Planting Season:  spring to summer  Harvest Season:  summer to fall  
   State/Territory Acreage:  5,400  % National:  0.65%  Average Field Size:  5 A  
   (data for cucumbers)

4. Insect/Disease/Weed:  Disease: downy mildew  
   Damage caused by pest:  Infected foliage reduces yield indirectly.

5. *Why is this use needed?:  Current biopesticide products not adequately effective

6. *Proposed Label Instructions  
   *Rate per Application (lbs a.i. per acre or 1000 linear ft):  not determined yet  
   Type of sprayers that may be used (e.g., fixed wing, ground boom sprayer,  
   chemigation, air blast, ULV, granular spreader):  ground boom sprayer  
   Range of Spray Volume (if applicable):  
   Maximum Acreage Treated per Day:  1550 A (1/100th of US cucumber acreage)  
   *Crop Stage during Application(s):  vegetative and fruiting  
   *Maximum no. of applications:  12  Minimum interval betw. applications:  ND  
   Maximum lbs active ingredient per acre per year/season:  ND  *PHI:  0 day

7. *Availability of Supporting Data*:  *Phytotoxicity(P)  X  *Efficacy(E)  X  *Yield(Y)  
   Supporting data may be required before a residue study will be initiated.

8. Brief Summary of proposed study and fund request:  Efficacy of Biofungicide Product  
   at the Early Stage of Development for Downy Mildew in Cucumber.  $6500

9. *Submitted By (print name):  Margaret Tuttle McGrath  
   *Signature:  Margaret Tuttle McGrath  *Date:  12-06-13

Send this completed form to:  
IR-4 Project Headquarters, 500 College Road East; Suite 201 W; Princeton, NJ 08540-6635;  
Telephone (732)932-9575 ext 4610 (Michael Braverman) FAX (609) 514-2612  
or e-mail: braverman@aesop.rutgers.edu
2013 Cucumber Downy Mildew Trial (Ivors) - MRS CucA13

ANOVA Means for Downy Mildew %LAD August 7 thru 21
18" spacing, 7 plants per plot
Variety: Raider
June 13 double seeded in plastic hole
6 foliar sprays made on Jul 17, 24, 31; Aug 7, 14, 21.

<table>
<thead>
<tr>
<th>TRT</th>
<th>8/7/13</th>
<th>8/21/13</th>
<th>AUDPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>53.691 a</td>
<td>81.212 a</td>
<td>2420.8235</td>
</tr>
<tr>
<td>Ranman 2.75 fl oz (1, 3, 5)</td>
<td>24.87 de</td>
<td>32.404 f</td>
<td>1084.843</td>
</tr>
<tr>
<td>Presidio 4.0 fl oz + Bravo</td>
<td>26.13 de</td>
<td>27.384 g</td>
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<tr>
<td>Weatherstik 2.0 pt (2, 4, 6).</td>
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<tr>
<td>Ranman 2.75 fl oz + Manzate ProStick 3.0 lb (1, 3, 5)</td>
<td>26.13 de</td>
<td>41.174 e</td>
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<tr>
<td>Manzate ProStick 3.0 lb (2, 4, 6).</td>
<td>32.404 c</td>
<td>57.445 c</td>
<td>1520.053</td>
</tr>
<tr>
<td>Ranman 2.75 fl oz + Manzate ProStick 3.0 lb (1, 3, 5)</td>
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<td></td>
<td></td>
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<tr>
<td>Tanos 8.0 oz (2, 4, 6).</td>
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<td>53.692 d</td>
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<tr>
<td>MBI-10605 2.0 qt (1, 2, 3, 4, 5, 6).</td>
<td>36.163 b</td>
<td>66.203 b</td>
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<tr>
<td>MBI-110 2.0 qt (1, 2, 3, 4, 5, 6).</td>
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<td>27.386 d</td>
<td>64.952 b</td>
<td>1399.481</td>
</tr>
</tbody>
</table>

% Leaf area Diseased
### Trial conducted by Wayne Wilcox, 2013

Downy Mildew on Chardonnay Leaves 8/7/13

<table>
<thead>
<tr>
<th>Material, rate/A</th>
<th>Timing</th>
<th>% leaves infected</th>
<th>ave leaf area infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zampro, 14 fl oz + Sylgard, 0.03%</td>
<td>1, 3, 5, 7, 9</td>
<td>2 f</td>
<td>0.05 d</td>
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<tr>
<td>Revus Top, 7 fl oz + Induce, 0.125%</td>
<td>1, 3, 5, 7, 9</td>
<td>2 f</td>
<td>0.07 d</td>
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<tr>
<td>CX-10055, 1.75 pt + Induce, 0.125%</td>
<td>1 - 10 inclusive</td>
<td>28 de</td>
<td>1.45 d</td>
</tr>
<tr>
<td>Dithane, 3 lb + Phostrol, 3 pt</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CX-10055, 1.75 pt + Induce, 0.125%</td>
<td>3, 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason, 2.7 oz + Induce, 0.125%</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CX-10055, 1.75 pt</td>
<td>7, 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ranman 400 SC, 2.75 fl oz + Phostrol, 2.5 pt</td>
<td>9</td>
<td>8 ef</td>
<td>0.21 d</td>
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<td>Dithane, 3 lb + Phostrol, 3 pt</td>
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<td></td>
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<tr>
<td>Zampro, 14 fl oz + Sylgard, 0.03%</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason, 2.7 oz + Induce, 0.125%</td>
<td>5</td>
<td></td>
<td></td>
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<tr>
<td>Zampro, 14 fl oz + Sylgard, 0.03%</td>
<td>7</td>
<td></td>
<td></td>
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<tr>
<td>Ranman 400 SC, 2.75 fl oz + Phostrol, 2.5 pt</td>
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<td>1 f</td>
<td>0.02 d</td>
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<td>1</td>
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<tr>
<td>CX-10470, 1.75 pt + Induce, 0.125%</td>
<td>3, 4</td>
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<td></td>
</tr>
<tr>
<td>Reason, 2.7 oz + Induce, 0.125%</td>
<td>5</td>
<td></td>
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</tr>
<tr>
<td>CX-10470, 1.75 pt + Induce, 0.125%</td>
<td>7, 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ranman 400 SC, 2.75 fl oz + Phostrol, 2.5 pt</td>
<td>9</td>
<td>3 f</td>
<td>0.07 d</td>
</tr>
<tr>
<td>Dithane, 3 lb + Phostrol, 3 pt</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reason, 2.7 oz + Induce, 0.125%</td>
<td>5</td>
<td></td>
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<tr>
<td>Ranman 400 SC, 2.75 fl oz + Phostrol, 2.5 pt</td>
<td>9</td>
<td>79 ab</td>
<td>4.17 bc</td>
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<tr>
<td>CX-10470, 1.75 pt + Induce, 0.125%</td>
<td>1 - 10 inclusive</td>
<td>7 ef</td>
<td>0.16 d</td>
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<tr>
<td>MBI-110 EP, 4 qt + Induce, 0.125%</td>
<td>1 - 10 inclusive</td>
<td>28 de</td>
<td>0.84 d</td>
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<tr>
<td>MBI-110 EP, 6 qt + Induce, 0.125%</td>
<td>1 - 10 inclusive</td>
<td>63 bc</td>
<td>2.29 cd</td>
</tr>
<tr>
<td>MBI-110 EP, 8 qt + Induce, 0.125%</td>
<td>1 - 10 inclusive</td>
<td>51 cd</td>
<td>1.80 cd</td>
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<tr>
<td>Regalia (MBI-10605), 2 qt + Induce, 0.125%</td>
<td>1 - 10 inclusive</td>
<td>82 ab</td>
<td>5.82 b</td>
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<tr>
<td>Regalia (MBI-10605), 2 qt + MBI-110 EP, 4 qt + Induce, 0.125%</td>
<td>1 - 10 inclusive</td>
<td>88 a</td>
<td>5.27 b</td>
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<tr>
<td>Check</td>
<td>100 a</td>
<td></td>
<td>22.13 a</td>
</tr>
</tbody>
</table>
Margaret Tuttle McGrath

Curriculum Vitae
Department of Plant Pathology and Plant-Microbe Biology
Cornell University
Long Island Horticultural Research and Extension Center
3059 Sound Avenue, Riverhead, New York 1190l-1098
Telephone: (631) 727-3595  Fax: (631) 727-3611  e-mail: mtm3@cornell.edu

Education:
Ph.D.  Plant Pathology  The Pennsylvania State University, 1988
M.S.  Botany  University of Vermont, 1983
B.A.  Biology  Carleton College, 1979

Employment History:
1996-present  Associate Professor, Department of Plant Pathology, Cornell University (Division of effort: 40% research and 60% extension)
1988-1996  Assistant Professor, Dept. of Plant Pathology, Cornell University

Research Interests and Experience:
Overall program goal is improving management of diseases affecting vegetable grown on Long Island under conventional and organic production focusing on IPM practices. Specific topics include evaluating resistant varieties and experimentals in collaboration with public and private sector plant breeders, evaluating fungicides for conventional and organic production with focus on biopesticides, investigating occurrence of fungicide resistance and its management for powdery mildew of cucurbits, developing scouting protocols and action thresholds for timing the initiation of fungicide applications after disease detection, investigating factors that favor disease development and using this information for timing fungicide applications. Management practices for improving soil health, including reduced-tillage production systems and compost soil amendments, are being examined for their impact on plant diseases. Impact of ambient ozone on plant productivity is being examined.

Experience in Organic Agricultural Production:
Sabbatical leave in 2002 to Australia focused on organic production systems.
Member Cornell Organic Production Program Work Team and Northeast Organic Network.
Pathology specialist on the educational team for Advanced Training in Organic Crop Production program conducted in 2005 with funding from NE-SARE.
Taught Organic Disease Management in Advanced Organic Vegetable Production Session for Beginning Farmer Service Organization Professional Development Training. 10/30/13.
Visits to organic farms to learn about production practices and to help identify disease problems and discuss management options.
Research evaluating organic disease management practices: disease resistant varieties, cultural practices, and biopesticides and other products approved and in development.

Web Site on Organic Disease Management (new):
http://www.longislandhort.cornell.edu/vegpath/organic.html

Select Recent Extension and Outreach Presentations on Biopesticides, Cucurbit Downy Mildew, and/or Organic Agriculture:
Margaret Tuttle McGrath

17. Late Blight Management on Organic Farms. Webinar. 7/2/10.

Select Recent Abstracts and Proceedings for Scientific Presentations:

Margaret Tuttle McGrath


Book Chapters:

Select Recent Scientific Publications on Cucurbit Downy Mildew and Biopesticides:
Efficacy of Biofungicides at the Early and Demonstration Stages of Development for Foliar Diseases in Organically-Produced Tomato

Preliminary Report on an Experiment Funded by the IR-4 Biopesticide Program, 2013

Principal Investigator:
Margaret Tuttle McGrath
Department of Plant Pathology and Plant-Microbe Biology, Cornell University,
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Introduction

Tomato is a good crop choice to target for biopesticide evaluations. It is an important crop that is routinely affected by diseases. It is important for both organic and conventional diversified vegetable growers, which are common in the northeastern US. Fresh local tomatoes are one of the most popular items during summer, therefore they are grown by many organic and conventional growers. There are several foliar disease affecting tomatoes, including Septoria leaf spot, early blight, bacterial speck and spot, late blight, powdery mildew and leaf mold. Foliar diseases are a common occurrence wherever tomatoes are grown. All plantings are affected, even those grown under protection (greenhouses and high tunnels) and in small home gardens. Organic growers on Long Island have identified tomato as a high priority for research.

Foliar diseases need to be controlled in tomatoes to maintain yield. Yield is reduced when foliar diseases are not adequately controlled because the pathogen also infects fruit and/or death of infected leaves reduces fruit production and fruit quality, especially flavor. Diseases are often the reason tomato crops are abandoned before the last fruit are harvested. A long harvest period is needed with fresh market tomatoes for retail marketers because of consumer demand. This is especially true for organic growers who have CSAs.

Applications of fungicides are the main way foliar diseases are managed in both conventionally and organically-produced crops. Resistant varieties, unfortunately, are not available for foliar diseases that have been affecting production. Fungicides are likely to remain the main management tool because of the diversity of tomato varieties, and the popularity of heirloom varieties.

Organic growers are especially eager for efficacy data on biopesticides because they would like to obtain better control of foliar diseases and prefer not to rely on copper. Conventional growers have been increasingly interested in biopesticides and other biocompatible products. Growers are reluctant to try new products without data from replicated evaluation studies documenting efficacy because of the potential impact of using an ineffective product.
Objectives

One objective of this study was to evaluate Optiva (aka Serenade Optimum), a new formulation of Serenade. Serenade is an established biopesticide that is widely available and broadly labeled. Thus Optiva is expected to also have especially good utility for small, diversified growers who use small quantities and do not have the resources to maintain an extensive inventory of products. Early evaluations of Serenade and Sonata are considered to not document their actual potential because rates used are now recognized by the manufacturer as being substantially lower than needed to effectively control many diseases. Additionally, Sonata needs an appropriate surfactant, which has not always been included in previous evaluations. Optiva is an improved formulation. Thus an important objective of this project was to evaluate Optiva applied at manufacturer-recommended rates considered necessary to control foliar disease in tomato. Optiva was tested alone and in combination with an organic copper fungicide, another foliar biopesticide (MilStop) as well as with Serenade Soil, a new soil-applied biopesticide capable of inducing plant resistance. This objective to evaluate Optiva was substituted for the proposed objective to re-evaluate Sonata at the manufacturer’s request when this new product became available.

Another objective was to evaluate Regalia used in combination with a copper fungicide. The goal was to determine whether this established biopesticide is more effective when applied weekly at a low rate or every 14 days at a high rate in a fungicide program with a copper fungicide.

A third objective was to evaluate a recently registered biopesticide, Double Nickle.

Additionally, two biopesticides at the early stage of development, BWN127N and BWN130N developed by Bioworks, Inc., were tested individually and in combination.

All treatments were compared to a copper fungicide (Cueva), which continues to be an organic standard and a conventional standard fungicide (chlorothalonil formulated as Bravo).

Materials and Methods

two biopesticides at the early stage of development, BWN127N and BWN130N developed by Bioworks, Inc., were tested individually and in combination.

The following biopesticides at the Demonstration Stage were selected for evaluation.

1. Actinovate AG. 0.0371% Streptomyces lydicus strain WYEC 108. EPA Reg. No. 73314-1. OMRI-listed. Natural Industries, Inc.
2. Double Nickel 55 LC. 98.8% Bacillus amyloliquefaciens strain D747. EPA Reg No. 70051-107. OMRI-listed. Certis USA, LLC.
4. Optiva (aka Serenade Optimum). 26.2% Bacillus subtilis strain QST 713. This bacterium produces compounds that affect pathogens directly and trigger metabolic pathways to activate the plant’s natural defenses and modulate growth. EPA Reg. No. 264-1160. OMRI-listed. Bayer CropScience.

6. **Serenade Soil.** 1.34% *Bacillus subtilis* strain QST 713. This bacterium colonizes roots and produces compounds that affect pathogens directly and trigger metabolic pathways to activate the plant’s natural defenses and modulate growth. EPA Reg. No. 69592-12. OMRI-listed. Bayer CropScience (formerly AgraQuest, Inc.).

The following treatments were used. With the exception of Serenade Soil, all products tested were applied to foliage on a 7-day schedule. These treatments were developed in cooperation with the manufacturer.

1. Non-treated.
2. Optiva at 24 oz/A
3. Serenade Soil at 2 qt/A as soil drench treatment after transplanting.
   - Optiva at 24 oz/A
4. Optiva at 24 oz/A on a 14-day schedule alternated with
   - Cueva at 2 qt/A on a 14-day schedule
5. Double Nickle LC at 1 qt/A tank-mixed with
   - Cueva at 2 qt/A.
6. MilStop at 2.5 lb/A tank-mixed with
   - Optiva at 24 oz/A on a 14-day schedule.
7. Regalia at 1 qt/A tank-mixed with
   - Cueva at 2 qt/A.
8. Regalia at 2 qt/A alternated with
   - Cueva at 2 qt/A.
9. Actinovate 6 qt/A + Nu-Film P.
10. Actinovate 6 qt/A on a 14-day tank-mixed schedule with
    - Badge X 2 qt/A.
11. BWN127N 2% v/v
12. BWN130N 1.5% v/v
13. BWN127N 2% v/v + BWN130N 1.5% v/v
15. Bravo Ultrex 1.3 – 1.8 lbs/A (rate increased over time)(Conventional Standard)

Nu-Film P was applied with Actinovate at the equivalent rate of 0.30% v/v.
The experiment was conducted at the Long Island Horticultural Research and Extension Center in Riverhead, NY, in a field with Haven loam soil that has been dedicated to research on evaluating fungicides on organically-produced crops. Organic fertilizer at 105 lb/A N was spread over rows to be planted, then incorporated. Three products were used each at 700 lb/A: Pro-Grow 5-3-4, Cheep Cheep 4-3-3, and 6-0-6 Cotton seed blend. Next drip tape was laid as the rows were covered with black plastic mulch. Annual ryegrass was planted between plastic mulch to establish a living mulch by broadcasting seed with a hand-operated spreader. The ryegrass plus weeds that grew were mowed routinely. Some weeds were removed by hand.

Seeds of tomato variety ‘Jasper’ were sown on 17 May in the greenhouse. This variety was selected because it has resistance to late blight and has exhibited good susceptibility to Septoria leaf spot, the primary disease of interest in this experiment. Seedlings were transplanted on 21 Jun by hand into holes opened in the plastic mulch by a Waterwheel transplanter that also placed in the holes starter fertilizer, Neptune’s Harvest Benefits of Fish (2-4-1 N-P-K). Plants were staked and trellised following standard procedure for fresh-market tomato production.

Plots consisted of 10 plants in a single row with 24-in plant spacing and 68-in row spacing. There was 5-ft spacing between plots in a row. Plots for each of the 4 replications were in 2 adjacent rows. There was a spreader row planted between each replication and to the west of the last row of plots. A completely randomized block design with four replications was used.

Serenade Soil was applied on 26 June as a drench around the base of plants in Treatment #3. Actinovate was applied on 20 June as a drench around the base of plants in Treatments #9 & 10. Foliar treatment applications were made using a CO₂-pressurized backpack sprayer with a boom that has a single twin-jet nozzle (TJ60-11003) delivering 50 gal/A at 54 psi. Each side of the planted row was treated with the boom held sideways to obtain thorough coverage of foliage mimicking a drop nozzle on a tractor sprayer. A preventive 7-day application schedule was used. Applications were made on 16, 20, and 27 Aug and on 6, 13, 17, and 24 Sept.

Leaves were examined routinely for disease symptoms. Disease severity was assessed by counting number of leaves with symptoms when incidence was low. When symptoms were more common, estimations were made of the percentage of leaves in each plot with symptoms (incidence) and the severity of symptoms on these affected leaves. Canopy severity was calculated with these values. Defoliation was assessed as percent of leaves that had died.

Average monthly high and low temperatures (°F) were 78/61 in June, 86/71 in July, 80/64 in Aug, 74/57 in Sep, and 67/51 in Oct. Rainfall (inches) was 9.92, 3.07, 2.43, 2.62, and 0.19 for these months, respectively.

**Results and Discussion**

During the 2013 growing season conditions became progressively less favorable for development of foliar diseases with declining rainfall.

No significant differences were detected among treatments in amount of leaves affected by Septoria leaf spot (Table 1). The biopesticide treatment with the lowest values on the first three assessments was Optiva alternated with Cueva.

No significant differences were detected among treatments in amount of leaves affected by powdery mildew (Table 2). Three biopesticide treatments had low values on the first three assessments: Double Nickle + Cueva, Regalia + Cueva, and Actinovate + Badge X.
### Table 1. Efficacy of biopesticides evaluated for Septoria leaf spot in tomato and compared with the fungicides Bravo and Cueva, used as standards for conventional and organic growers. Efficacy was assessed in terms of incidence of affected leaves (percentage of leaves with symptoms).

<table>
<thead>
<tr>
<th>Treatment and rate/A (application dates)</th>
<th>18 Sep</th>
<th>26 Sep</th>
<th>2 Oct</th>
<th>9 Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Control</td>
<td>35.0</td>
<td>55.0</td>
<td>22.5</td>
<td>37.5</td>
</tr>
<tr>
<td>Optiva 24 oz (1-7)</td>
<td>25.0</td>
<td>61.3</td>
<td>27.5</td>
<td>20.0</td>
</tr>
<tr>
<td>Soil Serenade drench; Optiva 24 oz (1-7)</td>
<td>25.0</td>
<td>43.8</td>
<td>25.0</td>
<td>52.5</td>
</tr>
<tr>
<td>Optiva 24 oz (1,3,5,7); alt w/ Cueva 2 qt (2,4,6)</td>
<td>7.5</td>
<td>20.0</td>
<td>10.0</td>
<td>32.5</td>
</tr>
<tr>
<td>Double Nickle 1 qt + Cueva 2 qt (1-7)</td>
<td>17.5</td>
<td>47.5</td>
<td>12.5</td>
<td>12.5</td>
</tr>
<tr>
<td>MilStop 2.5 lbs (1-7) + Optiva 24 oz (1,3,5,7)</td>
<td>35.0</td>
<td>43.8</td>
<td>40.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Regalia 1 qt + Cueva 2 qt (1-7)</td>
<td>27.5</td>
<td>57.5</td>
<td>37.5</td>
<td>55.0</td>
</tr>
<tr>
<td>Regalia 2 qt (1,3,5,7); alt w/ Cueva 2 qt (2,4,6)</td>
<td>35.0</td>
<td>51.3</td>
<td>12.5</td>
<td>22.5</td>
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<tr>
<td>Actinovatey 6 oz (1-7)</td>
<td>20.0</td>
<td>38.8</td>
<td>10.0</td>
<td>47.5</td>
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<tr>
<td>Actinovate 6 oz (1-7) + Badge X 2 qt (2,4,6)</td>
<td>22.5</td>
<td>51.3</td>
<td>10.3</td>
<td>37.5</td>
</tr>
<tr>
<td>BWN127N 1.5% v/v (1-7)</td>
<td>22.8</td>
<td>57.5</td>
<td>17.5</td>
<td>20.0</td>
</tr>
<tr>
<td>BWN130N 1.5% v/v (1-7)</td>
<td>22.8</td>
<td>50.0</td>
<td>22.5</td>
<td>30.0</td>
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<tr>
<td>BWN127N 2% v/v + BWN130N 1.5% v/v (1-7)</td>
<td>25.3</td>
<td>33.8</td>
<td>25.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Cueva 2 qt (1-7) (Organic Standard)</td>
<td>2.5</td>
<td>35.0</td>
<td>40.0</td>
<td>35.0</td>
</tr>
<tr>
<td>Bravo Ultrex 1.3–1.8 x (1-7) (Conventional Std)</td>
<td>5.0</td>
<td>36.3</td>
<td>2.5</td>
<td>12.5</td>
</tr>
</tbody>
</table>

| P-value (treatment)                     | 0.5616 | 0.8375 | 0.6926 | 0.0438 |

- Rate of formulated product/A. Soil drench on 6/20, and 6/26. Foliar application dates were 1=8/16, 2=8/20, 3=8/27, 4=9/6, 5=9/13, 6=9/17, and 7=9/24.
- Actinovate was applied with Nu-Film P.
- Rate increased over time.
Table 2. Efficacy of biopesticides evaluated for powdery mildew in tomato and compared with the fungicides Bravo and Cueva, used as standards for conventional and organic growers. Efficacy was assessed in terms of incidence of affected leaves (percentage of leaves with symptoms).

<table>
<thead>
<tr>
<th>Treatment and rate/A (application dates)</th>
<th>Powdery mildew incidence (% leaves affected)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18-Sep</td>
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<tr>
<td>Untreated Control</td>
<td>10.0</td>
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<tr>
<td>Optiva 24 oz (1-7)</td>
<td>17.5</td>
</tr>
<tr>
<td>Soil Serenade drench; Optiva 24 oz (1-7)</td>
<td>10.0</td>
</tr>
<tr>
<td>Optiva 24 oz (1,3,5,7); alt w/ Cueva 2 qt (2,4,6)</td>
<td>0.0</td>
</tr>
<tr>
<td>Double Nickle 1qt + Cueva 2 qt (1-7)</td>
<td>0.0</td>
</tr>
<tr>
<td>MilStop 2.5 lbs (1-7) + Optiva 24 oz (1,3,5,7)</td>
<td>0.0</td>
</tr>
<tr>
<td>Regalia 1 qt + Cueva 2 qt (1-7)</td>
<td>5.0</td>
</tr>
<tr>
<td>Regalia 2 qt (1,3,5,7); alt w/ Cueva 2 qt (2,4,6)</td>
<td>5.0</td>
</tr>
<tr>
<td>Actinovate (^T) 6 oz (1-7)</td>
<td>0.0</td>
</tr>
<tr>
<td>Actinovate 6 oz (1-7) + Badge X 2 qt (2,4,6)</td>
<td>2.5</td>
</tr>
<tr>
<td>BWN127N 2% v/v (1-7)</td>
<td>17.5</td>
</tr>
<tr>
<td>BWN130N 1.5% v/v (1-7)</td>
<td>5.0</td>
</tr>
<tr>
<td>BWN127N 2% v/v + BWN130N 1.5% v/v (1-7)</td>
<td>2.5</td>
</tr>
<tr>
<td>Cueva 2 qt (1-7) (Organic Standard)</td>
<td>0.0</td>
</tr>
<tr>
<td>Bravo Ultrex 1.3–1.8 x (1-7) (Conventional Std)</td>
<td>2.5</td>
</tr>
</tbody>
</table>

\(^z\) Rate of formulated product/A. Soil drench on 6/20, and 6/26. Foliar application dates were 1=8/16, 2=8/20, 3=8/27, 4=9/6, 5=9/13, 6=9/17, and 7=9/24.

\(^y\) Actinovate was applied with Nu-Film P.

\(^x\) Rate increased over time.
December 6, 2013

Timothy Johnson, PhD  
Global Product Development Director  
Northeast U.S. and International  
Marrone Bio Innovations  
14 Baldtop Heights  
Danville, PA 17821

IR-4 Project Headquarters  
Attn: Michael Braverman  
Biopesticide and Organic Support Program Manager  
500 College Road East Suite 201 W  
Princeton, NJ 08540-6635

Re: Proposal Titled “Efficacy of Biofungicide Product at the Early Stage of Development for Downy Mildew in Cucumber”

Dear Dr. Braverman:

I am writing in support of this proposal to evaluate various rates of a newly discovered isolate of *Bacillus amyloliquifaciens* alone and in combination with other fungicides for control of downy mildew on cucumber. Currently, cucumber producers have a limited number of options available for this perennial pest and the options that are available for organic producers are very limited in number and lack strong efficacy. Additionally, the threat of the development of resistance strains of downy mildew is a constant threat to all cucumber producers. We believe that MBI-110 could be a viable component for management of downy mildew in organic and conventional production.

Marrone Bio Innovations discovered this specific isolate while screening microorganisms for activity against oomycete diseases. Initial field studies in 2013 were promising and we are rapidly advancing this isolate toward commercialization. At this date we do not have a draft label but I can provide one as soon as it is available and this should be in the first quarter of 2014. I anticipate that we will submit a broad rate range of 1 – 12 quarts per acre that will be reduced prior to commercial launch through extensive field studies and advances in process development.
Thank you for considering this grant proposal. If you have any questions, please feel free to contact me by email at tjohnson@marronebio.com or by phone at 570-441-8775.

Sincerely,

Timothy B. Johnson

Dr. Timothy Johnson
Global Product Development Director
Marrone Bio Innovations
Appendix 1—Registrant Questionnaire

Please fill out the first page of this form for each crop/biopesticide combination and send to the registrant.

Registrant please return to IR-4 Project Headquarters, Michael Braverman, Biopesticide and Organic Support Program Manager, 500 College Road East; Suite 201 W; Princeton, NJ 08540-6635, Tel: (732) 932-9575 ext. 4610, Fax: (609) 514-2612, braverman@aesop.rutgers.edu

Principal Investigator: __Margaret Tuttle McGrath_____________________________

Address: Long Island Horticultural Research and Extension Center
Cornell University______________________________
3059 Sound Ave., Riverhead, NY 11901 __________

Telephone: ______(631) 727-3595________________________

Proposal Title: __Efficacy of Biofungicide Product at the Early Stage of Development for Downy Mildew in Cucumber ______________________

Registrant name and address: ____Marrone Bio Innovations, Inc.________________________
2121 2nd St # B107                                       ___
Davis, CA 95618________________________________

Product Name: __MBI-110_____ Active Ingredient: Bacillus amyloliquefaciens ____________
Trade Name: ____Not yet named________________________
The following section is to be completed by the Biopesticide Registrant. The PCR form is to be completed by the researcher for Early and Advanced Stage Proposals

1) Is this product EPA registered through BPPD? Yes____X____ No________

Is this use anticipated to be covered by the submitted label? Yes____X____ No________

If this product is not yet registered with EPA, describe where you are at in collecting the toxicology data or Stage of the registration process. If this project was previously funded, describe how the registration status has changed since last year. Toxicology work is nearing completion and a registration package is expected to be submitted to EPA very early in the first quarter of 2014.

Is label and toxicology work currently limiting product only to non-food uses? No

2) Assuming the efficacy data are favorable, what is the likelihood that this use will be added to your label? 100%, Oomycete diseases are the focus of this product.

3) Considering the use rate(s), what is considered to be the farm-level cost for the treatment in $/acre? $25 – 50.

4) How would you rank the importance of the proposed use compared to other potential uses? Very high

5) If you are only considered a potential registrant (do not currently own rights to the product), rank your degree of interest in this product.

6) Were you involved or consulted in the development of the treatments or proposal? Yes

7) What financial support are you planning on providing, if any? None. MBI will be providing financial support for an evaluation program to determine the effectiveness of MBI-110 for control of P. infestans on tomato and potato.

__________________________       _______________________
Timothy B. Johnson                      December 6, 2013
Name of Registrant representative

____________________________
Global Product Development Director

Other comments – Please attach a letter of support for this project by December 9, 2013
The Golden Earthworm Organic Farm
652 Peconic Bay Blvd.
P.O. Box 871
Jamesport, NY 11947
722-3302 (phone) 722-8166 (fax)

December 5, 2013

Dr. Michael Braverman
Biopesticide and Organic Support Program Manager
IR-4 Project, Rutgers University
Technology Centre of New Jersey
681 U.S. Highway 1 South
North Brunswick, New Jersey 08902-3390

Dear Dr. Braverman,

I am writing in support of Meg McGrath's research on the efficacy of biopesticides for managing downy mildew in cucumbers. It has not been possible to produce an adequate crop of cucumbers in the fall in recent years because of downy mildew. This has been unfortunate because our customers want cucumbers as late into the fall as we can produce them. Other organic growers in this area have had similar problems with this disease.

Several of the biopesticide type products that Meg has evaluated in the past and plans to evaluate next year are approved for organic production. Having comparative data on the performance of these products, especially from Meg’s plots where environmental conditions and disease pressure are likely very similar to mine since we are in the same area, is very valuable for me and other organic growers on Long Island, and also for non-organic growers interested in using environmentally friendly products. Through Meg’s work I have learned about several products I was not aware were available, likely because they are produced by small companies with minimal resources for advertising, and I am gaining information that enables me to select an effective and economic product. As Meg has already shown through her work, products labeled for powdery mildew on cucurbits vary in their effectiveness with some being ineffective.

I appreciate your considering Meg’s proposal for funding.

Regards,

James Russo