**PROJECT TITLE:** Biopesticides for ornamental production and landscape use: Creating a database of efficacy information and training people to use it

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**Summary**

As users look for alternatives to conventional pesticides for disease and insect management, sales of biopesticides in the US are increasing. There are many advantages to using biopesticides, including reduced toxicity to applicators and fewer undesirable environmental effects, their potential as rotational products to reduce the development of pesticide resistance, short restricted entry periods that fit well into production and landscape uses, and compatibility with biological control organisms. However, it can be difficult to find a single source where ornamental growers and landscape professionals can compare the efficacy of products, including biopesticides. Growers indicated that not knowing if biopesticides work and needing more information on how to use them limited their use. We created a database of biopesticides labeled for management of insect, disease, and weed pests of ornamental crops and landscapes by collating information gathered from a set of sources to provide growers with one resource for comparing the efficacy of these pesticides. Data were converted into a single efficacy rating while still including as much original information as possible. The database has information on 13 insect pest types, 19 diseases, grass and broadleaf weeds, 30 biofungicides plus additional strains and combinations, and 8 bioinsecticides plus additional strains and combinations. To make this database more easily used, a system allowing growers to input search terms relevant to their own operations to retrieve only the results with value to them will be created and presented to the ornamentals industry.

**Background and Justification**

As users look for alternatives to conventional pesticides for disease and insect management, sales of biopesticides in the US are increasing – from 900,000 to 4.1 million pounds over the period 2000-2012 (EPA, 2015). The EPA defines biopesticides as pesticides derived from natural materials, including microbial pesticides (EPA, 2016).

The advantages of using biopesticides include reduced toxicity to applicators and fewer undesirable environmental effects, their potential as rotational products to reduce the development of pesticide resistance, short restricted entry periods that fit well into production and landscape uses, and compatibility with biological control organisms. Biopesticides can be an important part of integrated pst management program (Arthurs and Dara, 2019).

As of 2019, 26 microbial products were registered for insect pests of greenhouse and nursery crops (Arthurs and Dara, 2019) and there are other products derived from organisms and minerals that are also labeled for ornamental insects and diseases. A wide variety of articles in trade journals promote the use of biopesticides to growers (e.g. Stivers and Benner, 2018). However, it is difficult to find a single source where growers can compare efficacy of products. In part, the diversity of both ornamental crops and products is to blame. It is also difficult to concisely compare data over the breadth of efficacy evaluations with differing methods and combinations of products. For an example of biopesticide efficacy summaries by Dunn, see https://nysipm.cornell.edu/environment/biocontrol/biocontrol-resources/biopesticide-efficacy-summaries/ While she has previously created a summary of biopesticide efficacy for disease management in greenhouse, nursery and ornamental crops, this project would update the existing information and expand it to include insect management and landscape settings.

One specific issue that can benefit from this database is the identification of alternatives for neonicitinoid insecticides to assist with pollinator protection in ornamentals production and landscapes. There are other pesticides that are no longer effective, or could be removed from the market, for which biopesticide alternatives would be welcome.

In 2019, there were 978 operations selling horticultural specialty crops, with over $309 million in sales (NASS, 2019). New York ranks 6$^{th}$ in Christmas tree sales and 10$^{th}$ in floriculture sales in the nation (NASS 2018). In 2020, Farm Credit East reported that in New York, greenhouse, nursery and floriculture production had a $613 million economic impact and employed 6,303 people. The economic impact of landscape services in the state was $ 5,737 million with 59,239 employed. Increasing biopesticide use to increase the sustainability of these industries would result in clear benefits to human health and the environment.

In order to increase biopesticide use, it is necessary to provide potential users with clear and easily found information on product efficacy and how these products can fit into disease and

insect management plans. In addition to creating the efficacy database, we will provide growers and landscape professionals information on effective use of biopesticides and its advantages through presentations at meetings and webinars, and promotion of the database through social media. Both Dunn and Lamb have experience presenting to ornamental producer and landscape organizations, and have blogs/listservs reaching those populations.

**Objectives**

1. Conduct a literature review of primary sources to create a database of efficacy of biopesticides labeled for management of diseases and insects in ornamental production and landscapes.

2. Present information on the uses of biopesticides and the efficacy data to grower and landscape professional audiences

3. Evaluate use of biopesticides by these audiences before and after presentations. Identify a group of attendees for additional questions on environmental and economic effects of use of biopesticides.

**Approach/Methods**

This project is based on a literature review to collect research results on pesticide trials including biopesticides to create a database of efficacy information. Dunn has already created a template and a procedure, with some examples of where to find information. The person hired for this position will need persistence and attention to detail as gathering the information can be time consuming and difficult to collate.

Once the database is completed, it will serve as the basis for user training, concentrating on ornamentals producers and landscape professionals. Information on types of biopesticides, including modes of action and the best uses for different products, will be combined with training on where to find the database and how to use it. This training can take place as part of the annual education season in late winter, with Extension run grower meetings, industry training sessions from the NYS Turf and NYS Nursery Landscape associations and NYS Flower Industries. It can also be archived as recorded presentations or webinars.

As part of these trainings, pre and post tests will be used to determine current use of biopesticides and intent to change practice to increased use of biopesticides. Active learning techniques, including electronic polling, during presentations will allow us to gather additional information on attendee understanding of biopesticides and their use. We will also identify some attendees who are willing to provide us additional information on pesticide expenditures and comparison of pesticides before and after using biopesticides, using a tool such as the Environmental Impact Quotient (https://nysipm.cornell.edu/eiq/). This will allow us to evaluate

the economic and environmental effects of the change. This last activity may need to occur outside of the funding period.

To reach a larger number of people, information on the database and how to use it will also be sent out on social media, including blog posts and listserv emails.

**Results and Discussion**

The background for this project was laid in advance – educating growers on what biopesticides are and how to use them for the best effect, and learning what growers see as the barriers to adoption. The most common answers on barriers (growers at the Long Island Ag Forum in January 2020) were not knowing if biopesticides work (41%) and needing more information on how to use them (24%). To answer those questions with a grower-oriented and on-line resource, a database of efficacy information on biopesticides for insect, disease and weed management in ornamentals was created. This was added as an extra facet of an existing project on collecting efficacy data over all pesticides for ornamentals. Mary Thurn was hired to collect and organize the materials needed for the database.

To create the database, data from pesticide efficacy trials was collated from a variety of sources for the last 20 years. The primary sources are:

Plant Disease Management Reports - (https://www.plantmanagementnetwork.org/pub/trial/pdmr/)
Arthropod Management Tests (https://academic.oup.com/amt)
IR-4 Project Entomology Efficacy
IR-4 Weed Science Efficacy
IR-4 Plant Pathology Efficacy
(https://www.ir4project.org/ehc/ehc-registration-support-research/env-hort-grower-resources/)

While there may be additional information available, most university or Extension scientists report their findings through these sources.

Because ornamentals are a very diverse set of species - including herbaceous and woody plants, grown in a variety of settings, creating an organized list is difficult. Also, not all tests use the same rating methodologies or production practices. Mary created a system for comparing results across sources (Table 1) as well as including as much original information as possible (Table 2). The database has information on 13 insect pest types, 19 diseases, grass and broadleaf weeds, 30 biofungicides plus additional strains and combinations, and 8 bioinsecticides plus additional strains and combinations.

Table 1: Efficacy comparison system

| Efficacy rating key | Definition |
|---|---|
| ++ | very effective; statistically as good as the most effective treatment in the trial |
| + | effective; statistically not as good as the most effective treatment in the trial, but statistically better than the least effective treatment |
| +/- | somewhat effective; statistically equivalent to both the most and least effective treatments in the trial (in other words, there was a lot of variability) |
| - | not effective; statistically equivalent to the worst treatment in the trial |

Table 2: Information included in biopesticide database

| | | | |
|---|---|---|---|
| Active ingredient | Mode of action group | Product name | Rate |
| EPA Registration # | Manufacturer | Setting (greenhouse, nursery, field container, etc.) | Location of test (state) |
| Pest* | Scientific name of pest | Crop on which it was tested, including scientific name and cultivar if available | Efficacy rating |
| Efficacy comments | Severity of infestation/infection | Source of information | Trial year |
| % IMPROVEMENT treatment compared to non-treated control | PEST ASSESSMENT treatment | % IMPROVEMENT best treatment compared to non-treated control | PEST ASSESSMENT best control in study |
| PEST ASSESSMENT non-treated control | PEST ASSESSMENT unit | | |

*(insect, disease, weed – while pages for each major insect or disease type were created separately, there are different species within that group – for example, there are 6 different aphid species on the aphid page)

Table 3 shows a small part of the biopesticide database for insect management pesticides. At the base of the table, you can see that in addition to the Biopesticide specific table, there are pages by insect pest which include the same information for all pesticides listed in the sources. There is similar information for fungicides and for herbicides.

You can perhaps appreciate from this table the difficulty a grower might have in using the database for identifying an appropriate biopesticide for a particular crop and setting. For example, there are 4 biopesticides tested for efficacy against red headed flea beetle on a subset of 3 crops and 5 cultivars of one of those crops by 4 researchers who don't all use similar systems of rating/testing. We have initiated but not completed the creation of a search system where growers can input information from their operations which will help them retrieve only the results with value to them. A simplified version of the table will be posted on the NYS IPM website at https://nysipm.cornell.edu/environment/biocontrol/biocontrol-resources/biopesticide-efficacy-summaries/ by the middle of April 2022 (there is an existing, older version without insect and weed management or landscape uses there currently).

Table 3: Visual of part of the biopesticide database for insecticides

| Active ingredient(s) | IRAC Group Number | Biopesticide | Genus species | Crops | Efficacy rating | Efficacy comments |
|---|---|---|---|---|---|---|
| *Bacillus thuringiensis galleriae* strain SDS-502 | 11A | yes | *Systena frontalis* | *Hydrangea paniculata* 'Grandiflora' 'Pee Gee' hydrangea | - | 2 applications (foliar spray), 7-day interval; not effective, statistically equivalent to non-treated control. |
| *Bacillus thuringiensis galleriae* strain SDS-502 | 11A | yes | *Systena frontalis* | *Forsythia* sp. forsythia | + | 3 applications (foliar spray), 7-day interval; significantly less damage than non-treated control, but not as effective as best trt in the trial (Upstar-Gold). |
| *Bacillus thuringiensis galleriae* + ? strain SDS-502 | 11A + ? | yes + ? | *Systena frontalis* | *Forsythia* sp. forsythia | ++ | 3 applications (foliar spray), 7-day interval; significantly less damage than non-treated control, statistically equivalent to best trt in the trial (Upstar Gold). |
| *Beauveria bassiana* strain GHA | UNF* | yes | *Popillia japonica* | *Rosa* sp. 'Louis Phillippe' | - | 2 applications (foliar spray), 7-day interval; not effective, statistically equivalent to non-treated control. |
| *Beauveria bassiana* strain GHA | UNF* | yes | *Popillia japonica* | *Rosa* sp. | - | 2 applications (foliar spray), 7-day interval; not effective, statistically equivalent to non-treated control. |
| | | | | | + | 2 applications (foliar spray), 7-day interval; significantly less damage than non-treated control, but not as effective as best |

Notes | BIOPESTICIDE | APHIDS | COLEOPTERA | CRANE FLY | LEAFMINER | LEAFHOPPER | MEALYBUG

We intended to present the information on the database to a broad range of growers and green industry personnel. The information was finalized later than expected and there were fewer than expected opportunities to present it. It was presented to a group of 40 Cornell Cooperative Extension 'multipliers' at the Agriculture, Food & Environmental Systems In-Service in November 2021 and to a greenhouse grower audience of 15 in Erie County in February 2021. For the grower audience, we incorporated active learning activities to help engage the audience in understanding biopesticides and how to incorporate them into a production system (Figure 1).

Figure 1:  Growers indicating with smiley face cards (yellow=yes, green=no, orange=unsure or confused) their choices in an active learning session on biopesticides, East Aurora, 2.9.22

Next steps include finalizing the search system and creating a 'how to' document, and advertising those through the list servs we manage for greenhouse and nursery ornamentals, and landscape professionals, and at future programs. Identifying growers who use, or start to use, biopesticides for a comparison of economic and environmental impacts would provide additional tools to encourage growers to include biopesticides in their pest management 'toolbox', and we will work to find a focus group for that purpose.

**Outcomes and Impacts**

Most of the growers at the February presentation (83%) were already using some biopesticides and the remainder (27%) indicated that they would add a biopesticide to their pest management program because of the information they learned at the presentation.

In addition, half of the respondents answered 'biopesticides' for the open-ended question "During the session, what did you learn to help make more informed decisions for your horticulture business, or those you support in the Horticulture industry?" after hearing 5 topics discussed.

While this project is only peripherally connected, NYS IPM is expected to receive additional funding starting in 2022 in part based on its programming on alternatives to neonicitinoid insecticides and other pesticides that negatively affect pollinators. This database will provide ornamentals growers and the landscape industry with efficacy information on alternatives to pesticides with negative environmental consequences or those removed from the market.

Presentations:

Agriculture, Food & Environmental Systems In-Service, Cornell Cooperative Extension (virtual), November 15, 2021, Biopesticide and biocontrol resources – 40 participants

Winter Greenhouse Growers School, East Aurora NY, February 9, 2022, - 15 participants