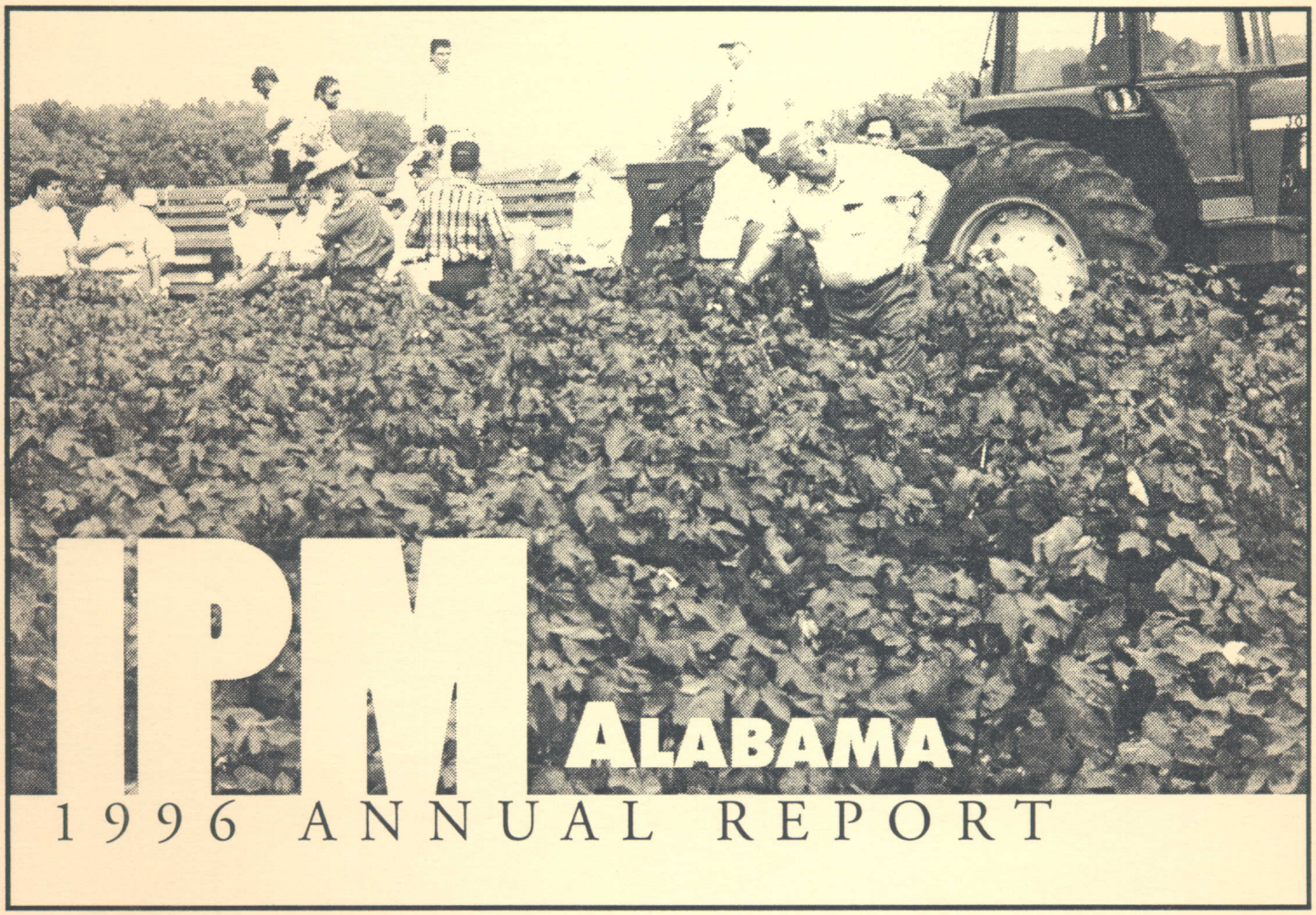


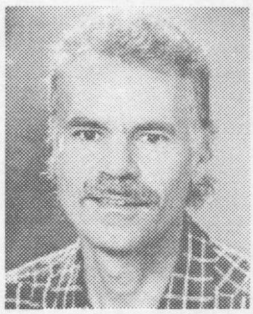
IPM ALABAMA

1996 ANNUAL REPORT

INTEGRATED PEST MANAGEMENT IN ALABAMA

FEBRUARY 1997

Letter From The Director



I'm proud to be associated with the IPM Alabama Program, and to be a member of the team that contributed to this, our first IPM Alabama Annual Report. The purpose of this report is to familiarize the citizens of Alabama with some of the accomplishments of the IPM Alabama Program, and with the benefits of the program to the public.

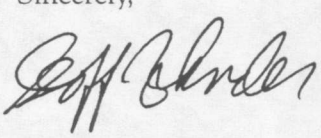
The concept of IPM, or Integrated Pest Management, has been recognized and practiced in the U.S. and in Alabama for over a quarter century. It was conceived after we recognized that reliance on the "silver bullet," pesticide-only approach was no longer possible because of widespread pest resistance to pesticides. Likewise, concerns about public health and the environment were growing. IPM is an approach that relies on knowledge of the pests to be controlled and also knowledge of the crop or habitat, enabling us to choose the most cost-effective combination of pest management strategies with the least negative impact on the environment. You will become familiar with some of the IPM strategies being developed in Alabama as you read through this report.

Although IPM programs have existed in Alabama for many years in specific commodity areas like cotton, peanuts and tree fruit, there has not been an official mechanism to promote IPM programs and to encourage interdisciplinary projects until 1996 when the organizational structure of the IPM Alabama Program was established. The program relies on IPM Commodity/Area Teams comprised of both extension and research personnel. The Commodity Teams (1) identify critical pest problems through contacts with growers, county agents and other clientele, (2) determine the research and extension work that is needed to solve the problems, and (3) develop plans to carry out the pest management programs. An IPM Mini-Grants Program, supported by federal funds earmarked for IPM, was recently established to support research and extension projects in Alabama that address critical pest management needs. IPM projects in Alabama are also supported by various commodity and industry organizations and by USDA grants to teams of research and extension specialists working in specific commodities or areas.

The hiring this year of an IPM Program Assistant, Mr. Mark Rumph, has facilitated the development of new program areas including the IPM Alabama Website and the IPM Alabama Newsletter. These resources provide easier access for citizens of Alabama to a wide range of pest management information. In addition, the program assistant facilitates interaction between IPM specialists and various groups representing the agricultural industry, the environment, and other government and non-governmental organizations.

We are experiencing a new era in pest management technology, as evidenced by the recent introduction of genetically enhanced crops with genes for pest resistance, and the development of new-generation pesticides that target specific pests but are "softer" on the environment. Other new and promising crop protection technologies under development in Alabama include the use of beneficial microbes to induce crop resistance to pests, or to "out-compete" pathogenic microorganisms on crops thereby reducing their potential for damage. The role of IPM research and extension personnel in the viability of Alabama agriculture will be increasingly important as we strive to determine how new products and technologies will best fit into our pest management programs. We invite you to read this report of our program's accomplishments this past year, and to learn about the various projects underway. It is our goal to further the adoption and successful implementation of IPM methods for the benefit of the citizens of Alabama.

Sincerely,



Geoff Zehnder
State IPM Coordinator

INTRODUCTION

Integrated Pest Management, more commonly referred to as IPM, is not a new concept in Alabama, but the average citizen may not be aware of the meaning of IPM. IPM can be defined as the combined use of biological, cultural, physical, and chemical controls to manage pests with minimum negative impact on man and the environment. Private and public agencies involved in agriculture have encouraged the implementation of IPM practices, and the federal government recently announced a goal to have IPM methods established on 75% of America's crop land by the year 2000.

The IPM Alabama Program embraces this challenge, and our mission is to develop and facilitate the use of effective and economical pest management programs for our clientele, both on-farm and in urban settings. In addition to developing the component research and development needed to address critical pest problems, education and information transfer comprise a growing and important facet of the program. The program is continually developing new ideas to make pest management information more accessible and to inform the public about IPM programs and activities.

The program also received a boost in 1996 with the addition of an IPM program assistant, Mark A. Rumph. This position was developed, in part, to enable the program to provide more outlets from which IPM information could be made available. In May of 1996 an IPM Alabama site on the World Wide Web was developed that now contains more than 70 articles and fact sheets on IPM (with additions being made regularly). The site also contains information about the IPM Alabama Program, links to other IPM programs and information, and an interactive form for users to complete and provide comments.

A quarterly IPM Program newsletter, the first issue published and distributed in late summer, is another source of information on IPM Program activities and developments. The newsletter is published by the Communications Group in the Alabama Cooperative Extension System, and will be distributed in February, May, August, and November of each year. A copy of the newsletter is also available on the IPM Alabama web site.

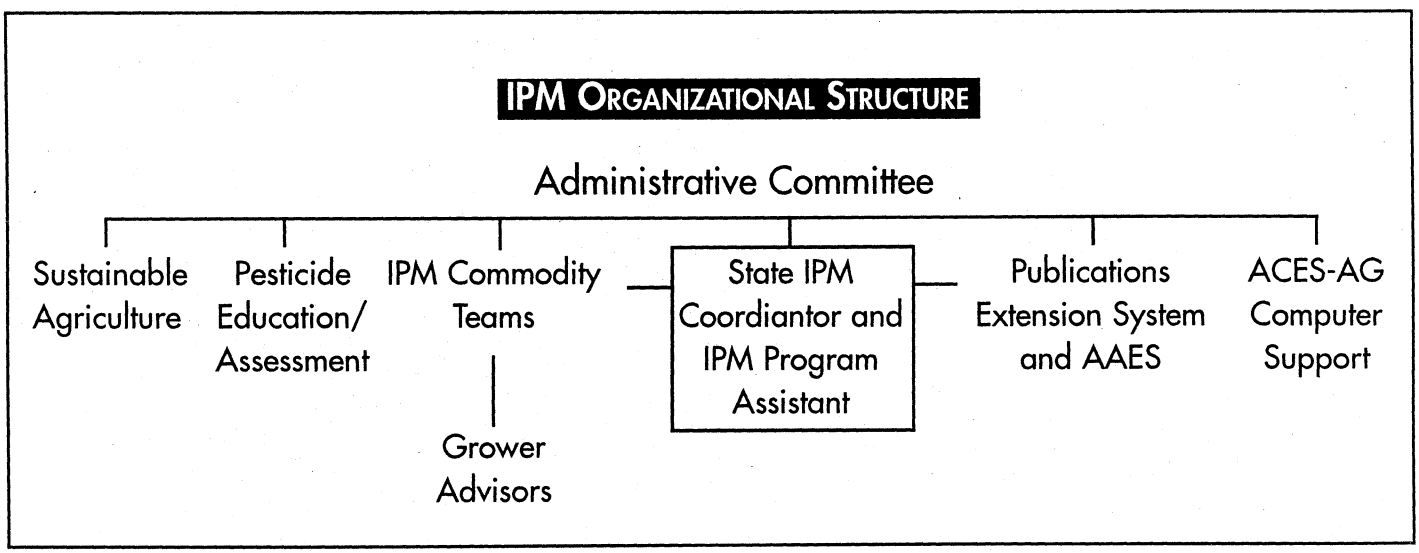
Within the pages of this annual report you will find information about the accomplishments of IPM Program extension and research personnel during 1996, as well as a glimpse of some objectives and goals for the program in 1997. We hope that this report will provide you with a better understanding of the IPM approach, and that you will share in our enthusiasm of the IPM Alabama Program and it's accomplishments. Please feel free to contact us with any thoughts or questions.

Mark Rumph,
IPM Program Assistant

IPM ALABAMA - ORGANIZATIONAL STRUCTURE

The IPM Alabama Program represents a cooperative effort between the Alabama Cooperative Extension System (ACES), the Auburn University College of Agriculture, and the Alabama Agricultural Experiment Station (AAES). Dr. Geoffrey Zehnder, Extension Specialist and Associate Professor of Entomology at Auburn University, serves as the **State Coordinator** of Alabama's IPM program. An **Administrative Committee,** consisting of members of ACES, AAES, and college administrators and department heads, consults with the state coordinator to aid in program direction and planning. The foundations of the IPM Program are the **Commodity Teams** made up of extension specialists and county agents, and researchers. These multi- disciplinary teams work cooperatively to identify and prioritize critical pest management problems in Alabama. This is facilitated by the extension team members who have direct contact with Alabama farmers and other clientele. Once they identify critical needs, the teams develop IPM research and extension education programs designed to address the problems. Funding to support the IPM programs is provided by ACES, AAES, federal (USDA) formula and special project funds, various commodity groups, and by the IPM Alabama Mini-grants program (described below).

In 1996 Mr. Mark Rumph filled the position of IPM Alabama **Program Assistant**. Mr. Rumph assists the coordinator with administrative duties and developed and maintains the IPM Alabama web site and the quarterly IPM Alabama newsletter. More details on these program areas are provided in the following pages. The IPM Program also works with several complimentary organizations including the **ACES and AAES Research Information units**, the **State Sustainable Agriculture Program**, **ACES-AG Computer Support Division**, and the **Pesticide Education and Pesticide Impact Assessment Programs**. The chart below represents the current organizational structure of the IPM Alabama Program.



IPM Alabama Website and Publications

Website

During 1996, the IPM Alabama Program added an information site on the World Wide Web. Currently, the site houses more than 70 articles dealing with the control of various pests of field crops, fisheries and wildlife, forestry, forages and small grains, tree fruit and nuts, commercial turf and landscape, urban pest management, and vegetables. We are in the process of uploading new and existing pest management articles as time and resources permit, so our electronic library of IPM publications will continue to grow. In addition, we plan to upload all of the Alabama pesticide recommendations for crops and urban areas so that these will be available online.

IPM Alabama's web site offers general IPM information and links to other sites that provide information on pest management. The web site also provides an interactive questionnaire so that users can provide input on any requests or ideas. The site also contains a list of the IPM commodity team members and their e-mail addresses. Users will be able to access special pest hotline information for several commodities including cotton and pecans in 1997.

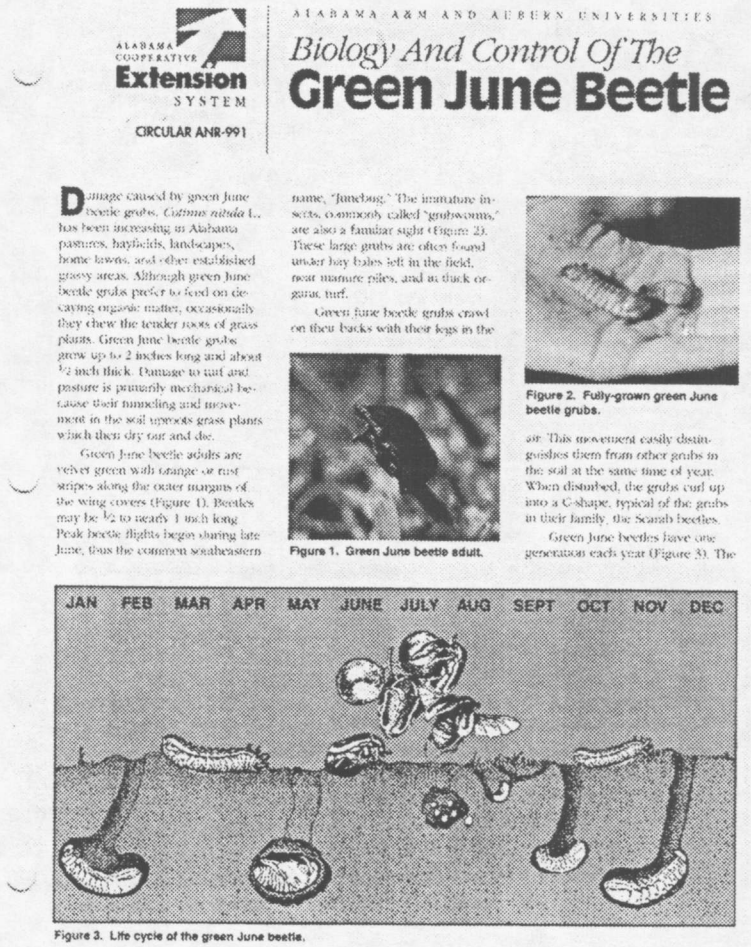
To find our web site, you must have a computer with Internet access and a "web browser" such as Netscape Navigator or MicroSoft Internet Explorer. Our Internet address, or URL, is:

http://www.acesag.auburn.edu/department/ipm

If you have any questions about the site or how to gain access, you can contact the IPM office at the address and phone number listed on the back cover of this report.

Publications

Each year, the Alabama Cooperative Extension System Communications Division produces many print articles written by IPM specialists on pest management topics. These include Circulars and Timely Information Sheets addressing a variety of pest management problems on commercial farms and in urban settings. Literally hundreds of these publications are in print on virtually any pest management subject. ACES also publishes an annual *Alabama Pest Management Handbook* providing treatment recommendations for disease, insect, and weed pests. The Alabama Agricultural Experiment Station Office of Research Information also publishes articles that may contain information on pest management, including the popular magazine *Highlights of Agricultural Research*. For information about these publications, please contact the IPM Alabama Program office, your local county agent, the Alabama Cooperative Extension System Communications Division, or the Alabama Agricultural Experiment Station Office of Research Information.



ALABAMA COOPERATIVE Extension SYSTEM
CIRCULAR ANR-991

ALABAMA A&M AND AUBURN UNIVERSITIES

Biology And Control Of The
Green June Beetle

Damage caused by green June beetle grubs, *Cotinis nitida* L., has been increasing in Alabama pastures, hayfields, landscapes, home lawns, and other established grassy areas. Although green June beetle grubs prefer to feed on decaying organic matter, occasionally they chew the tender roots of grass plants. Green June beetle grubs grow up to 2 inches long and about ½ inch thick. Damage to turf and pasture is primarily mechanical because their tunneling and movement in the soil uproots grass plants which then dry out and die.

Green June beetle adults are velvet green with orange or rust stripes along the outer margins of the wing covers (Figure 1). Beetles may be ½ to nearly 1 inch long. Peak beetle flights begin during late June, thus the common southeastern name, "Junebug." The immature insects, commonly called "grubworms," are also a familiar sight (Figure 2). These large grubs are often found under hay bales left in the field, near manure piles, and in thick organic turf.

Green June beetle grubs crawl on their backs with their legs in the air. This movement easily distinguishes them from other grubs in the soil at the same time of year. When disturbed, the grubs curl up into a C-shape, typical of the grubs in their family, the Scarab beetles.

Green June beetles have one generation each year (Figure 3). The

Figure 1. Green June beetle adult.

Figure 2. Fully-grown green June beetle grubs.

JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC

Figure 3. Life cycle of the green June beetle.

Example of IPM publication

COTTON PROGRAM

Ron Smith, Barry Freeman, Mike Patterson, Bill Gazaway,Charlie Burmester, Dale Monks, Bob Goodman

Overview: Established in 1972, the cotton IPM program has served the pest management needs of Alabama cotton farmers for more than 24 years. Insect pests are a primary concern in Alabama cotton production, therefore a major focus of the cotton IPM program is on insect management. All of the approximately 3,000 cotton growers are using some IPM technology, but not all are using the recommended IPM methods to the fullest extent possible for various reasons. Due to continually changing needs and pest problems, cotton IPM strategies are revised each year based on several factors such as weather and anticipated pest development. Therefore, the cotton IPM program objective is to develop the best set of strategies for the current season's conditions.

The effectiveness of the cotton program has been evaluated primarily through user feedback. This is possible because the cotton IPM team has personal contact with over 50% of all cotton growers in the state on an annual basis. Because of this personal relationship, the cotton IPM program continues to grow and evolve to match the needs of Alabama's growers.

The cotton industry was dealt a severe economic blow in 1994 and 1995 by the development of insecticide resistance in the tobacco budworm and its resulting damage. Unfortunately, no pest management tools were available at the time to prevent the severe loss of yields that occurred. But just prior to the 1996 season, the new, genetically altered Bt cotton variety *BollGard* was introduced by Monsanto and approved by the EPA. With pest management guidelines developed by the cotton IPM team specifically for *BollGard* cotton, Alabama growers planted approximately 70% of the state's cotton acreage with this new technology. As a result, Alabama growers had a highly successful cotton production season in 1996. Less than 20% of the state's 580,000 cotton acres received a single foliar insecticide application; this is the lowest input since the introduction of synthetic insecticides in the 1940s. This also resulted in increased effectiveness of beneficial insects for control of cotton pests. The cost of insect control was reduced from $115 to approximately $36 per acre, which included the $32 per acre cost for the *BollGard* variety. This resulted in a savings of $45.8 million to Alabama cotton growers. At the same time, yields for 1996 are near an all time high statewide (750 pounds of lint per acre). This is an example of how the adoption and utilization of IPM technology can result in a sustainable production system, both economically and environmentally.

Success Story: Mr. Bibb Mims, a cotton producer from Monroe County, Alabama, has been producing cotton on his farm for more than 50 years, and his ancestors 50 years before that. Mr. Mims maintains accurate records of production costs and insecticide use, and has done so during his entire farming career. In 1996 he planted 96% of his 1,257 acres with the new *BollGard* cotton variety. Because of this new technology, Mr. Mims made an average of only 1.5 foliar insecticide applications on only 4% of his acreage. His insect control costs were reduced from $78.75 per acre in 1995 to $33.74 per acre in 1996 (note that $32 per acre was used to purchase the *BollGard* technology). This resulted in a savings of $45.01 per acre or a total savings to Mr. Mims of $56,577.57. Mr. Mims uses a complete cotton IPM package, including use of a scout and incorporation of treatment thresholds, cultural practices and methods to conserve beneficial insect populations.

Grants:

Funding for a Statewide Pheromone Monitoring Network
Alabama Cotton Commission (R. Smith, W. Moar, W. Foshee) $20,000

Funding for Five Television Satellite Broadcasts of IPM Recommendations
Alabama Cotton Commission (R. Smith) $2,000

For in Support of "800" Toll Free Insect Line
The Cotton Foundation, Memphis, TN. (R. Smith) $2,000

To Prepare a Statewide Cotton Insect Loss Report
Mississippi State University (R. Smith and B. Freeman) $250

FORAGES AND SMALL GRAINS

Kathy Flanders, Paul Mask, Bill Gazaway, David Buntin, Don Ball, Ed van Santen, Richard Shelby, Pat Cobb, John Everest, Mike Patterson, Leonard Kuykendall, Frank Wood, Jack Brewer, Gregg Hodges, Nancy Graves, Dus Rogers, Olin Farrior, Tim Reed

Overview: The Small Grains and Forages IPM Team was formed in 1996. It is comprised of smembers who represent the disciplines of entomology, agronomy and soils, and agricultural economics, and the team hopes to add a plant pathologist in 1997. The team has identified priority research and extension needs within their commodity area with input from more than 50 producers, county agents, USDA Agricultural Stabilization and Conservation Service (ASCS) personnel, and commodity group leaders. Several projects to address these needs are currently underway. The team also organized a forage insect in-service training session for county agents in three areas of the state.

IPM Priorities Identified in 1996 for Forages and Small Grains:

1. Develop a management strategy for the barley yellow-dwarf virus on wheat.
2. Develop a management strategy for grubworms.
3. Management of foliar diseases on small grains.
4. Management of wild mustard, annual ryegrass, and wild garlic in small grains.
5. Develop cost-effective methods for fire ant management in pastures.
6. Develop alternative control strategies for soil borne small grain diseases.
7. Management of weeds in pastures and hayfields.
8. Develop alternative control methods for alfalfa pests in grazing-tolerant alfalfa.
9. Develop alternative management strategies for the cereal leaf beetle.

Gregg Hodges, County Agent Coordinator, Cullman County, scouting for green June beetles.

Success Story: Alabama has three million acres of perennial grass pastures and hayfields. At least 40% of these pastures are at risk for green June beetle infestations. This is because they are grown in sandy soils in counties with high broiler production. Use of poultry litter as an organic fertilizer in pastures and hayfields is increasing. It is an excellent fertilizer and helps cattle producers reduce the cost of inputs. However, decaying organic matter, including broiler litter, is the favorite food of the green June beetle. Green June beetles uproot forage grasses during their feeding activity. Severe infestations can destroy 80-90 % of the grass within a field, leaving bare ground for subsequent infestation by weeds. In Cullman County approximately 25% of pasture productivity was lost to green June beetles in each of the last two years.

In 1995-96 we began a program in Blount, Cullman, and Geneva Counties to address the green June beetle problem. We had two objectives: (1) to decide the best time to treat for green June beetles; and (2) to increase grower awareness of green June beetles before the damage is done. Results of the program demonstrated that the best time to treat for green June beetles is in September and October. At this time green June beetle grubs are still small, and have not yet seriously damaged perennial grass stands. We have developed a tentative action threshold of four green June beetle grubs per square foot of pasture. If populations exceed that amount, an application of carbaryl insecticide is recommended. Fall treatment is contrary to current grower practice. Most growers notice the infestations only after the green June beetles have damaged a perennial grass stand in late fall (December) or early spring (April). By then, most of the damage to pastures has already occurred.

During the past year, the program has recommended that growers

with high risk pastures (sandy soil and a history of broiler litter application) scout fields in September and October for signs of green June beetle infestations. Newspaper and magazine articles with information on green June beetles have been published, and a fact sheet is in press. The level of grower- adoption of these methods remains to be seen, but we will continue to refine our management strategies and to encourage implementation by Alabama growers.

Grants:

Cereal Leaf Beetle Management
Alabama Wheat and Feed Grain Committee (K. Flanders, P. Mask, G. Buntin) $12,500

Biological Control of Cereal Leaf Beetle
Alabama Wheat and Feed Grain Committee (K. Flanders, P. Mask, G. Buntin) $5,000

Development of a Management Strategy for Green June Beetle
Auburn University IPM Mini-Grants Program (K. Flanders and J. Crews) $3,475

Evaluation of Aphid Behavior-Modifying Insecticides for Control of Barley Yellow Dwarf on Wheat
Alabama Wheat and Feed Grain Committee (P. Mask and K. Flanders) $5,000

Evaluation of Planting Date and Seed Treatment (Gaucho) for the Control of Barley Yellow Dwarf on Wheat
Alabama Wheat and Feed Grain Committee (P. Mask and K. Flanders) $8,150

Aphid Populations and Timing of Arrival into Alabama Wheat Fields in Relation to Barley Yellow Dwarf
Alabama Wheat and Feed Grain Committee (P. Mask, J. Murphy, K. Flanders, S. Halbert) $9,100

Establishment of Two Precision Agriculture Demonstrations in Alabama
Alabama Wheat and Feed Grain Committee (Mask, et al.) $24,000

PEANUTS

Paul Backman, Ron Weeks, Dallas Hartzog, Austin Hagan, John Everest

Overview: The Alabama peanut IPM program has three focus areas. The first is to maintain peanut farming as a profitable enterprise. A second goal of the program is to increase awareness by growers of alternative management strategies that will reduce costly pesticide usage. A final consideration of the peanut program is to help growers, consultants, and county agents who provide assistance to growers in the identification of new pest problems and help to devise management strategies for their control. The overall goal of the program is to facilitate the adoption of current IPM technology by 80% of Alabama peanut growers within the next four years. We propose to accomplish this by training county agents, crop consultants, and agribusiness personnel so that they can properly advise peanut growers in the proper use and adoption of IPM techniques.

Success Stories: In cooperation with Dr. Austin Hagan, extension plant pathologist, several peanut cultivars were evaluated for pest tolerance. It was determined that root-knot nematodes less seriously affected the peanut variety *Andru95* than the *Florunner* variety of peanuts. Research also revealed that root-knot nematode more seriously damaged the *Southern Runner* variety than other varieties. Based on this research, growers were advised in 1996 to plant *Andru95* peanut variety when soil tests showed high levels of root-knot nematode populations. The recommendations were disseminated through a series of peanut production meetings and in newspaper articles. As a result, Alabama growers increased plantings of *Andru 95* peanuts from 10% in 1995 to 25% in 1996.

In 1996, tomato spotted wilt virus (TSWV), a thrips-transmitted virus of peanuts, increased to significantly damaging levels in many peanut fields in Alabama. Infection rates of 25% to 30% were found in fields surveyed by county agents and crop consultants. In cooperation with extension and research colleagues in Georgia and Florida, we are developing an IPM system for management of TSWV using variety selection, planting dates, seeding rates and other cultural practices. In anticipation of increased problems with TSWV, management guidelines developed from this multi-state effort were made available to Alabama growers through farm visits and demonstrations, newsletters and media broadcasts. This information enabled our growers to better manage the outbreak of TSWV that occurred in 1996.

Grants:

Peanut IPM Research and Demonstration
Alabama Peanut Producers Association (R. Weeks) $10,000

TREE FRUITS AND NUTS

John McVay, Ed Sikora, Ellen Bauske, Arlie Powell, Robert Boozer, Chuck Ogburn, Bill Goff, Monte Nesbitt, Mike Patterson, Wheeler Foshee

Overview: The tree fruit and nut IPM program focuses on two target commodities: apples and pecans. The pecan IPM program has been in operation for 19 years, and the apple program for the past four years. As a result of these programs, 100% of Alabama pecan growers use at least some of the available IPM techniques, and 80% use the complete IPM program. Similarly, most apple growers use some IPM methods, and approximately 75% adopt all of the IPM methods that are effective and practical for use in apple production. The main goal of the IPM team is to keep abreast of changing pest problems as they occur, and to revise the IPM program to accommodate new pests or changes in pest development and importance.

During the 1996 season pressure from foliar arthropod pests was light on both apples and pecans. Due to low numbers of aphids and only sporadic mite populations most apple orchards received no more than a single chemical application. In contrast, infestations of fruit pests, particularly lepidopterous species (moths), were greater than normal on apple crops. For the first time since the program's inception, populations of the codling moth were widespread in Alabama and required treatment in approximately 50% of commercial apple orchards. Disease pressure was moderate due to dry weather during the spring. Apple growers using the IPM program applied an average of 12 fungicide and 6-8 insecticide/ acaracide applications in 1996 and produced a high quality crop with little fruit damage from pests. The IPM program saved growers an average of six fungicide and 6-8 insecticide applications, compared with a conventional, calendar-based spray program.

Because of light infestations of foliar arthropod pests, less than 10% of Alabama pecan orchards were treated with insecticides for control of foliar-feeding pests. Incidences of the more damaging black pecan aphid were more frequent. However, aphid populations were low in most orchards and only 20% of pecan orchards were chemically-treated for aphid control.The scorch mite was present throughout the season but caused little economic damage.

Pests attacking pecan fruit (the nuts) were more abundant than normal in 1996. For the first time in 20 years, populations of the pecan nut casebearer, a lepidopterous pest, were extremely heavy in Alabama. This pest caused widespread damage where orchards were not monitored and treated as necessary. Populations of the hickory shuckworm and pecan weevil were also heavy and the potential for damage was great. Disease pressure was moderate due to dry weather during the late spring. Pecan growers using IPM practices applied an average of seven fungicide and four insecticide applications, nearly a 50% reduction compared with a conventional, calendar-based spray program.

Researchers using weather monitoring equipment to develop fungicide application schedules.

Success Stories: An apple grower with an isolated orchard in Chambers County, Alabama, had a history of severe fruit damage in his apple orchard due to a lepidopterous pest with which he was unfamil-

iar. Upon the determination of the pest's identity (the Oriental fruit moth), by IPM program personnel, a pheromone trap was installed in the orchard along with monitoring devices for other pests. The pheromone trap contains a sex attractant specific to males of the fruit moth species. Using the trap to determine when fruit moths were present, the grower was able to apply insecticides specifically when they were needed. As a result, the grower produced a better-quality apple crop using less insecticide than in previous years. Convinced of the benefits of the IPM approach, he now uses all available IPM strategies in his orchard.

Populations of the pecan nut casebearer were unusually high in the Alabama and in other southeastern states in 1996. Fortunately, IPM team members were conducting large scale evaluations of the sex pheromone for this pest. Due to the effectiveness of the pheromone as a monitoring tool, the team advised pecan producers of the potential for heavy damage in sufficient time to apply controls in heavily infested areas. Producers who availed themselves of this information, particularly via the telephone pecan hotline, were able to implement timely controls and avoided significant damage from casebearer feeding. Growers not using the information suffered as much as 30% crop loss from casebearer feeding damage.

Grants:

To Provide Pheromone and Trapping Equipment to Producers Interested in Adopting the IPM Program for Apples
Auburn University IPM Mini-Grant (J. McVay) $1,500

For the Operation of the Orchard Monitoring System and Telephone Hotline
Horticultural Crop Research Funds (J. McVay) $17,500

Dr. Patt Cobb soap-flushing mole crickets for sampling on a golf course.

TURF AND LANDSCAPE

Pat Cobb, Beth Guertal, Coleman Ward, Austin Hagan, Mike Williams, John Everest, Olin Farrior, Rick Beauchamp, Jeff Higgins

Overview: Turf and landscape comprises an area for the Alabama IPM Program that has made great strides in developing IPM programs that result in reduced use of chemical pesticides on golf courses and in other landscape settings. The team has specifically targeted grubs, fire ants and mole crickets as the major insect pests of turf areas. Recent advances in the mass production of insect-killing nematodes and fungi have made them a practical option for the biological control of some soil-dwelling pests. Field trials are underway to evaluate the effectiveness of these biological control agents for control of white grubs and mole crickets. Another promising, new soil insect management tool under evaluation is the practice of mapping soil pest infestations in order to target controls in the areas where they are needed. This will be facilitated by new developments in global positioning system technology that will permit precise location and treatment of pest infestations, thereby avoiding pesticide application in noninfested areas.

Success Story: Alabama has more than 20,000 commercial landscape settings in areas adjacent to office complexes, schools, banks, etc. Many landscapes in major urban areas are managed internally by buildings and grounds department personnel, or externally by commercial companies. Red imported fire ant (RIFA) annual control costs in Alabama are estimated at $10 million. Treatment of RIFA by landscape managers is highly expensive in labor and insecticide costs. Environmental concerns over widespread pesticide use in public areas is also a consideration.

In 1992 a pilot IPM program was initiated in a business complex landscape setting with the cooperation of the property management company. Within three years, the fire ant control cost (labor and chemical) decreased by 90%. This IPM program utilized maps of fire ant infestations, established priority areas, and targeted perimeter treatments with fire ant baits rather than whole area treatment.

In 1995 a pilot IPM RIFA program began on a university campus in Mobile, Ala. in cooperation with the buildings and grounds manager

for the university campus. A map of the campus was created that identified priority areas determined by traffic, visibility, and number of RIFA colonies. Cooperators scouted surrounding areas to determine locations from which infestations originated. Perimeter bait treatments were applied in June, and again on two areas in September. One area did not require a second treatment. In 1996, only the perimeters of these areas were treated.

The total RIFA control cost savings from the pilot program have not yet been determined because the program will continue for another year. However, the property manager reported fewer complaints and no reports of RIFA stings from these areas. He also reported that the time spent in controlling fire ants in these priority areas dropped by at least 50% the first year.

Several commercial landscape management companies have adopted this procedure of mapping RIFA infestations, identification of priority areas, and perimeter bait treatment. The extent to which this method will be adopted by other public and private landscape managers (i.e., schools and universities, commercial properties, etc.) remains to be seen. However, knowledge of the successful utilization of IPM practices by a few practitioners will undoubtedly lead to increased adoption by others.

Grants:
The Turf and Landscape program is currently participating in a Southern Region IPM Grant (listed below), and derives funding from various industry sources.

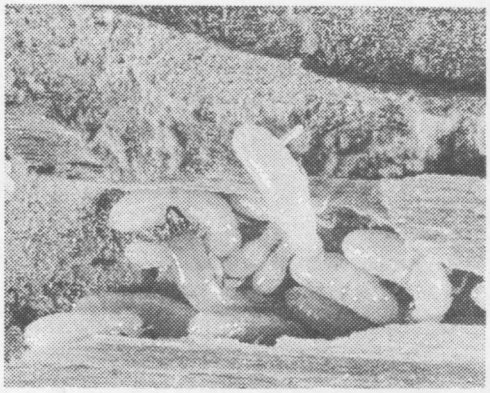
Entomopathogenic Nematodes and Fungi vs. Chemical Pesticides in Urban Turfgrass
(P. Cobb, et al (cooperators from Texas, Florida and Alabama). USDA Southern Region IPM Grant.

URBAN PROGRAM

Faith Oi, Art Appel, David Oi, Lane Smith, Guy Shelton

Overview: Throughout 1996 the urban IPM program focused on two areas: (1) state and regional urban IPM technology transfer, and, (2) research involving subterranean termite control. The urban IPM team received a $20,000 National IPM Initiative Phase I Planning Grant that enabled them to form a regional urban IPM group. During a series of meetings, the members summarized the current research topics for each pest category (ants, termites, cockroaches, and fleas). They also determined that pest control operators who attend training meetings have around a 90% understanding of IPM practices and theories, but they could make no accounting for those who did not attend training. Team members decided to form focus groups that include pest control operators, homeowners, and builders who build energy-efficient but pest-conducive homes. The team also defined research objectives that focused on sampling and monitoring techniques, two areas vital to successful IPM programs.

Although federal IPM funds to implement the 1996 plans were not appropriated, the information gathered in the planning project will be used for other regional programs in urban pest management. A team has been assembled by Mike Linker (IPM Coordinator, NC State) and Gerrit Cuperus (USDA IPM Coordinator and Oklahoma State



Subterranean termite infestation.

IPM Coordinator) to produce an urban IPM handbook for the Internet that will include insect pests, diseases, and water quality issues. Researchers will also examine urban IPM strategies against standard "spray-only" methods to decide if IPM is more effective. The regional group is also working to identify needs and develop programs for IPM use in public schools and to raise re-certification issues with pesticide education and state regulatory officials.

A second focus of the IPM Alabama urban program has been research and demonstration projects for subterranean termite control. Subterranean termite infestations are a major problem for structures in Alabama and around the region. Currently there are four demonstration projects to examine the effectiveness of baiting in below-ground and above-ground situations. Baiting is a method of termite management where alternative food sources (wood blocks) are placed in and around structures. Once it is established that the termites are feeding on the alternative source, then the original blocks are replaced with bait treated with a termite growth inhibitor. The

advantage of the bait program is that it does not rely on barrier treatments of broad-spectrum insecticides.

The urban team was awarded an Auburn University IPM Mini-grant to examine the reasons behind problems and high failure rates for termite control encountered by pest control operators. Specifically, the group is looking at two areas: (1) the termite infestation rates in relation to termite population size, and (2) the foraging activity of termites in the presence and absence of alternative food sources. Researchers plan to carry on the experiment through the middle of 1997, and no preliminary results are available. Once the group has an idea of population size, territory, and rate of infestation, they can test different control methods, examine reinfestation rates, and modify their termite detection methods.

Success Story: The major household and structural pests are generally regarded as termites, ants, cockroaches, and fleas. Termites are the only structural pests for which there have been no commercially feasible reduced chemical measures developed. Reducing the use of chemicals in pest management programs also reduces risks to pesticide applicators, consumers, and the environment. The current method of termite control is to drench the entire soil surface beneath and around a structure with 300 to 500 gallons of termiticide for a house of about 1,500 square feet. Termiticides have been applied for remedial control of existing structures as often as every three to five years.

A survey of pest control operators at the Florida Pest Control Association's biannual Termite Symposium suggested that retreatments for subterranean termite reinfestations occur at a more frequent interval than three to five years. In fact, yearly retreatments were not uncommon. The survey revealed that 68% of pest control operators had failure rates within five years after performing a pretreatment, and 93% experienced failures within five years after post treatment. Clearly, a 93% failure rate within five years using current practices underscores the need to explore emerging reduced chemical technologies, in particular, subterranean termite baits.

To demonstrate the effectiveness of an IPM approach, researchers installed the below-ground bait technology at a house in Montgomery during April of 1995. In addition to the below-ground bait, two sites were established to test an experimental above-ground bait technology. In July of 1996 the group established the first of these two sites at the communications center of the Russell Corporation in Alexander City, Ala., where conventional post-treatments were not an option because drilling would have damaged the buried wires.The second above-ground site was established at the same time in a high-rise building in the dropped ceiling of the 15th floor in Birmingham, Ala.

These demonstration and experimental projects have resulted in a better understanding of termite biology and behavior by pest control operators, homeowners and building managers. In Alabama, we have learned that baits should be in place by the end of February or the beginning of March for maximum feeding. If termites do not consume sufficient amounts of the active ingredient before winter when foraging activity significantly decreases, control cannot be achieved until the following spring if hexaflumuron is used. (Hexaflumuron is a chitin synthesis inhibitor that is dose-independent). These data correspond with results from other regions. The overall goal of these projects is to demonstrate that termites can be controlled using IPM methods and reduced chemical input.

Grants:

Information on Subterranean Termite Foraging Behavior Needed Toward Increased IPM Adoption
Auburn University IPM Mini-Grant (F. Oi, D. Oi, A. Appel, B. Cauthen) $3,000

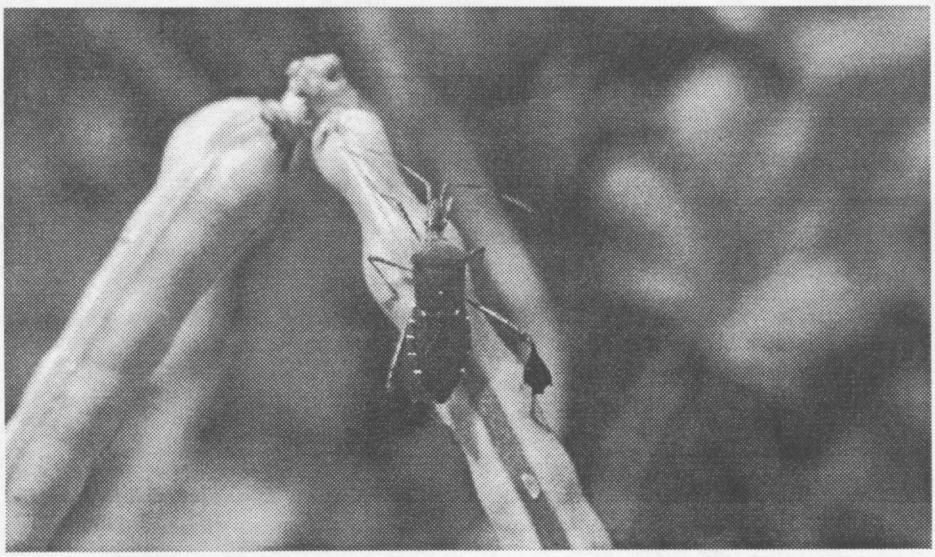
Management of Fire Ants in Landscape and Pasture Lands
Auburn University IPM Mini-Grant (D. Oi, K. Flanders, B. Farrior, F. Oi) $3,500

IPM of Arthropod Pests in Urban Environments
National IPM Implementation Program, Phase I, USDA/CSREES/Land Grant Universities (F. Oi, A. Appel, B. Forshler, P. Koehler) $20,000

VEGETABLE PROGRAM

Ed Sikora, Geoff Zehnder, Joe Kemble, Ellen Bauske, Mark Wilson, John Murphy, Chuck Ogburn, Eric Simone, Mike Patterson, Dale Monks, Joe Kloepper, Paul Backman, Dan Porch, Mary Baltikavski

Overview: Vegetable production in Alabama is highly diverse with more than 20 different crops grown throughout the state. The core of the Alabama vegetable IPM team includes Edward Sikora (plant pathologist), Geoffrey Zehnder (entomologist), Ellen Bauske (plant pathologist, horticulturist), and Joseph Kemble (horticulturist). Dr. Kemble organized the Vegetable IPM Task Force in 1994. The task force now serves as the vegetable IPM working group.



Leaf-footed bug on Southern pea.

The Alabama vegetable IPM program has many focus areas. The development and demonstration of low input production practices, development and evaluation of biological control agents, and deployment of pest monitoring and management programs comprise several of these areas. Though they are currently conducting work on several different vegetable crops, the greatest emphasis has been on the tomato and cucurbit industry.

Throughout 1996 the team made a great deal of headway with vegetable IPM and achieved several notable accomplishments. The team conducted a large scale grower survey to determine the current level of IPM use on tomatoes grown in the southeastern U. S. They used the information to identify priority pest management needs. More than 200 tomato producers in Alabama, Georgia, South Carolina, North Carolina, Florida, Tennessee and Kentucky took part in the study. Extension and research personnel from the major agricultural universities in each state were involved in the project.

The team initiated a project to increase the level of IPM adoption in the major tomato producing regions of Alabama. This is a cooperative project involving the departments of Agronomy, Horticulture, Plant Pathology, and Entomology at Auburn University. It also includes researchers from the Department of Weed Science at North Carolina State University. In Alabama, the main focus will be to implement tomato IPM practices by using large scale on- farm demonstrations. Also, they will evaluate the use of flame cultivation for use in a vegetable IPM production system.

The group established a "Vegetable IPM Rotation Plot" to show the benefits of crop rotations and other IPM practices. In 1996 the team implemented an insect and disease scouting program for southern peas, sweet corn, and lima beans. They also included the use of disease resistant tomato varieties as part of the field demonstration. The team also showed in field tests that transgenic tomato plants with resistance to the cucumber mosaic virus showed resistance to the disease even under conditions of high disease pressure. Field and greenhouse experiments demonstrated that specific strains of root colonizing bacteria induce resistance against the cucumber mosaic virus on tomato. Those experiments also showed that specific strains induced resistance against cucumber beetles and bacterial wilt of cucurbits.

The group made several other notable accomplishments regarding vegetable IPM in 1996. On-farm evaluations demonstrated the effectiveness of reflective mulch for control of aphid- borne diseases of squash. Researchers also showed the effectiveness of the velvet bean as a nematode suppressive crop in squash production. A statewide survey of Irish potato fields indicated that virus infection of potato is widespread, and that potato virus Y (PVY) was the most common virus infecting potato. Field experiments proved that application of foliar insecticides based on

insect presence is more effective than the more environmentally-hazardous soil insecticides for control of insect damage in sweet potato. Other field experiments displayed that trap plantings of squash can be used to reduce infestations of pickleworm in adjacent plantings of cucumber.

Success Stories: Alabama tomato growers must produce quality tomatoes despite severe disease and insect pest problems. Their main approach to pest management has been the prophylactic use of pesticides to protect the crop before damage occurs. This requires frequent application of toxic pesticides that are expensive and pose a hazard to public health and the environment. IPM methods are available to reduce dependence on pesticides, but the current level of adoption of IPM methods by Alabama tomato growers is not known. This information is critical because the Clinton Administration has set a goal of IPM adoption on 75% of crop land acres by the year 2000. To help tomato growers increase their use of IPM practices, we must also obtain grower ideas on their priority pest and production problems. After the problems have been identified, the growers must be involved in research and extension activities that they believe can help them to implement IPM better.

A tomato IPM team was organized to help tomato growers increase their use of tomato IPM practices. The team comprised entomology, plant pathology, and horticulture specialists, an agricultural economist, county agents, and key growers in the state. The team produced a comprehensive list of currently available IPM methods for tomato production that resulted in the development of a working definition of tomato IPM. Researchers then used the list to develop a survey to determine baseline levels of IPM used by growers. The survey was also used to identify the priority pest problems and research and extension needs as reported by tomato growers. Tomato grower meetings were held in the winter of 1996 to increase grower knowledge of available tomato IPM practices, and to provide an opportunity for growers to complete the surveys.

Approximately 65 growers attended these meetings, and the majority expressed approval of the meetings and of the tomato IPM program. In addition to pest management information, growers were provided with a hand lens to help them identify pests in the field. They also received tomato scouting manuals to increase their knowledge of pest monitoring procedures. The Alabama tomato growers surveyed scored an average of 57% out of a possible 100% in the tomato IPM survey. This shows that most growers are using some IPM practices, but that they are not using all IPM methods that are available to them. The growers identified specific pest and production problems on the surveys as limiting factors in tomato production. Collectively, this information will allow the team to focus future research and extension education efforts in areas that will provide the greatest benefit to Alabama tomato growers.

Soil insects, particularly whitefringed weevil larvae, are limiting factors in Alabama sweet potato production. The larvae live in the soil and create feeding scars on developing sweet potato roots, resulting in reduced marketability of the crop. Alabama growers produce more than 5,000 acres of sweet potatoes annually, but soil insect damage has affected yields. Growers typically use soil-applied insecticides at planting to prevent damage, but soil insecticides provide only marginal control of insect damage. Therefore, a need exists for alternative methods for whitefringed beetle management based on the insect's seasonal development and damage in the crop.

Field studies were done in sweet potato fields in Clanton, Ala., to develop information on the seasonal development of whitefringed beetle adults and larvae. Entomology personnel worked with the staff at the Chilton Area Horticulture Substation in an intense program to monitor the seasonal occurrence of adult populations on the sweet potato foliage and of larval populations in the soil. In addition, they sampled sweet potato roots throughout the season to learn when insect feeding damage occurred. This work determined that soil insecticides were ineffective because insect damage occurred late in the season after the insecticide residue had dissipated. This information was used to develop an alternative management program for whitefringed beetle and other soil insect pests of sweet potato. The program relies on the application of foliar insecticides only when adult beetles are detected in the crop. Subsequent studies proved that the foliar sprays were more effective than the soil insecticides for reducing soil insect damage in sweet potato. The team provided results of the program to all ANR agents via Timely News Sheets and over the Internet. In addition, they mailed results to the sweet potato growers in Alabama and provided to members of the Alabama Sweet Potato Grower's Association at their annual meeting.

Most of Alabama's sweet potato growers have foregone the use of soil insecticides in favor of the more environmentally benign approach of using

foliar insecticides. Growers apply the foliar insecticides when adult beetles are detected in the field. This has resulted in improved control of soil insect damage in Alabama sweet potato. Overall, the program has reduced the potential for insecticide contamination of groundwater supplies and for contamination of lakes and ponds next to sweet potato fields.

Grants:

Implementation of Tomato IPM Practices
USDA Southern Regional IPM Program (E. Bauske, D. Monks, E. Sikora, G. Zehnder, M. Patterson, D. Heiniger, R. Goodman, J. Kemble) $127,000

A Biologically Based IPM Program for Control of Cucumber Mosaic Virus on Tomato
USDA Southern Regional IPM Program (G. Zehnder, J. Murphy, E. Sikora, J. Kloepper) $84,500

Control of Cucumber Beetle and Bacterial Wilt of Cucurbits with Beneficial Bacteria
USDA Pest Management Alternatives Program (G. Zehnder, J. Kloepper) $119,000

Agricultural Systems Management with Current Technologies: On-Farm Application of Doppler Radar
USDA NRICGP (K. Bowen, E. Bauske, P. Backman, A. Hagan) $153,000

Implementation of TOM-CAST for Control of Early Blight on Tomato
Auburn University IPM Mini-Grant (E Bauske, M. Baltikauski, and E. Sikora) $3,500

Statewide Survey for Incidence of Plant Viruses in Commercial Cucurbit, Pepper, and Tomato Productions in Alabama
Auburn University IPM Mini-Grant (J. Murphy, E. Sikora) $2,000

IPM Alabama Program Grants

Many IPM Alabama Program activities are supported by outside grants awarded to individual IPM specialists or to interdisciplinary teams. Federal government programs and various commodity and agricultural industry groups provide these grants. Program research and extension personnel received more than $500,000 in federal grant funds and more than $100,000 in industry support in 1996.

The IPM Alabama Program also coordinates an IPM Mini-Grants program supported by federal formula funding for IPM programs. Established in 1995, the Mini-Grants program is open to all Alabama extension and research personnel working in IPM. The purpose of the program is to support projects leading to increased adoption of IPM practices by farmers and other clientele. In 1996, the IPM Mini-Grants program provided approximately $26,000 in support of nine IPM projects. The topics of those projects range from the use of biological control agents to control frost damage on peaches to the management of fire ants in pastures.

1996 AU IPM Mini-Grants

Information on Subterranean Termite Foraging Behavior Needed Toward Increased IPM Adoption
$3,000
(*Leader*: F. Oi. *Cooperators*: D. Oi, A. Appel, and B. Cauthen)

Subterranean termite infestation is a major problem for structures in Alabama. The failure to successfully control the infestations has been blamed on any number of reasons ranging from "technician error" to the presence of alternate food sources. Despite a great deal of research and work in this area, no studies have linked subterranean termite population pressure to the failure to control the infestations. The study has two major goals. The first goal is to examine the infestation rates in relation to termite population size. Determining the foraging activity of termites in the presence and absence of alternative food sources is the second goal.

Set up in June of 1996 the experiment involves 10 areas of known subterranean termite infestation. Researchers mapped all of the sites checked for subterranean termite activity every six weeks. The team expects the experiment to run for at least one year before they can fully understand results. If the presence of alternative food sources influences termite populations, the find exhibits further evidence that termites do not feed randomly. Project members can use this information as further confirmation that contractors and builders who bury grade stakes and form boards during construction contribute to termite problems.

Once the team has an idea of population size, territory, and rate of infestation, they can field test different control methods, examine reinfestation rates, and work on enhancing bait station designs. These projects would be dependent on industry cooperators. Alternatively, they can examine the effect of clearing property for construction on termite populations and territory by raking off the ground cover in forested areas. These data

would contribute to extension programs because they can cite quantitative data in addition to qualitative observations.

Management of Fire Ants in Landscape and Pasture Lands
$3,500
(*Leaders*: D. Oi, K. Flanders, and P. Cobb. *Cooperators*: B. Farrior, F. Oi, and S. Diffie)

Fire ants are found in every county in Alabama. The cost to control those pests exceeds $10 million per year in non-crop areas such as nurseries, home lawns, golf courses, athletic fields, churches, and schools. These figures are for the cost of control only, and do not include any loss estimates due to the damage that fire ants can cause. Likewise, the cost to control fire ants in crop type areas is probably just as high, but no good estimates of those costs exist for Alabama either. But, the cost for such control in Texas using currently the registered granular baits is estimated at $10 to $12 per acre. The purpose of this study is to evaluate the current methods of fire ant control in Alabama, and to use those results to develop the safest and most cost effective approaches.

Fire ants are often controlled by individual mound treatments, which can be done in two ways. First, approximately one gallon of insecticide is drenched or injected into the soil. This method introduces about 4.25 gallons per acre into the environment for each mound treated. Treatment may have to be repeated because of colony movement away from the treated area due to the disturbance of the mound. The second mound treatment method incorporates granular baits. Many people do not apply these baits properly, and this hampers the efficacy of the bait. Furthermore, these baits take a longer time toward control (about seven to 14 days) as opposed to the apparent immediate elimination after a soil drench with a contact insecticide. However, broadcasting the bait over an area is by far the most efficient means of control. Use of the broadcasting method allows that individual mounds need not be located, and baiting uses the smallest amount of the active ingredient. While bait applications can control fire ants, the difficulty of their application hampers the adoption of baiting for fire ant control. Application problems with bait also promote the rapid reinfestation of treated areas by fire ants.

The objectives of this year's project were to: (1) show that strip application of baits can control fire ants effectively, and (2) extend the suppression of fire ant populations by maintaining low levels of fire ants and encouraging the establishment of non-fire ant species that may prevent or impede the reinvasion by imported fire ants in areas previously treated and cleared. Four study sites were chosen, one in Georgia and three in Alabama. At one site Amdro fire ant bait was applied using the broadcast method in part of a pasture. Researchers applied it in alternating strips in the other part of the pasture. At the other three sites they broadcast Fenoxycarb fire ant bait (Award/Logic) at a rate of approximately 1.5 pounds per acre. They made the applications in June of 1996 and they assessed the ant populations at approximately six week intervals.

The results of objective one indicate that strip applications were intermediate in their fire ant control, resulting in a 41% reduction in active fire ant mounds as compared to a 79% and 15% reduction in the broadcast and control areas, respectively. Researchers recorded similar trends for the August evaluation. Strip applications of fire ant baits have the potential of reducing application times. Since fire ants are territorial in their food or bait gathering, further studies using narrower untreated intervals may improve control with strip applications.

The results of the second objective show that they obtained more than 95% control in treated plots by the 12th week after application. The percentage of fire ants decreased by 44% and non-fire ant species increased by 157% just 19 weeks after treatment, however they sampled similar changes from the control plots. Broadcast bait applications with fenoxycarb were successful in reducing fire ant populations. Encouraging the establishment of non-fire ant populations and extending fire ant control will probably require several bait applications. The next applications are scheduled for the spring of 1997 with subsequent applications being timed with increases in fire ant populations.

As this study progresses, the team will determine treatment thresholds that are based on the number of active fire ant mounds per area, and the dominance of fire ants at baited vials. The prevalence of fire ants at bait vials indicates when fire ant populations are large enough to dominate food resources, including fire ant baits, and thus reduce the effect of the baits on non-target ant species. Minimizing pesticide exposure to non-fire ant species may allow these ants to compete with fire ants and further slow fire ant reinfestation of previously treated areas. By continuing these projects we

hope to provide a way to more effectively apply fire ant baits. We also hope to establish a fire ant treatment threshold that could help eliminate unnecessary insecticidal bait applications.

Implementation of Apple IPM Efforts
$1,500
(*Leader:* J. McVay. *Cooperators:* C. Grissom, F. Wood, D. Porch, C. Andrews, L. Kuykendall, G. Gray, and J. Sharp)

After successfully initiating the apple IPM program, this mini-grant enabled the project leader and cooperating county staff to continue to encourage adoption and implementation of the program. The ability to provide grower-cooperators with necessary traps and lures and other monitoring tools in exchange for detailed information concerning their scouting program and data concerning pest information on a block by block basis is a very important aspect of the program. The information is analyzed annually and is vital for detecting pest trends and making adjustments to the IPM program.

They expended the largest portion of the grant in the purchase of pheromone lures and traps, which the apple team installed in each of the cooperating producers IPM blocks. These monitoring tools allowed the producers and/or their scouts effectively to monitor arthropod pest populations to make management decisions throughout the season. An additional portion was used to pay a consulting fee to an apple scout in Limestone County. This amounted to 1/2 of the cost of scouting for producers in that area. This enabled the project leader to obtain more detailed information on pest populations from that important production area. The producers involved paid the remainder of the scouting costs. A minor portion went toward project leader travel.

The Alabama apple IPM program has resulted in a large reduction in the use of unnecessary insecticide and acaracide applications and an accompanying reduction in production costs during each year of its operation. Control needs vary from location to location, but most producers apply an average of at least nine fewer insecticide/acaracide sprays as compared to a calendar-driven spray schedule. This resulted in a cost per acre savings of approximately $220 each year and approximately 10 pounds fewer pesticide active ingredient applied to each acre. Annual production cost savings across the state amount to about $500,000 and pesticide reduction in close to 10,000 pounds of active ingredient each year.

Development of a Management Strategy for green June beetle, a Pest of Alabama Pastures
$3,475
(*Leaders:* K. Flanders and J. Crews)

Alabama's three million acres of perennial grass pastures are the basis of the $374 million cattle industry. Green June beetle, *Cotinus nitida*, has become a chronic pest in pastures where producers use organic fertilizers such as poultry litter. Tunnels made by the larvae loosen the soil around plants and make the plants more prone to drought stress. Grubworms leave characteristic trails of pulverized soil on the surface. When pastures are grazed, grasses growing in soil loosened by green June beetle tunneling activity are more likely to be pulled up. Thus, bare spots in pastures may also be a sign of grub injury. Weeds, such as spiny amaranth, crabgrass, and common bermudagrass, can colonize the thinned turf. Fescue pastures, and winter forages planted in infested pastures, are especially prone to injury. Gregg Hodges, County Agent Coordinator, Cullman County, estimates that 25% of the productivity of pastures is lost due to green June beetle in Cullman County alone.

The objective of this project was to develop an IPM program for green June beetle in pastures. The proposed plan of work will provide two components of this program: (1) an economic evaluation program to assist scientists, extension personnel, and growers in choosing the appropriate treatment, and (2) determine the cost-effective timing and rate for insecticide applications. To determine optimum timing rates for insecticide applications, the team established on-farm demonstrations in Geneva, Cullman, Blount, and Jackson counties. They designed each demonstration to answer a specific question. In Geneva County the study focused on determining if an insecticide application in early winter would be feasible. Cullman County was the site of a project that centered on the effectiveness of fall versus spring applications. What, if any, alternative control methods or insecticides could be used to control green June beetles was the problem being explored in Blount County, and the question of using two carbaryl applications rather than just one is being tested in Jackson County.

This work has helped develop an integrated pest management program for green June beetles. A concurrent extension effort has increased grower knowledge of IPM and green June beetle biology and impact. Researchers made four presentations on green June beetles in

1996, and they plan more for 1997. A magazine article was prepared and published in *Cattle Today*. A colored fact sheet, ANR-991, Biology and Control of the Green June Beetle, was released in November of 1996.

The Epidemiology of Ice+ Bacteria and the Efficacy of BlightBan (*Pseudomonas flourescens* A506) as a Control for Bacterially Mediated Frost Injury of Peach in Alabama
$2,000
(*Leader:* Mark Wilson)

BlightBan (a commercial product containing the beneficial bacterium *Pseudomonas flourescens* A506) is registered for the control of fire blight (*Erwinia amylovora*) and frost injury in pears. BlightBan, a bacteria itself, works when it is applied prior to a frost and utilizes the nutritional resources that would normally be used by other pathogenic bacteria; therefore it out competes the harmful bacteria. However, scientists have not evaluated BlightBan for control of diseases caused by harmful bacteria in peaches, and little information is available concerning the importance of biological ice nucleation in peaches.

In this project, BlightBan was scheduled for application by backpack sprayers to peaches in several separate orchard settings at the recommended rate of five ounces in 100 gallons of water per acre. This biocontrol agent was to be applied at both low and high rates. Due to an early hard freeze, the researchers could only apply BlightBan at the lower rate some 76 hours before the freeze event. Thus, they evaluated the proposed high and low treatments as two separate applications. The team made a second set of applications to those blossoms that survived the initial freeze. These applications occurred 96 hours before another hard freeze. After the second freeze, few viable peach ovaries remained within the orchard. BlightBan was not applied again in 1996.

Despite the early hard freeze circumstances under which the tests were run, there was success in the initial trials. BlightBan reduced the percentage of frost-damaged blooms from 60% to 42.5% even though the product was only applied once. If the BlightBan had been applied more often and under better environmental conditions the damage rates could have been considerably lower.

Statewide Survey for Incidence of Plant Viruses in Commercial Irish Potato Production in Alabama
$2,000
(*Leaders:* J. Murphy and E. Sikora. *Cooperators:* L. Tapley and E. Tunnell)

Potatoes represent one of the largest vegetable industries in Alabama. Most of the potato cropping area resides within three counties: Baldwin, Jackson, and Cullman. We know little about viral disease problems in potato crops grown in Alabama. Because potato is an early season crop, it could serve as a reservoir for several viruses that infect other crops grown throughout the summer.

In this project scientists surveyed potato fields for three viruses, cucumber mosaic virus (CMV), potato virus Y (PVY), and tobacco etch virus (TEV). Aphids transmit all three viruses in a non persistent manner. Insecticide applications cannot control those pests. Samples were randomly collected during May and June from fields in Baldwin County, Jackson County, and Cullman County. All samples were placed on ice, transported to the laboratory and tested for the presence of the three viruses by enzyme-linked immunosorbent assay (ELISA).

A total of 251 samples were collected from Baldwin County. PVY occurred most frequently, being detected in 24.7% of the samples. Testing indicated CMV in 17.1% of the samples, while the incidence of TEV was 4.4%. In Jackson and Cullman counties 211 samples were collected for analysis. PVY and CMV were detected at levels similar to those noted in Baldwin County, but surprisingly TEV occurred in 55% of the samples from those two counties.

The team will share the results from this survey with growers in the state to make them aware of the potential problems associated with plant viruses in potato. This would include yield reductions previously attributed to factors such as adverse weather conditions or other pest problems. This study also illustrates the potential for potato to act as an early season reservoir host for viruses. Growers will be made aware of the potential impact this can have on production of late season crops, such as tomato and cucurbits. Information from this survey will also require growers to reevaluate their IPM programs in terms of both virus and aphid management.

Plant Growth-Promoting Rhizobacteria as an Alternative Treatment for Methyl Bromide in the Production of Loblolly Pine Seedlings in Forest-Tree Nurseries
$3,500
(*Leaders:* S. Enebak and K. McNabb. *Cooperators:* D. McCraw, R. Bower, M. Reddy, and D. Kenney)

The use of methyl bromide as a soil-fumigant before sowing is the most common disease control practice in forest-tree nurseries throughout the United States. However, federal regulatory agencies have classified it as an ozone-depleting compound.

This broad spectrum disease, weed, and insect control treatment will not be available after the year 2001. Research to find a treatment as effective as methyl bromide is ongoing in agricultural and forestry research communities throughout the United States. A few of the potential treatments to replace methyl bromide include the use of alternative chemical fumigants and fungicides, and non-traditional treatments such as steam, solarization, crop rotations, microwaves, resistant plant varieties, and biological control. To date, however, none of the proposed treatments has been as effective as methyl bromide.

In this study the use of plant growth-promoting rhizobacteria (PGPR) as a seed treatment before sowing was used to examine its effectiveness in increasing the growth and survival of seedlings. Two conifer bare-root nurseries, both members of the Auburn University Southern Forest Nursery Management Cooperative, agreed to participate with the PGPR research trials and provided the equipment, nursery space, pine seed and maintenance of the plots. In each nursery, one section was designated for the study, of which half was treated with 375 pounds per acre of methyl bromide and served as the fumigated soil while the other half was left untreated and served as the non-fumigated soil. One week prior to sowing, loblolly pine seeds were treated with one of two bacterial isolates (*Bacillus subtillis*, *Burkerholderia cepecia*) that have been shown to be effective on other plant species. The seed was sown in April 1996 and maintained under current operating practices which included weed, insect and rust control, top and root pruning to maintain seedling outplanting characteristics, and applications of fertilizer to maintain seedling vigor over the growing season. The emergence of seedlings within treatments was assessed five, 15 and 24 weeks after sowing. Seedling information gathered within each plot included germination rate, survival, damping-off, cutworm damage, weeds and soil-borne fungus levels. At the end of the growing season, 25 seedlings within each of the treatment plots were removed from the soil and seedling characteristics such as grade, stem caliper, height, biomass, and root area were determined.

The result of the testing showed that there was little, if any, impact made by the addition of the PGPR to the seeds. Given the results of the two nursery trials, they can make no decision as to the effectiveness of PGPR seed treatment as an alternative to methyl bromide fumigation. Proper comparisons between the two treatments would be to compare non-fumigated/bacteria plots to fumigated/control plots. In both nurseries the difference between those treatments was not significant based on statistical analysis (although the non-fumigated/bacteria had fewer seedlings than the fumigated/control plots). Thus, based on these two trials, the extra cost to treat the seed is not economically justified when sowed into either a fumigated or non-fumigated soil bed. Plans for the upcoming growing season include a repeat of the same experiment, sown in the same nursery section in both nurseries. In this way, the soil section classified as non-fumigated will have had three growing seasons since the last treatment of methyl bromide and the fumigated plots will have had two growing seasons without fumigation. The deleterious soil-borne pathogens may have increased to levels in these areas to show an increase or decrease in the number of seedlings.

Implementation of TOM-CAST for Control of Early Blight on Tomato
$3,500
(*Leaders:* E. Bauske, M. Baltikauski, and E. Sikora)

Producers apply fungicides to tomatoes in Alabama primarily to control early blight, caused by the fungus *Alternaria solani.*

Development and spread of early blight occurs under warm, wet conditions, and it causes severe defoliation resulting in reduced fruit number and quality. Because of the crop's high value and it's susceptibility to disease, growers may make 10 or more fungicide applications during the growing season. TOM-CAST is a weather-based spray program for control of early blight, Septoria leaf spot, and anthracnose. TOM-CAST uses hourly temperatures and leaf wetness measurements to determine optimum fungicide spray applications. Researchers have tested TOM-CAST in Alabama and it was proven effective. On average a grower will save three applications per season using TOM-CAST.

The goal of the project was to increase grower confidence in TOM-CAST by demonstrating its effectiveness on farms. Originally the plan was to release TOM-CAST advisories via an electronic bulletin board, the Internet, and the County Extension Office. But, due to a lack of federal funding, the Southeast Agricultural Weather Service Center of the National Weather Service was closed. This affected all aspects of the ACES Weather Program and the project had to be delayed one year while the program regrouped and reorganized.

Biological Control of Southern Red Mite (*Oligonychus ilicis* McGregor) for Nursery Production
$3,000
(*Leaders:* C. Hesselein and M. Williams)

Southern Red Mite (SRM) is the most important cool weather arthropod pest for nursery producers in the Southeastern United States. Many ornamental plants host this mite, and it is particularly destructive to Japanese hollies, azaleas and camellias. SRM is similarly problematic to producers because of its rapid rates of reproduction. Often infestations which are not detected at the producer's property will become a problem at the customer's when the temperatures increase and mite populations explode. While many pesticides control SRM (e.g., acephate, insecticidal oils, dienochlor) it is difficult for nursery producers to achieve thorough coverage in the dense canopy of finished, market ready, plant material. Discussions with various growers have led to the belief that with some guidance, growers would be willing to use effective biological control agents for control of this pest.

The study will be conducted in two stages, the first stage in the laboratory at Auburn University, the second at the Ornamental Horticulture Substation in Mobile. The initial study will involve the screening of several predatory mites species to determine which, if any, can successfully utilize SRM as a host. The second stage of the study will be field trials of those predatory species determined to be successful predators in stage one. Though the experiment did not take place in 1996, plans are to begin it in 1997 with the aid of several new employees.

FEDERAL FUNDING

IPM of Arthropod Pests in Urban Environments — $20,000
(F. Oi, A. Appel, B. Forshler, and P. Koehler)
National IPM Implementation Program (USDA/CSREES/Land Grant Universities)

Urban arthropod insects such as cockroaches, ants, termites, and fleas can spread disease, bite and sting, and destroy homes and property. No cohesive IPM strategies exist for controlling arthropod pests in and around structures, although tactics exist for a few individual urban pests. Chemical control is usually the first choice for control of urban pest, and residents in the Southeast are exposed to higher levels of pesticides in the home when compared with residents in other parts of the country. Through a series of three meetings, the urban IPM team will develop an IPM program to augment current control tactics simultaneously for arthropod and vertebrate pests with structural modifications. IPM training and education for the general public, pest control, and building construction industries will be conducted through the cooperative extension system, county agents, and association (housing, building, and pest control) seminars and workshops. State regulatory agencies will be enlisted to create a state certification program for urban IPM. Such certification would result in economic and environmental benefits, and serve as an incentive to use IPM.

The economic and environmental impact of our IPM program to homeowners/renters will include a measurable decline of pests in the home, leading to a decrease in the amount of money spent on pest control; a decrease in pesticide use, leading to improved environmental quality of the areas in and around homes; and decreased property (structure and belongings) loss due to insect damage, leading to less spent on repair and replacement. Pest control companies that follow the IPM program will produce knowledgeable personnel who do a better job in pest control. The second highest cost of running a pest control business is liability insurance, and insurance rates can decline because pesticide use and possibility of misuse will decrease. Furthermore, completion of a state certified IPM program will help pest control operators defend against frivolous punitive damage claims because they can document the use of proper IPM procedures. Finally, reduced chemical usage will have a positive impact on the environment.

The building construction industry will benefit from the IPM program because their liability will be limited during the first five years after construction of a structure for building "pest-resistant" houses. Pest-resistance via structural modifications will enhance the image of the building construction industry and improve salability of structures by advertising certified pest-resistant construction. Pest-resistant structures will be attractive investments to homeowners and the benefit to the environment will be positive because reduced amounts of pesticides will be used for pest control after structural modification.

Implementation of Tomato IPM Practices — $127,000
(E. Bauske, C. Monks, E. Sikora, G. Zehnder, M. Patterson, D. Monks, R. Heiniger, R. Goodman, and J. Kemble)
USDA Southern Regional IPM Program.

Improved pest control strategies exist for fungal and insect pests of tomato, and are in developmental stages for weed control. The overall goal of this project is to develop a comprehensive IPM program for fresh market tomato production that controls all major pests (diseases, weeds, and insects) typically encountered by tomato growers in the southern region. This project will allow producer participation to modify the IPM strategy, and will give producers a stake in the outcome. The effectiveness of simultaneous use of TOM-CAST (a weather-based pest control recommendation system) and a disease and insect scouting program will be demonstrated in six on-farm tests with the cooperation of producers in key tomato production areas in Alabama. IPM practices will be compared with standard disease and insect management practices, evaluated by producers and investigators, and modified as needed.

The efficacy and crop safety of flame cultivation, mechanical cultivation, mulching, and various combinations of these practices for controlling weeds in vegetable crops will be determined in field tests in both Alabama and North Carolina. Producers and investigators will evaluate those successful nonchemical techniques incorporated into the six IPM on-farm demonstrations. They will also assess and compare the economic performance of IPM practices with the performance of standard pest control practices. They will distribute results to producers in language that is readily understandable. To provide the producers with the information necessary to continue using the IPM practices, the team will develop a producer-oriented publication describing the IPM practices. The publication will emphasize the importance of a scouting program, TOM-CAST, pest identification, weed control, and economic aspects of IPM.

A Biologically Based IPM Program for Control of Cucumber Mosaic Virus on Tomato — $84,500
(G. Zehnder, J. Murphy, E. Sikora, and J. Kloepper)
USDA Southern Regional IPM Program.

The overall goal of the project is to develop a biological control system for the cucumber mosaic virus (CMV) and the aphid vector of the virus. This has been a limiting factor in Alabama tomato production in recent years, particularly in northern Alabama. Our project is based on induced systemic resistance (ISR) to diseases and insects resulting from seed treatment with beneficial bacteria, which has been reported in greenhouse and field trials at Auburn University over the past five years. After examining the results from previous work with plant growth promoting rhizobacteria (PGPR) and ISR in cucumber, it is believed that this technology can be used in tomatoes as well (e. g., that CMV severity will be reduced, and that insect transmission of the pathogen will decline). Several PGPR strains will be evaluated for induced resistance against CMV in the greenhouse where plants will be mechanically inoculated with the virus. They will also evaluate the strains under field conditions where natural aphid populations and CMV inoculum exist.

The group will also investigate PGPR effects on feeding, development, and virus transmission in aphids, the most important group of insect vectors of plant viruses. The specific objectives of the first two-year phase of this project will be the following: (1) evaluate first the capability of selected PGPR to control CMV on tomatoes in the greenhouse, and then compare PGPR treatment efficacy with standard insecticide treatment for control of aphid-transmitted CMV in field tomatoes, (2) determine the effects of PGPR on aphid feeding and development on tomatoes, and (3) determine the influence of PGPR treatment on natural aphid transmission of CMV on tomatoes.

In the first year of the project six PGPR strains were selected for field testing based on greenhouse screening experiments for protection against CMV symptoms on tomatoes. Field experiments showed that tomato treated with PGPR strains showed significantly reduced symptoms of CMV infection. Those tomato plants also had lower ELISA absorbency readings, indicating reduced presence of the virus in plant tissue. In addition, PGPR treated tomato had greater yields than the non treated tomato. Field experiments will be repeated in 1997, and concurrent experiments will be done to determine whether the PGPR treatment affects aphid feeding behavior and transmission of the virus.

Control of Cucumber Beetle and Bacterial Wilt of Cucurbits with Beneficial Bacteria — $119,000
(G. Zehnder, J. Kloepper, and G. Wei)
USDA Pest Management Alternatives Program.

This project addresses the control of bacterial wilt disease and the cucumber beetles that transmit the disease in the field. This represents a critical need in cucurbit production because producers spray pesticides routinely to prevent loss of yields from bacterial wilt disease, yet are largely ineffective for control. In addition, pesticide residues represent a health and food safety hazard. Furthermore, the residues are undesirable, particularly to the cucumber processing industry (e.g., Campbell and Vlasic Foods) who have made a commitment to implementing alternative pest management strategies on their farms when such strategies are available.

The team has found that seed treatment with specific strains of beneficial bacteria, also called plant growth-promoting rhizobacteria (PGPR), induces resistance in cucumber against bacterial wilt disease, and against cucumber beetle feeding which spreads the disease. They have also shown that PGPR induce physiological changes in the plant leading to reduced levels of the cucumber beetle feeding stimulant cucurbitacin. These previous experiments were done with a slurry of laboratory-cultured, vegetative PGPR cells.

The underlying hypothesis of this project is that these results can also be achieved using PGPR spore preparations. These spore preparations are required in a commercial seed treatment because bacterial spores are much more resistant to environmental stresses than vegetative cells and have a much greater shelf-life. Based on previous work, the team will select six of the most promising PGPR strains that have shown induced resistance against bacterial wilt. Then they will conduct experiments in the greenhouse and in experiment station plots to test the hypotheses that seed treatment with spore formulations of PGPR will induce resistance in processing and fresh-market cucumber cultivars to bacterial wilt disease, and will inhibit feeding and spread of the disease by cucumber beetles. It will also be determined whether PGPR spore formulation treatment reduces levels of the beetle feeding stimulant cucurbitacin. The most effective PGPR strains will be evaluated in on-farm trials supervised by Campbell Research and Development and Vlasic Foods, who will provide the efficacy data needed for registration by the EPA. If registration is achieved, Campbell will adopt the seed treatment as part of their IPM program. In addition, Gustafson will involve the vegetable seed industry in initial testing of promising PGPR strains, thereby transferring the technology throughout the U. S.

Agricultural Systems Management with Current Technologies: On Farm Application of Doppler Radar — $153,000
(K. Bowen, E. Bauske, P. Backman, and A. Hagan)
USDA NRI Grant

Precipitation is the most important environmental parameter in agriculture. Rainfall is critical for crop growth, and disease and pest population development. Currently, there are approximately 133 official rainfall observations collected throughout Alabama, which provides inadequate data for use on an individual farm in routine management decisions. Estimates of rainfall from WSR-88D (Doppler) radars have a 2 km x 2 km resolution, which is better than that provided by the current network. Weather-based control strategies exist for fungal and insect pests of many crops. In the southeastern United States, where the pests of peanuts are particularly important, researchers have shown that they can maintain control, reduce the number of pesticide applications, and improve yields by using weather-based control strategies.

The ultimate goal of this project is to use WSR-88D radar estimates of precipitation to assist in on-farm decision making and increase profits while reducing pesticide inputs. This will be accomplished by verifying the accuracy of WSR-88D rainfall estimates in comparison to rain gauge data; integrating WSR-88D radar data into pest advisories and verifying the accuracy of advisories; distributing advisories through electronic communication media; and evaluating the net returns to producers. The integrated management of insects, foliar disease, and aflatoxin contamination of peanuts in the southeastern United States has been chosen as a model system to test the application of WSR-88D radar precipitation estimates.

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