

V(A). Planned Program (Summary)

Program # 4

1. Name of the Planned Program

Climate Change- low-impact alternatives for ornamental crop production

Reporting on this Program

V(B). Program Knowledge Area(s)

1. Program Knowledge Areas and Percentage

KA Code	Knowledge Area	%1862 Extension	%1890 Extension	%1862 Research	%1890 Research
133	Pollution Prevention and Mitigation				5%
211	Insects, Mites, and Other Arthropods Affecting Plants				70%
212	Pathogens and Nematodes Affecting Plants				20%
605	Natural Resource and Environmental Economics				5%
	Total				100%

V(C). Planned Program (Inputs)

1. Actual amount of FTE/SYs expended this Program

Year: 2012	Extension		Research	
	1862	1890	1862	1890
Plan	0.0	0.0	0.0	23.8
Actual Paid Professional	0.0	0.0	0.0	16.5
Actual Volunteer	0.0	0.0	0.0	0.0

2. Actual dollars expended in this Program (includes Carryover Funds from previous years)

Extension		Research	
Smith-Lever 3b & 3c	1890 Extension	Hatch	Evans-Allen
0	0	0	834150
1862 Matching	1890 Matching	1862 Matching	1890 Matching
0	0	0	834150
1862 All Other	1890 All Other	1862 All Other	1890 All Other
0	0	0	697998

V(D). Planned Program (Activity)

1. Brief description of the Activity

Identify new pesticide, biopesticide, and treatment methodologies for container and field-grown nursery stock to manage disease and insect problems.
 Determine the lowest effective rates for synthetic petroleum-based pesticides and develop new reduced rate insecticide / biopesticide combinations.
 Identify new biopesticides that can substitute for synthetic petroleum-based pesticides and reduce worker exposure risk and environmental impact.
 Release phorid-decapitating flies in Tennessee to provide imported fire ant biological control.
 Provide extension training and literature to producers on imported fire ant and Japanese beetle management and train students in pest management and research techniques.
 Provide data to support new treatments in the Domestic Japanese Beetle Harmonization Plan and the Federal Imported Fire Ant Quarantine, as well as data to support new insecticide label amendments.
 Conduct assessment of current and future energy use by greenhouse and nursery businesses.
 Identify alternative energy sources for the greenhouse and nursery industry.
 Hold focus group meetings with greenhouse and nursery business owners.

2. Brief description of the target audience

Nursery growers, extension specialists, consumers and policy makers.
 Regulatory agencies (e.g., U.S. Environmental Protection Agency, USDA-APHIS, Tennessee Department of Agriculture).
 Agrochemical manufacturers.

3. How was eXtension used?

A webinar for the Imported Fire Ant eXtension Community of Practice was presented on 10 May 2012. The webinar had 126 viewers at the time it was given, not counting a group of school children that also participated. The presentation is also archived on the eXtension website for continued viewing at <http://www.extension.org/pages/33719/fire-ant-webinars>. Scientists reviewed 27 eXtension webpages for the Imported Fire Ant CoP as required for before online publishing and participated in annual CoP planning meetings. TSU scientists co-organized the 2012 Annual Imported Fire Ant Conference in Nashville, TN. TSU served as the lead institution in hosting the meeting. The Imported Fire Ant eXtension CoP met during a special session of the Conference.

V(E). Planned Program (Outputs)

1. Standard output measures

2012	Direct Contacts Adults	Indirect Contacts Adults	Direct Contacts Youth	Indirect Contacts Youth
Actual	1237	0	460	0

2. Number of Patent Applications Submitted (Standard Research Output)
Patent Applications Submitted

Year: 2012

Actual: 0

Patents listed

3. Publications (Standard General Output Measure)

Number of Peer Reviewed Publications

2012	Extension	Research	Total
Actual	6	9	15

V(F). State Defined Outputs

Output Target

Output #1

Output Measure

- Workshops to inform producers about alternative insect control methodologies.

Year	Actual
2012	4

Output #2

Output Measure

- Disease resistant cultivars developed.

Year	Actual
2012	1

Output #3

Output Measure

- Extension factsheets about alternative methods to control disease and insects in nursery production.

Year	Actual
2012	2

Output #4

Output Measure

- Workshops held to inform/encourage nursery producers about alternative energy use.

Year	Actual
2012	0

Output #5

Output Measure

- Extension publications to inform nursery and greenhouse growers about alternative energy options.

Year	Actual
2012	0

V(G). State Defined Outcomes

V. State Defined Outcomes Table of Content

O. No.	OUTCOME NAME
1	Number of producers educated on proper management of invasive pests through presentations and workshops.
2	Number of producers educated on proper management of invasive pests through publications and factsheets.
3	Number of new treatments for invasive pests.
4	Number of new reduced-risk treatments developed for invasive pests.
5	Number of new treatments for invasive pests approved by quarantine regulatory agencies.
6	Number of confirmed establishments of new invasive pest parasites.
7	Number of producers informed about new or emerging diseases.
8	Number of producers informed about new biological control treatments.
9	Number of producers informed about new sources of host resistance.
10	New cultivars exhibiting disease resistance available to growers.
11	Organisms identified as potential biocontrol candidates.
12	Number of biological control product efficacy tests conducted for invasive insect control.
13	Number of new product registrations for biological control of invasive insects.
14	Number of nursery/greenhouse operators trained on alternative energy use.
15	Number of nursery/greenhouse operators utilizing alternative energy.

Outcome #1

1. Outcome Measures

Number of producers educated on proper management of invasive pests through presentations and workshops.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	944

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Invasive pest species disrupt natural ecosystems and are detrimental to agriculture because they exhibit rapid population growth that can cause greater crop damage and harm to human health and welfare. Multiple invasive pests now impact the U.S. nursery industry. Many producers must manage multiple invasive pests simultaneously with limited, ineffective, and costly treatments, which threatens economic viability and undermines integrated pest management efforts. Producer education via workshops and other training outlets is essential for providing up to date information on rapidly evolving modifications to agro-ecosystems and guidance on successful and profitable control tactics.

What has been done

Producers and other agricultural stakeholders were trained at multiple workshop and educational venues on the latest management techniques developed from field research on invasive insects.

Results

Producers were educated on proper management of invasive insects at several local, regional and national workshops, as well as thorough the filming at TSU of a documentary on imported fire ants by the British Broadcast Corporation for the "Nature's Weirdest" program (unknown number of viewers, but could be as high as 50,000+ including many agricultural producers). Total number of growers/stakeholders educated through direct presentations estimated at 566, not counting the BBC documentary. In addition, 378 direct requests were made for information on invasive pest management by producers, stakeholders, or extension personnel that serve producers.

4. Associated Knowledge Areas

KA Code	Knowledge Area
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133 Pollution Prevention and Mitigation
211 Insects, Mites, and Other Arthropods Affecting Plants

Outcome #2

1. Outcome Measures

Number of producers educated on proper management of invasive pests through publications and factsheets.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	350

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Due to time constraints with managing and running farm operations, as well as expense, some producers are not able to physically attend educational workshops to obtain information on management of invasive insects. As a result, publications, factsheets, and internet-available materials are another route to indirectly reach these producers and stakeholders with guidance, training, and the latest successful measures for effective and sustainable pest management.

What has been done

Producers and stakeholders were educated by multiple printed and internet-based outlets.

Results

We conservatively estimate 200+ producers/stakeholders per year are likely viewing the eXtension IFA materials developed or reviewed by our program. In addition, we estimate at least 100 producers/stakeholders per year are viewing online extension publications at the TSU Cooperative Extension website and online cooperative reports at the USDA-APHIS Imported Fire Ant website based on the 378 direct requests for information that we received (i.e., 1/3 the amount of total direct requests). Lastly, we gave about 50 copies of a new extension publication on Camphor shot borer directly to nursery and forestry producers at educational meetings and workshops.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #3

1. Outcome Measures

Number of new treatments for invasive pests.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Treatment methods for cleansing nursery stock of imported fire ant, Japanese beetle, and numerous non-indigenous ambrosia beetles are expensive, hazardous, impractical or ineffective, and often result in shipping delays. Imported fire ant treatment methods like the Federal drench protocol are hazardous due to producer handling exposure and early site re-entries, labor intensive, and expensive. Most treatments for these pests rely on only a few active ingredients, providing producers with only limited alternatives. New biopesticide treatments that are under development may have a role in reducing climate change by offering producer alternatives for synthetic petroleum based agrochemical inputs. Invasive borers also have major impacts on forest systems and landscape plantings supplied by the nursery industry, which serve as important carbon-sinks, so improved treatments for borers may indirectly reduce climate change. It is also important that new treatments are made available to producers through modifications of federal and state regulations governing these quarantine pests.

What has been done

Research with a new in-field drench treatment for imported fire ant and Japanese beetle larvae utilizing common grower-accessible items (5-gallon buckets; Tree Rings) has continued during this reporting period. Multiple biopesticides and conventional products were evaluated alone and in combination with a pesticide synergist. In addition, pre-harvest surface treatments targeting Japanese beetle larvae using several new and low cost generic imidacloprid compounds were performed. Data from the pre-harvest generic imidacloprid testing were shared with the U.S. Domestic Japanese Beetle Harmonization Plan (JBHP) Regulatory Treatments Committee for consideration as new treatments in the JBHP. Data were also shared with agrochemical

companies producing to facilitate any necessary label modifications.

Results

Rates and drench volumes are still being evaluated for the in-field drench treatments we are testing. Efforts are focusing on reducing the cost, while still maintaining treatment efficacy against imported fire ants and Japanese beetle. Soil and burlap samples harvested from root balls continue to provide 100% alate imported fire ant control at all post-harvest sampling intervals. For the pre-harvest surface treatment evaluations of generic imidacloprid, we collected data that demonstrate Lada 2F Insecticide, Mallet 2F T&O Insecticide, and Quali-Pro Imidacloprid 2F T&O Insecticide generic products were as effective as current JBHP approved insecticides. These data have been shared with the JBHP Regulatory Treatment Review Committee for consideration as new treatments in the JBHP.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #4

1. Outcome Measures

Number of new reduced-risk treatments developed for invasive pests.

Not Reporting on this Outcome Measure

Outcome #5

1. Outcome Measures

Number of new treatments for invasive pests approved by quarantine regulatory agencies.

Not Reporting on this Outcome Measure

Outcome #6

1. Outcome Measures

Number of confirmed establishments of new invasive pest parasites.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Condition Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	1

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

To slow imported Fire Ant (IFA) spread and provide region-wide sustainable suppression of IFA populations, the USDA has an on-going classical biocontrol program to establish phorid-decapitating fly parasitoids of IFA in the US. There are about 20 species of Pseudacteon flies in South America, which exhibit niche partitioning of IFA by worker size, species, activity (foraging, mating flights), and time of day. Therefore, to effectively manage IFA with Pseudacteon flies, it will likely require introductions of a suite of fly species.

What has been done

Multiple Pseudacteon species have been released in Tennessee over several years, including *P. curvatus* (Formosan and Los Flores biotypes), *P. tricuspidis*, and *P. obtusus*. *P. obtusus* was released in Tennessee for the first time in three middle Tennessee counties, including Moore (2009), Sequatchie (2010 and 2012), and Franklin (2011).

Results

Efforts to recollect and confirm establishment of *P. tricuspidis* and *P. obtusus* have been unsuccessful to date. It may take several years for the newly released *P. obtusus* species to reach levels where field detection is possible. It is likely *P. tricuspidis* releases were ineffective, since other states have also not been successful in establishing this species at higher latitudes like Tennessee. The *P. curvatus* Los Flores biotype is now established statewide and was again confirmed at all of our sites where new species like *P. obtusus* are being released.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
211	Insects, Mites, and Other Arthropods Affecting Plants

Outcome #7

1. Outcome Measures

Number of producers informed about new or emerging diseases.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	37

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Nursery growers need to be informed about new and emerging diseases so they can be prepared for the disease by taking preventive measures and minimize the potential economic impact of the disease.

What has been done

Cherry Leaf spot is an emerging disease that can impact plant sales and increase production costs. Studies on the source of initial infection and the timing of infection establishment were performed to confirm previous results.

Results

Results have determined source of initial infection and how to avoid economic impact from this disease. Disease management strategies developed have confirmed previous results on effective fungicides and the timing of fungicide applications as well as cultural practices that can reduce disease incidence.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #8

1. Outcome Measures

Number of producers informed about new biological control treatments.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	36

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Nursery production systems use high rates of chemical fungicides to control powdery mildew of dogwood. This is detrimental to the environment and grower income by increasing dogwood production costs. Alternatives to chemical fungicides are desirable.

What has been done

Microorganisms isolated from dogwood leaves in the wild where chemical fungicides have not been used were isolated and some bacteria, fungi and yeast showed good potential in powdery mildew control. The organisms were evaluated for best application methods and their mechanism of action.

Results

Results confirmed previous studies showing two biological control bacteria had superior activity against powdery mildew. They not only reduce disease severity, they also improved plant growth. The bacteria produced some chemical metabolites that may be involved in disease control, these metabolites were isolated and characterized. The bacteria were applied through the roots and by foliar sprays and both methods produced positive results. The bacteria colonized the root endophytically.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #9

1. Outcome Measures

Number of producers informed about new sources of host resistance.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	35

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

The need for routine fungicide applications has increased dogwood production costs and even forced some small producers out of dogwood production. The availability of resistant plants that do not require fungicide applications will save money to producers, increase their net income from plant sales.

What has been done

A new generation of dogwoods that are resistant to powdery mildew are being introduced to the market. New powdery mildew resistant plants are generated from plant selections and from crosses made between selected plants followed by repeated evaluations and selections for disease resistance.

Results

About 10 selections are in the process of propagation and evaluation in replicated trials.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #10

1. Outcome Measures

New cultivars exhibiting disease resistance available to growers.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Disease resistance is the best method for disease control by producers. New generation of cultivars that are resistant to powdery mildew would be a great contribution to nursery growers in that they would not require routine fungicide applications.

What has been done

Powdery mildew resistant selections have been identified and characterized for release as new disease resistant cultivars.

Results

Two selections are ready for release as new powdery mildew resistant cultivars and five other lines are under evaluation.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #11

1. Outcome Measures

Organisms identified as potential biocontrol candidates.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	2

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Alternatives to fungicides in powdery mildew control are needed to reduce the number of fungicide applications. Biopesticides and biological agents provide good alternatives to chemical fungicide either individually or as part of an integrated disease management system.

What has been done

Research on how to integrate biological organisms or biodegradable biopesticides with host resistance was initiated.

Results

The integration of moderate resistance with biological agents and with biopesticides improved disease control. Results are preliminary at this stage.

4. Associated Knowledge Areas

KA Code	Knowledge Area
133	Pollution Prevention and Mitigation
212	Pathogens and Nematodes Affecting Plants

Outcome #12

1. Outcome Measures

Number of biological control product efficacy tests conducted for invasive insect control.

Not Reporting on this Outcome Measure

Outcome #13

1. Outcome Measures

Number of new product registrations for biological control of invasive insects.

Not Reporting on this Outcome Measure

Outcome #14

1. Outcome Measures

Number of nursery/greenhouse operators trained on alternative energy use.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Knowledge Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Increase in energy cost has raised the cost of operating greenhouse and nursery businesses in the last few years. This has a negative impact on profitability of their operations as well as on other issues such as employment and capacity utilization. Energy use is essential especially for the Green house business as plants require heating during the winter and cooling during the summer. Thus, there is need to address the issue by examining alternative energy sources that are cost effective. Understanding producer's intentions in adopting them is also important.

What has been done

A database with a list of certified greenhouse and nursery operators was acquired from the State Department of Agriculture. It was used to conduct a mail survey of certified green house and nursery growers to assess their current energy use and preferred alternative for the future. IRB approval was obtained; data collection is complete and is being checked prior to being entered into the database.

Results

As a result of the mail survey a total of about 500 greenhouse and nursery operators were reached. Collaboration with the State Department of Agriculture, an important stakeholder, is found to be useful. Feedback from producers was also useful in gaining insights on challenges and opportunities pertaining to energy use that the greenhouse and nursery businesses face. Training plans are being formulated.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics

Outcome #15

1. Outcome Measures

Number of nursery/greenhouse operators utilizing alternative energy.

2. Associated Institution Types

- 1890 Research

3a. Outcome Type:

Change in Action Outcome Measure

3b. Quantitative Outcome

Year	Actual
2012	0

3c. Qualitative Outcome or Impact Statement

Issue (Who cares and Why)

Exploring alternative sources of energy is needed to identify lower cost sources. Such sources range from bioenergy operated by an individual operator to others available through institutions in the energy business. There are various stakeholders in the private and public sectors that have a stake in the issue.

What has been done

This project introduced research in an important emerging area. It can promote efficient and cost effective management practices that can overcome some of the challenges faced by greenhouse and nursery businesses.

Results

A total of 102 completed responses were received from the mail survey administered to certified green house and nursery businesses. Preliminary results show that majority of the respondents will adopt alternative energy sources.

4. Associated Knowledge Areas

KA Code	Knowledge Area
605	Natural Resource and Environmental Economics

V(H). Planned Program (External Factors)

External factors which affected outcomes

- Natural Disasters (drought, weather extremes, etc.)
- Economy
- Government Regulations

Brief Explanation

V(I). Planned Program (Evaluation Studies)

Evaluation Results

Research impact and relevance was measured by one-on-one interaction with nursery growers in meetings and at field research sites, counting the number of requests from producers for research-related information or assistance, and surveying producers for impact and content relevance at workshops and meetings. One-on-one interactions with producers and regulatory stakeholders has indicated our research objectives are addressing their critical needs and our outcomes are reducing their costs. Direct requests from producers or related stakeholders for research-related information during the 2011 to 2012 reporting period totaled 378, indicating a need within the nursery community of interest for our research results. Finally, a survey given at a Disease and Pest Management Workshop that we hosted provided the following information about our research and its impacts:

- Relevance of research content to your needs (94.7% very satisfied, 5.3% somewhat satisfied, 0% neutral, 0% somewhat dissatisfied, 0% very dissatisfied).
- Learn something new? (100% yes, 0% no)
- Plan to adopt or use information provided from our research programs (88.2% yes, 0% no, 11.8% maybe, 0% uncertain)
 - Will information shared from our research improve your safety (38.9% yes, 5.6% no, 50% maybe, 5.6% uncertain)
 - Will the information from our research programs save you money (25% yes, 18.8% no, 31.3% maybe, 25% uncertain)
 - Will the research information presented modify the way you manage pests or diseases (68.8% yes, 6.3% no, 25% maybe, 0% uncertain)
 - Plan to share information provided from our research programs with others (94.4% yes, 0% no, 5.6% maybe, 0% uncertain)

Key Items of Evaluation