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COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

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PROPOSAL TYPE

For National Research Initiative Competitive Grants Program Proposals Only

[ ] Standard Research Proposal
[ ] Conference
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  Strengthening:
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For Higher Education Program Proposals Only:

Need Area: _____

Discipline: _____

Project Title:

Guardian Plant Systems for Greenhouse Integrated Pest Management, Year 2

Guardian plant, guardian plant system, indicator plant, banker plant, trap plant

Key Words: natural enemy habitat, greenhouse biological control, whitefly biological control

An innovative pest management system using eggplants as crop guardians has evolved over the last decade in Holland and Canada in peppers, tomatoes, fuchsias, and poinsettias. For whitefly control, the eggplants pull whitefly out of the crops, the growers apply natural enemies directly to the eggplants, and in some crops, the eggplants supply reproduction sites for the natural enemies. The eggplants have also assisted in determining if pesticide action thresholds have been reached by offering the grower an efficient snapshot of the natural enemy impact on pest populations within the greenhouse. Thus, the eggplants have been serving as indicator, trap and banker plants in a technique that we refer to as Guardian Plant Systems (GPS). These GPS have substantially enhanced grower confidence in biological control, reduced monitoring time, and reduced the purchases of natural enemies, thereby reducing the cost of biological control and IPM. In our 2007 NEIPM study, we demonstrated that eggplants reduce monitoring time for detecting both greenhouse and sweet potato whiteflies and the whiteflies' mortality. Importantly, the eggplants strongly attracted both the normal and the Q biotype strains of sweet potato whitefly adults. We also created guidelines for the best way to deploy eggplants in a crop. However, we need a second year of observations to refine and fully analyze the eggplant/crop/whitefly relationship.

Three experienced pest management groups from two northeastern states -- one from a university research laboratory (VT), and two from private industry (NY) – will each demonstrate one of the following two Guardian Plant/crop combinations for the second year: eggplants in poinsettias or eggplants in specialty annuals. All of the demonstrations will occur at commercial greenhouses. Each cooperator will gather and compare data on whitefly and natural enemy incidence in the crop with data on whitefly and natural enemy incidence on the GPS. They will also compare costs, depending on available data, between conventional chemical treatments and biological control, or between biological control with and without GPS. Participants will share information by meeting for the purposes of comparing data, results and styles of observation and analysis.

All cooperators will actively share the project information with many grower groups and with the GO IPM Working Group of NE IPM. This project will encourage rapid innovation by timely sharing of methods to seed rapid implementation by greenhouse growers. This project addresses the working group priority to develop practical, user friendly methods of less toxic methods of pest management implementation

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4. Project Description

a. Problem, Background and Justification

Problem

Greenhouse production in the US represents a significant high-value crop which in the Northeast enables growers of to extend the growing season and increase profits. Greenhouses provide protection for year-round production, but also offer ideal conditions for pest outbreaks. By design, most greenhouses exclude pests and their natural enemies, eliminating the natural checks and balances found in outdoor plantings. Even if a grower introduces beneficials into the greenhouse, many crops lack sufficient habitat to sustain the populations at levels needed for control. Therefore beneficials must be released repeatedly, which is expensive, especially when shipping costs often exceed the cost of the contents. Greenhouse growers therefore need specialized tools to cost effectively cope with the challenges of greenhouse pest management.

Production of greenhouse ornamentals is a burgeoning Northeastern industry. In 2005 >2,800 greenhouses in CT, MA, MD, NJ, NY, and PA grew bedding plants at a wholesale value of $320 million. Over 12 million poinsettias with a wholesale value of $49.5 million were produced in the same states by 437 greenhouses with >$100,000 sales in 2005[9]. Insect pests represent a major constraint on revenues for greenhouse production. They impact grower profits directly by reducing crop yield and/or quality as well as requiring cash and time expenditures for control. The number of Northeastern growers of greenhouse ornamentals who have tried or are regularly using beneficials has increased significantly based on informal surveys conducted among attendees of greenhouse IPM workshops in ME, NH and VT (M. Skinner, pers. comm.). This increase is a direct result of heightened awareness among growers of the effectiveness of biological controls and how to use them.

Background

Guardian Plant Systems. Techniques are being developed and tested in North America utilizing specialized plants to sustain natural enemies in greenhouses, thereby providing an on-going supply of beneficials to combat arthropod pests. Research is also underway to evaluate plants as early indicators of pests or beneficials. It appears that indeed, some plants can be used effectively to detect pests early, others can sustain natural enemy populations over time. In this project we propose to demonstrate for a second year one model plant, eggplant, that can serve all of these functions simultaneously. By concentrating pests and natural enemies, eggplant give the pest manager a concentrated view of population levels of the pest and beneficials and at the same time serves as a continuous supply of natural enemies. In 2006 we coined the term “Guardian Plant Systems (GPS)”, which combines the multiple uses. This concept recognizes the dynamics of the model: the same plant can serve as an indicator plant and function as a trap plant drawing the pest from the crop. Likewise, a trap plant can act as a banker plant, providing an on-going source of beneficials. For clarification, these uses are described below:

Banker plants: Banker plants supply prey to support natural enemy populations. For example, the papaya whitefly is used to support whitefly parasites on papaya banker plants.

Habitat plants: Habitat plants supply food and shelter to beneficials. The plant provides basic needs for natural enemy survival (pollen, nectar, resting and/or oviposition sites).

Indicator plants: Many pests show preferences for certain plants over others, and natural enemies may follow them there. By attracting pests and their natural enemies, indicator plants provide sites to monitor both populations simultaneously. Indicator plants can be more accurate than sticky cards because they detect both non-flying as well as flying stages of pests. If substantial parasitism or predation occurs on an indicator plant, it has also become a trap plant.

Trap plants: Trap plants are indicator plants on which crop pests are killed. When biological controls are applied, the plants may become banker plants for those beneficials.

The above discussion demonstrates the complexity of the interactions between plants, pests and their natural enemies in a greenhouse ecosystem, and IPM strategies must move toward "ecologically-based" approaches that optimize these natural systems[1,3,6]. This concept is gaining momentum in the International Organization of Biological Control too, as evidenced by the new working group "Landscape management for functional biodiversity", which focuses on improving pest, disease and weed control through landscape ecology.

Examples of Guardian Plants for Pest Control. Growers demonstrate a natural ability to observe pest/plant interactions and make reasoned decisions accordingly. Several growers in the region have been informally exploring the approach of guardian plants for some time. These include Don Banyar of PA who uses tomato plants to draw whitefly out of poinsettias and John Sirak of PA who used marigolds to trap thrips. P. Ramakers, Glasshouse IPM Research, NL noted that many years ago Dutch growers used eggplant to attract whitefly from peppers, reducing inputs of *Encarsia formosa*. In Canada, growers use eggplants in poinsettia and fuchsias for whitefly control, and the mum var. Saskia in mums for thrips. These are described in a 2007 GrowerTalks article by IPM Laboratories www.growertalks.com/archive/articles/2322.asp.

This project is a continuation of research we started last year with support from the NE IPM Center. Below is a brief summary of our results to date.

UVM RESERCH SUMMARY. We tested eggplant GPS (var. Fairy Tale hybrid) in commercial greenhouses at two locations, both having the pesticide resistant Q-biotype whitefly. At site A with 3 greenhouses, we applied 3 treatments: 1). GPS and *Eretmocerus eremicus* parasitoids [BIO], 2). GPS as trap plants without parasitoids,and 3). Conventional pesticides. At site B, the single greenhouse had just the BIO treatment. Preliminary data show that at site A pesticide use was reduced by >50% in the BIO house and employed less toxic pesticides. At site B, no pesticides were applied and whitefly populations have remained low (<1 per plant) throughout the experiment duration.

Throughout the experiment at both sites there were significantly more parasitoids and whitefly on the GPS than on poinsettias, clearly indicating that GPS were more attractive to whiteflies than poinsettias. Limited dispersal of the parasitoids away from the GPS occurred which was expected given the high number of whitefly on the GPS compared with the poinsettias. At site A, whiteflies were found throughout the poinsettias at a constant low level (<4 per plant) over the trial period. This suggests that dispersal away from the GPS did not occur, but also shows that not all of the whitefly were attracted to the GPS. Similar levels of

parasitism (~45%) were found among whiteflies on the GPS and poinsettias. Parasitoids also killed whitefly nymphs by host feeding. It appeared that parasitoid impact on the whitefly population was responsible for 50 to 100 % reduction in pesticides. Conditions at site B did not warrant GPS removal due to low levels of whitefly.

In Vermont, whitefly adults were found 1 wk earlier on the GPS than on sticky traps in two of the greenhouses. It also took significantly less time to find a whitefly on the GPS than on randomly inspected poinsettias. This shows that GPS have the potential to save growers time and money by providing a cost effective scouting tool.

NYS RESEARCH SUMMARY. *Annual Stock Plants:* Whitefly were monitored on leaf samples of eggplants and whitefly-prone specialty annual stock plants (fuchsia, duranta, sweet potato vine, flowering maple) and yellow sticky cards. Whitefly were present throughout the experiment and evident by all means of monitoring. However, the GPS strongly magnified the late May generational populations spike, predicting increases of adults on the sticky cards by 1-2 wks. In late June, the GPS stopped attracting whitefly, possibly due to fruit set or drought stress, but produced whitefly parasites from the parasitised whitefly nymphs through July. The data suggested that fuchsia could also be used as a Guardian Plant, as it strongly produced whitefly nymphs until the eggplants got big enough to attract whitefly.

Poinsettias: Sweet potato whitefly numbers were amplified on the eggplants and parasitism was detected throughout both ranges. One pesticide treatment was applied to the poinsettias.. Preliminary results indicate no difference in control was created by the eggplant treatment.

PA RESEARCH SUMMARY. Dwarf eggplants introduced into a greenhouse of full-grown tomatoes with whitefly had no observable use. The whitefly were already too numerous at the outset of the project, and the eggplants were <1 ft tall compared with 6-ft tall tomatoes. Because of the results of this trial were poor, this aspect of the project will not be repeated in the future.

EGGPLANT DEPLOYMENT GUIDELINES: The work we conducted last year in the specialty annuals, poinsettias and tomatoes provided us with important insights that led to several guidelines that should be followed to best use of eggplants as GPS in greenhouses:

- Eggplants should be >¼ to ½ the size of the crop plant. Because attraction of the pest is likely based on visual and olfactory cues[12] the GPS should be level with the top of the crop.
- Eggplants need to be healthy.
- Eggplant pests, such as thrips spider mites and aphids, should be kept under control by assuring a continuous supply of the appropriate natural enemies, and thrips control is enhanced by removing flower buds from the eggplant.

These guidelines will be incorporated into our continued testing of GPS, as proposed herein.

Justification

Wherever biological controls are introduced into conventional pest management systems, pesticide use is commonly reduced by 50-95%. In addition growers select classes of pesticides that are soft on natural enemies and the environment. The GPS for whitefly control addresses

two key barriers to grower use of biological control: reduction of the time needed for pest scouting and reduced costs of natural enemies.

Eggplants in these studies will serve as focal points where growers can detect whitefly and their demise by natural enemies. Conversely, if biological control is insufficient, the GPS serve as an early warning that more beneficials or a pesticide treatment is needed. The eggplant GPS will be a tool to simplify biological control for growers.

The GPS concept is just starting to be adopted in the Northeast as evidenced by the 2005-2006 NE IPM aphid banker plant projects of Van Driesche & Sanderson[11], aphid banker plant projects of Skinner & Brownbridge[8], and the NE SARE Habitat Pot Systems by Glenister, Skinner & Nyrop[2]. The rate of adoption by growers is likely to be high because costs and risks are minimal and benefits to growers are tangible. The concept is definitely catching on in Canada. In 2003, one eastern Canadian grower tried the western Canadian practice of using whitefly parasites and trap plants in fuschias. In 2005, 3 poinsettia growers decided to try using whitefly parasites and eggplants. In 2006, 9 more growers participated in the trial. Other growers are using the system independently after witnessing its success. Now, on the US side, particularly for poinsettia growers who have experienced severe outbreaks of pesticide–resistant whiteflies a window of opportunity is open for keen attention and rapid adoption of new methods of whitefly control.

b. Objectives and Impacts

Objectives:

1. Evaluate use of eggplant Guardian Plant Systems (GPS) in two greenhouse crop systems: bedding plants and poinsettias.
2. Compare costs of GPS with those of standard parasitoid release strategies and conventional chemical control.
3. Disseminate information about GPS and trial results regionally via fact sheets, web pages and presentations at grower meetings.

Anticipated Impacts for Growers, the Environment and IPM Implementation

Safeguarding human health and the environment: This project will demonstrate the effectiveness of GPS and increase grower confidence in biological control, encouraging biological control adoption and decreased pesticide use. In eastern Canada, GPS and weekly parasite releases reduced pesticide applications for whitefly to zero or 1 per poinsettia crop, compared with routine weekly sprays. A NH poinsettia grower reported cutting from 20 sprays to 1 spot spray per crop by adopting biological control. In our 2007 NE IPM research, pesticide use was reduced 50 and 100% at two VT poinsettia greenhouses using GPS and whitefly parasites. This impact could be realized region-wide with development of simple but effective tools like the GPS for using biological control.

Economic Benefits: Parasite release rates by Canadian poinsettia growers using eggplant GPS are 0.2-0.3 times less than the US rate. The cost of parasites at the US rate is equal to that of pesticides[11]. Therefore, when parasites are used with GPS, biocontrol costs could be reduced by 50%. This GPS may offer a solution to the pesticide resistant Q-Biotype whitefly.

Implementation of IPM: Assessment of the eggplant GPS is needed before it can be broadly recommended to growers. Demonstrating and measuring GPS has already fostered grower interest and reduced pesticide use. Claussen's Greenhouses implemented the GPS on an additional 4000 sq. ft of poinsettias during our 2007 demonstration. Both VT cooperators had struggled with Q biotype in the past, yet reduced pesticide use by 50–100% in the presence of Q biotype in our trial. We expect grower adoption of GPS to be rapid because there is minimal cost or risk associated with trying them. The timing of GPS is perfect because growers need solutions for Q-biotype whitefly and are receptive to pesticide alternatives. Efficient communication is key. This project has generated much interest among the Assoc. of Zoological Horticulturists, and the Assoc. of Ed. Research Greenhouses. Other venues will be: the Tri-State Greenhouse IPM workshops in ME, NH and VT, New England Greenhouse Conf., and possibly OFA. Manuscripts will be offered to the Ecological Landscaping Assoc., Assoc. of Zool. Horticulture, NYS Flower Industries, and GrowerTalks. Our results will be disseminated rapidly to IPM professionals, including the GO IPM working group and >1,000 growers at our presentations and thousands via the web. A GPS fact sheet will be produced for distribution to growers and a web version will be uploaded for growers and extension personnel. This project evaluates GPS for whitefly in the Northeast, but the technique is applicable to other regions. The GPS model can also be adapted to other crop types and pests.

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C. Approach and Procedures

Poinsettias in VT: UVM scientists will test eggplant GPS in poinsettias at two commercial greenhouses (Claussen's Greenhouses [site A] and Paquette Full of Posies [site B]). At site A, three 2,000 sq. ft. greenhouses will be used testing the following three treatments, each in one of the greenhouses: 1) GPS with parasitoids (BIO) ; 2) GPS without parasitoids (TRAP); 3) no GPS or parasitoids (CON, i.e., conventional production). Each greenhouse will have the same number, size and varieties of poinsettias, spaced according to standard practices. Yellow sticky traps and GPS will be placed in the crop at a rate of 1/1,000 sq. ft. in September during the finishing phase of production. Eggplants (var. Fairy Tale hybrid) will be grown from seed in a quarantine facility to a height of 20-30 cm prior to introduction into the crop to ensure that they are not infested prior to placing them in the greenhouses. Our experience has been that if the GPS is too small relative to the crop plant, it will not effectively attract whitefly from the poinsettias. They will be scouted weekly and treated as necessary to eliminate pests. At site B, one 3,000 sp. ft. gutter connected greenhouse will be used as the research location, testing only the BIO treatment throughout, following procedures described above.

We will place yellow sticky cards in each greenhouse 1 wk before the poinsettias and GPS are brought in. We will record the number of whiteflies on the sticky cards, the GPS, and 24 poinsettias per greenhouse selected at random.

The wasp parasitoid, *Eretmocerus eremicus*, will be released weekly into the BIO greenhouse. Eggplants and poinsettias will be sampled weekly for 20 wks to determine the number of live whitefly by species, number of live *Eretmocerus* adults, and the number of parasitized and unparasitized whitefly present on the poinsettias and eggplants. Parasitoid and whitefly dispersal away from the GPS will be monitored on designated poinsettias at three distances from each GPS (adjacent, 1 and 2 m) at the four cardinal directions. Whitefly numbers on GPS will be compared to numbers found on sticky cards to assess the effectiveness of these two monitoring methods. The following data will be collected weekly and analyzed for differences over time between plants and among treatments when possible:

a) Number of whiteflies on yellow sticky cards; b) Number of adult and immature whitefly (by species) on GPS and random poinsettias; c) Number of parasitized whiteflies on GPS and poinsettias at 4 distances and directions from GPS. d) Number of minutes to detect first whitefly on the poinsettias and the GPS. e) Cost of parasitoid releases vs. standard chemical control.

The VT growers will retain final decision-making authority over whitefly control in their crops. Because this research will be done in a commercial greenhouse for retail and wholesale and retail sale, the grower may need to apply insecticides. In this event, the grower will discuss the matter with the project PI and UVM scientists to select the appropriate compound to minimize impact on the parasitoids.

b. Poinsettias in NY. IPM Labs, Inc. will work with poinsettia grower, Mischler's Florist to demonstrate biological control of whitefly using GPS in a commercial setting. Mischler's will purchase the whitefly parasites and provide two greenhouses full of poinsettias, (~ 4000 sq. ft).

One greenhouse will be treated with four dwarf GPS and a reduced rate of whitefly parasites weekly after the first sign of whitefly. The other will serve as a control with the "conventional" rate of one whitefly parasite per square foot per week. Natural enemies will be released weekly starting at the first sign of whitefly. An IPM consultant will monitor pests and natural enemies weekly for presence/absence of whitefly on 24 poinsettias per greenhouse and perform a weekly assessment of parasitism levels and whitefly presence on the GPS. The number of minutes that it takes to detect the first whitefly will be noted on the poinsettias and on the GPS. Up to 6 whitefly-infested poinsettias per house will be marked and whitefly growth stages and survival recorded weekly. If whitefly populations are not adequately controlled by natural enemies, 1-2 insect growth regulator treatments will be applied before poinsettia bracts begin to turn red (as demonstrated by Van Driesche et al.[10]). Mischler's Florist will retain final decision-making authority on whitefly control in their crop. The number of whitefly per plant will be evaluated in mid November, before the crop is sold.

c. Specialty annuals. IPM Labs will cooperate with Bakers Acres, NY, to demonstrate whitefly control with GPS in a 1,000 sq. ft. special annuals production house. Bakers Acres is a perennial nursery that prides itself on its diverse and unique offering. The special annuals house will contain ~75 varieties many highly susceptible to whitefly (bacopa, fuchsia, sweet potato vine, Felicia). This greenhouse typically is sprayed 3 times per season for whitefly.

Two GPS will be placed in the greenhouse and 1,000 whitefly parasites/wk will be released after propagation. Plants move quickly through the house, so we will maintain this high release rate for 16 wks from mid-April-July. On first entering the house each week, we will do an overall encounter survey, detecting, and noting plant species that harbor whitefly and their distance from the GPS. Next we will inspect 10 plants each of 5 species for whitefly and parasites, timing ourselves on first whitefly detection for each species. On the GPS, we will record time to first whitefly detection and the number, stage and species of whitefly per leaf and number of parasites on 2 leaves each on the upper, middle and lower leaves. We anticipate excellent whitefly control with the possible exception of a few small hot spots that may need an IGR treatment. Bakers Acres will retain final decision-making authority on whitefly control in their crop. Data will be used to compare whitefly levels on the GPS to that on the crop. Success will be demonstrated if whitefly numbers on the crop remain low and high levels of parasitism are detected on the GPS. Success will also be proven if we detect new trap plant species.

2. Compare Costs: Cost comparisons are described under evaluation plans.

3. Disseminate information: We will continue fulfilling the 2007-2008 three-pronged approach to share this project's information: website, hard copy via fact sheets and trade journals, and conference presentations. We will update 3 grower web pages to broadcast project progress and results to their customers and other growers with links to our main description. We will prepare a web-ready fact sheet geared to growers and document hits at the website. We will print 5000 copies of the fact sheet and share it with our audiences and the GO IPM Working Group. We will present our results at grower conferences, and via trade journals and newsletters, including the Tri-State Greenhouse IPM workshops which are managed by M. Skinner, and, by invitation, to other venues, including the biannual New England Greenhouse Conference.

d. Evaluation Plans

1a. Trust and confidence in biological control is difficult to measure. However, we will measure adoption of GPS (with whitefly natural enemies or with pesticides) and the proportion of these growers that are using natural enemies in conjunction with GPS. In late 2005 and early 2006, we distributed a survey to >500 growers asking for the plants they used as indicator, trap, banker, or habitat plants. Each function was defined on the survey. The level of grower comprehension and use of Guardian Plants will be documented by a final survey that will be comparable to the baseline data.

b. Reduction in pest monitoring time. For this project, scouting will be intensive and time consuming. However, GPS have the potential to reduce grower's scouting time because these plants serve as a magnet for the pest. We will record and compare the number of minutes that it takes to detect the first pests and first parasite activity in the presence and absence of eggplants.

c. Informal survey of future plans to adopt Guardian Plants. Evidence of success in poinsettias and specialty annuals will support adoption by other growers, including growers of many other crops. We will assess the real interest of our grower audiences in this new technique by adding a question to our Guardian Plant survey described above in (1) by asking , "Do you plan to incorporate eggplants into your pest management system in the next one or two years?", with multiple choice answers: definitely, very likely, likely, not likely, definitely not. We will include blanks to write the crops in which the respondents plan to deploy GPS.

2. Cost comparisons. Cost comparisons will show how much GPS can reduce biological control costs and/ or how the GPS cost compares to chemical costs. The UVM group will compare the costs of the conventional to best management practices. At the NY poinsettia site we will make direct comparisons between biological control costs in the presence and absence of GPS.

3a. Presentations. The list of presentations, numbers in the audiences and the number of surveys collected will be evidence of the coverage by our speakers.

b. Web Report. Web access to the web reports will be recorded as number of hits per page.

TIME TABLE

Obj.	Task	Start	Finish	By whom
1	Set up poinsettia trials, collect & analyze data	July 2008	Jan. 2009	All
	Set up annuals trials, collect & analyze data	Apr. 2008	Dec. 2008	NY
2	Compile data on costs and analyze results	July 2008	Mar. 2009	All
3	Present results at assorted grower workshops	Oct. 2008	Jan. 2009	VT
3	Prepare articles for trade journals	Jan. 2009	Jan. 2009	All
All	Attend annual cooperators meeting	Dec. 2008	Dec. 2008	All
All	Annual and Final Report	Nov. 2008	Mar. 2009	NY
3	Revise grower web announcements	April 2008	May 2008	NY
3	Prepare web summary for grower sites	Jan. 2009	Mar. 2009	All
3	Draft final GPS fact sheet	Jan. 2008	Jan. 2009	All
3	Place fact sheet on web & reproduce copies	Jan. 2009	Feb. 2009	NY
3	Announce & disseminate link to other sites	Feb. 2009	Mar. 2009	NY

5. Cooperation and Institutional Units Involved

IPM Laboratories, Locke, NY: Carol Glenister, president, will serve as the Project Director for the project. She will coordinate activities among the partners, manage the greenhouse tests in New York, prepare reports for the project, and collaborate with the subcontractors to produce the fact sheet and web content, but be responsible for their production. Carol will oversee a scout to monitor the crop at Bakers Acres, and a consultant (Karen Dean Hall) to monitor Mischler's. Carol will serve as the primary contact and represent the project at meetings of the NE IPM Advisory Council.

The University of Vermont, Entomology Research Laboratory: Margaret Skinner, entomologist, will serve as the Principal Investigator for the segment of the project dealing with research in Vermont. She will also assist with development of the fact sheet and website for the GPS Concept. She will assist with disseminating results at regional grower meetings.

Bakers Acres of North Lansing, NY: Maureen Sandsted, manager, will provide the greenhouse and the plants for the NY specialty annual trials. Maureen retains final decision-making rights over Bakers Acres crops.

Karen Dean Hall Agricultural Services: She will make weekly monitoring visits to Mischler's and communicate observations to Carol.

Mischler's Florist, NY: Mark Yadon, owner/manager, will provide the greenhouses, poinsettias, and beneficial insects for the NY poinsettia trial.

6. Key Personnel (resumes follow for Glenister and Skinner)

Carol Glenister is founder and president of IPM Laboratories, Inc. She has been an IPM consultant since 1981 and active in the production and promotion of beneficial insects and mites for pest management since 1985. She is committed to the support of biological control, IPM, sustainable farming and small farms. She co-owns an organic crop farm and a cow-calf livestock herd with her husband, Richard Glenister, the farm operator.

Karen Dean Hall is an IPM consultant and program director of the NYS Flower Industries. She is a former Cooperative Extension agent for greenhouse ornamentals.

Margaret Skinner is a Res. Assoc. Professor, at the University of Vermont Entomology Research Laboratory. She combines entomology research with public awareness projects on many insect pests in the Northeast. Skinner coordinates IPM education in three states, serves on the National Science Advisory Committee for the Asian Longhorned beetle and is a key link between northern New England growers and the latest entomology research. She annually organizes the Tri-State IPM Workshops in ME, NH and VT.

Bakers Acres, North Lansing, NY opened in 1980. As a 30-acre 10-greenhouse operation, it is one of the largest herb and perennial growers in central NY. Its nursery offers trees and shrubs, and they grow >1000 varieties of perennials, 250 varieties of herbs and >75 kinds of specialty annuals. During its busy season Bakers Acres employs about 30 people. Maureen Sandsted, the owner, is involved with Tompkins Sustainable, a grassroots project that educates the public about the importance of sustainable agriculture.

Mischler's Florist grows and retails ornamentals year round in Williamsville, NY. Mark Yadon of Mischler's Florist is a long-time user of natural enemies. He manages large greenhouses of cut roses and gerberas, poinsettias and potted ornamentals, and general bedding plants. Mark retains final decision-making rights over Mischler's crops.

Claussen's Greenhouses and Florist, VT: Chris Conant, owner and manager will provide three 1,000 sq. ft. greenhouses of poinsettias in which to test the GPS.

Paquette Full of Posies, VT: Ron Paquette, co-owner and manager will provide one 4,000 sq. ft. greenhouses of poinsettias in which to test the GPS.