Crop Production
FY 2003 National Program 305 Annual Report

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Introduction

The goal of the Crop Production National Program is to develop technologies for sustainable crop production that are applicable to small, medium, and large-sized farms in a variety of production systems. Program outcomes ensure and promote the use of sustainable agricultural production systems, as well as organic farming systems. Research includes, but is not limited to, models and decision aids, integrated pest management of multiple pests in a holistic approach, sustainable cropping systems, economic evaluation, automation and mechanization to improve labor productivity, application technology for agrochemicals and bioproducts, sensor and sensing technology, controlled environmental production systems, and worker safety and ergonomics. The program also focuses on all aspects of bees as efficient pollinators and honey producers, as well as their protection and management.

Specific accomplishments made by ARS in its FY 2003 crop production research are listed below. The annual progress reports for each of the research projects assigned to the Crop Production National Program can be viewed at this site to obtain additional information on progress and accomplishments.

Selected Accomplishments by Component

Component I. Integrated Production Systems

Yield estimates for grapes and wine. Accurate yield estimates are critical for growers, juice processors, and wineries to make decisions on crop thinning, harvest, and the management of finite processing facilities; but the current standard method is based on hand sampling and provides only limited information and static estimates. ARS scientists at the USDA-ARS Horticultural Crops Research Unit, Corvallis, Oregon, and located at Prosser, Washington, in collaboration with faculty at Washington State University, have developed an automated method of measuring trellis wire tension and vibration frequencies to estimate grapevine yield. This novel method improves production efficiency by saving labor and by providing nearly continuous estimates of fruit mass and has the potential to enhance production management strategies across hundreds of thousands of acres of vineyards in the United States and elsewhere.

Pecan abnormality corrected. The increasing incidence, severity, and negative economic impact of a physiological abnormality of pecan, termed "mouse-ear", merited research to learn the cause and to provide a cure. Scientists at the USDA-ARS Southeastern Fruit and Tree Nut Research Laboratory in Byron, Georgia, investigated the problem. The disorder was discovered to be due to a nickel (Ni) deficiency. This discovery will allow for development of improved nutrient management strategies that will improve orchard profitability and likely reduce applications of nitrogen, zinc, and copper in pecan production.

Earlier planting increases cotton yields. Depressed cotton prices are forcing growers to reduce input costs and to improve yields in order to sustain profitability. To increase yields of quality cotton, growers need new technology to improve their production practices. ARS scientists at the Crop Genetics and Production Research Unit in Stoneville, Mississippi, conducted a long-term study of early planting on cotton yield and fiber quality. Early planting was found to increase yields by about 10 percent with no major effect on fiber quality. Growers can use these findings to increase yield by planting cotton earlier, which in the Mississippi Delta Region is early April.

Mechanical removal of post-harvest sugarcane is necessary. Environmental concerns are jeopardizing the sugarcane industry's use of burning as a tool to remove plant residues either to increase harvesting efficiency and sugar recovery or to avoid yield loss of subsequent crops. ARS scientists at the Sugarcane Research Unit in New Orleans, Louisiana, found that the presence of a blanket of residue at the start of the sugarcane ratoon crop's production year slowed the emergence and development of the crop. Cold soil temperatures and high rainfall exacerbate the slower growth. Therefore, growers should mechanically remove post-harvest residues, at least from the row top, as soon after harvest as possible. The research findings will lead to more productive and environmentally sustainable sugarcane production.

Subsurface drip irrigation can save money for cotton growers. Growers tend to apply nitrogen fertilizer to cotton following peanut at rates higher than is recommended by current management practices. ARS engineers and scientists at the Peanut Research Laboratory in Dawson, Georgia, in cooperation with the University of Georgia, found that when nitrogen fertilizer was applied at two rates through a subsurface drip irrigation system with two lateral spacings there were no differences in cotton yield or grade. These results indicate that using subsurface drip irrigation to supply the recommended nitrogen rate to cotton could save producers millions of dollars in fertilizer cost without reducing yield or grade of cotton.

Component II. Agroengineering, Agrochemical, and Related Technology

Improved sorting for apple defects. An automated apple defect detection/sorting system would reduce packing labor costs, improve labor productivity, and provide the consumer with consistent high quality fruit. ARS Engineers at the Appalachian Fruit Research Laboratory in Kearneysville, West Virginia, in cooperation with Cornell University, developed a conveying system that positions apples in the desired orientation for automated detection and sorting of fruit with defects. Tests showed that nearly 98 percent of apples from fourteen cultivars were oriented properly. This development of apple orientation technology is a key step towards implementation of the effective, automated apple sorting needed to improve economic competitiveness of the U.S. apple industry.

Better nematode application for biocontrol. Use of biological control agents, such as entomopathogenic nematodes (EPNs), are limited by a lack of understanding on how to deliver nematodes to the target area with minimal damage. ARS engineers and scientists at the Application Technology Research Unit in Wooster, Ohio, conducted laboratory experiments and computer simulations to determine the stresses that EPN would be subjected to when delivered through typical commercial delivery systems. Nematode viability was dependent on the size and host-seeking behavior of the nematodes, as well as on the type of agricultural nozzle through which they were delivered. These findings demonstrate to equipment manufacturers, nematode suppliers, and pest management specialists the methods of application that insure greatest nematode viability and greatest pest control potential.

Spray adjuvants properly used reduce pesticide drift. Off-target spray drift deposition is a significant problem associated with aerial application of agricultural production and protection materials. ARS engineers and scientists at the Areawide Pest Management Research Unit, Southern Plains Agricultural Research Center in College Station, Texas, atomized newly marketed drift retardant adjuvants in a high-speed wind tunnel to assess their ability to increase spray droplet size and thus reduce the number of fine droplets in the driftable component of the spray spectrum. Most of the twelve test adjuvants increased droplet size and reduced driftable fine droplets, but three were ineffective, and five were not sufficiently effective to change the spray distribution from a fine to a medium spray category. This accomplishment provides aerial applicators with the information required to select spray drift retardant adjuvants that will significantly reduce or eliminate off-target spray drift.

Ceramic pesticide application nozzles are more environmentally friendly. Off-target spray drift deposition is a significant problem associated with aerial application of agricultural production and protection materials. There is need for nozzles or other droplet formation techniques that will produce fewer fine, driftable droplets than those produced by metal disc core nozzles. ARS engineers and scientists at the Areawide Pest Management Research Unit, Southern Plains Agricultural Research Center in College Station, Texas, used a high-speed wind tunnel to develop an atomization model that describes the performance of ceramic nozzles over a wide range of aerial application hardware and operational conditions. Ceramic nozzles produced significantly lower percentages of fine droplets than did commonly used metal nozzles. This accomplishment shows that use of ceramic nozzles should result in reduction of spray drift (as compared to metal nozzles), which would improve aerial application efficiency and reduce adverse environmental impacts.

Sensor measures moisture of baled cotton. The loss of quality in baled lint during long-term storage has been traced to excessive moisture of the lint as a result of improperly controlling moisture restoration systems during ginning. Improved moisture sensing technology is needed for management to avoid these significant losses. ARS engineers at the Cotton Production and Processing Research Unit in the Cropping Systems Research Laboratory, Lubbock, Texas, in cooperation with a private company developed a novel low-cost microwave-based cotton bale moisture sensor. Suitable frequencies and algorithms for calibration of the sensor were found by using a high-end microwave impedance analyzer that was then replaced with low-cost circuitry. This research has resulted in development of a low cost instrument that can be used by managers in the cotton ginning industry to avoid cotton quality losses associated excessive moisture.

Component III. Bees and Pollination

Finding that lipids stimulate germination of bee disease may provide management options. The single most important pollination management concern of U.S. alfalfa seed producers is a chalkbrood disease that kills immatures of the alfalfa leafcutting bee. This bee pathogen has been notoriously difficult to culture, and existing tests for spore germination give highly variable results. Scientists at the Bee Biology and Systematics Laboratory, Logan, Utah, collaborating with scientists at the Biosciences Research Laboratory, Fargo, North Dakota, recently discovered that lipids act to stimulate the germination of chalkbrood spores. Very few fungi are known to require lipids for germination or growth; however, the alfalfa leafcutting bee has unusually large stores of lipids. These results will be used to develop a reliable and standardized chalkbrood spore viability test and will form the basis of investigations leading to management options for beekeepers designed to disrupt the disease cycle in commercial-scale populations of the alfalfa leafcutting bee.

ARS scientists in Logan, Utah, provide information to Federal land managers in inventory of native pollinators. The National Park Service has identified the inventory of native pollinators as a high priority for management planning. In response to this need, scientists at the Bee Biology and Systematics Laboratory, Logan, Utah, are providing information on native pollinators to land managers and recently completed the fourth year of a survey of the bee pollinators of Grand Staircase-Escalante National Monument. This work has highlighted the importance of long-term studies for monitoring the health of pollinator services. Similar projects are currently underway in the John Muir National Historic Site and Great Smoky Mountains National Park. The expanding demand for this information among Federal land management agencies has led to the development of joint efforts on native pollinators and their impact on rare plants, fire, and grazing management in Zion National Park, Yosemite National Park, and with the Bureau of Land Management, Clark County, Nevada. These scientists also lead the development of a world checklist of bees at the request of the U.S. Geological Survey. A prototype using one subfamily of bees was initiated during an international workshop and completed this year by the research team.

Parasitic mites of honeybees transmitting viruses to uninfected bees. Honeybee colonies are threatened by an assortment of parasites, pathogens, and pests that affect their well-being. Research was conducted to evaluate the role of parasitic mites in transmitting honeybee viruses. Scientists at the Bee Research Laboratory in Beltsville, Maryland, demonstrated conclusively that parasitic mites of honeybees are capable of transmitting viruses from infected bees to uninfected bees. Using molecular techniques, researchers were able to calculate the transmission efficiency from mites to bees and demonstrate that non-infected mites can acquire virus by sharing the same cell with one or more infected mites. The immediate impact is a better understanding of how bee viruses are spread between bees and emphasizes the importance of mite control.

Identification of difference in the chemical profiles of European and Africanized honey bee queens may lead to better processes to requeen Africanized hives. Once European honey bee colonies become Africanized, it is difficult to introduce European queens successfully. Studies to determine why there is such a low acceptance rate for European queens in Africanized colonies are being conducted at the Carl Hayden Bee Research Center in collaboration with CRADA partner Pima Research, Tucson, Arizona. Scientists developed a technique to sample volatile compounds emanating from honey bee queens and analyze them using gas chromatography and mass spectroscopy. They found that European and African queens differ in volatile chemical profiles and that this factor might be responsible for the low acceptance rate of European queens into Africanized colonies. These findings will serve as the basis for developing new recommendations and tools to enable beekeepers to requeen Africanized colonies with European queens.