Component II: Protection of Agricultural and Horticultural Crops

2m. Legume Field Crops [U.S. Value 2007: $38 billion (peanuts, alfalfa, dry bean, pea, lentil)]

Problem Statement: The principal legume field crops (soybeans, peanuts, and alfalfa) do not produce maximum yields due to the following pests.

- Lygus and Alfalfa Plant Bugs (alfalfa, especially seed alfalfa in the northwestern United States)
- Soybean Aphid (soybeans)
- Brown Marmorated Stink Bug and Other Stink Bugs (soybeans and peanuts in southern states)
- Sporadically and Regionally Important Pests (including; various Lepidoptera species; several species of alfalfa aphids; thrips which vector diseases; planthoppers; alfalfa weevil; slugs, grubs, millipedes, and other soil pests; bean leaf beetle, pyrethroid-resistant corn earworm, and other foliar feeders; and native *Dectes* stemborers)

Research Needs:

1. **Lygus and Alfalfa Plant Bugs**

   Importance: Several lygus bug species (tarnished plant bugs) are among the most economically damaging insects for many crops in North America. They reduce the yield and quality of seed alfalfa and many other important food, fiber, and seed crops. The importance of lygus has increased because of the development of pest resistant bioengineered crops and area-wide management programs that reduce the impact of other key pests, and development of lygus resistance to widely used insecticides. The introduced European alfalfa plant bug damages seed alfalfa and other forage legumes throughout the United States. Native natural enemies do not cause significant mortality in plant bug populations.

   Research Gaps: A better understanding is needed regarding the movement of lygus between host plants. Research is needed regarding the role of landscape ecology in governing the increase and dispersal of plant bug populations and their natural enemies. New management tools, especially biological control agents adapted to specific climatic regions and integrated areawide approaches, are needed to combat resurgent lygus populations in many parts of the United States.

   Actions: ARS will:

   Basic Biology

- Study and implement novel molecular-based control strategies for whitefly and plant bugs.
- Identify and functionally characterize genes/proteins in sucking pests with application for disruption of key physiological processes.

Monitor, Dispersal Behavior

- Determine the extent to which lygus bugs and their associated natural enemies disperse between key cropping systems including alfalfa, cotton and new cropping systems such as lesquerella and guayule.

Control, Biological

- Conduct foreign exploration in Europe, Africa and Asia for new biological control agents of lygus and alfalfa plant bug, based on host specificity and climatic tolerances for establishment in the United States.
- Determine the impact of introduced biological control agents on lygus in alfalfa and other host crops in the United States.

Genetics

- Use molecular genetic markers to clarify the relationships among lygus species and populations and assist in biological control agents with their hosts.

2. Soybean Aphid

Importance: The invasive Asian soybean aphid (SBA) was detected in 2000 in the northern United States and rapidly spread throughout soybean production regions in the United States and eastern Canada, resulting in major changes in soybean insect management and increased use of pesticides. Aphid populations vary regionally, with the north central states experiencing the greatest levels of damage. SBA outbreaks often correspond to potyvirus outbreaks in other legume crops including dry beans and snap beans, and other crops including vine crops and potato, thus extending the overall impact of this species beyond soybeans. Soybean aphid overwinters on several introduced buckthorn species that are widespread in North America, but the influence of this landscape interaction on SBA populations in soybean is not well understood.

Research Gaps: Environmentally sustainable management methods are needed to reduce soybean aphid populations and reduce management costs to farmers. Biological control by natural enemies is one sustainable strategy with great promise. Efforts to introduce new biological control agents and to conserve native and naturalized natural enemies both contribute to this approach. Screening of candidates for biological control introductions, based on host specificity and climatic tolerances, introduction of the most promising species, and evaluation of impact on target and non-target species are necessary. In addition, efforts are needed to develop and evaluate cultural and host plant resistance management tactics. Research is also needed to understand the role of aphid dispersal and overwintering aphid populations on buckthorn in reinfesting soybeans the following season.

Actions: ARS will:

Landscape Ecology

- Determine the impact of resident biological control agents on soybean aphid populations in overwintering host reservoirs.

Control, Biological

- Determine the impact of resident biological control agents on soybean aphid populations in North American soybean production regions.
- Determine the microhabitat preferences, alternate prey or hosts, and dispersal behavior of effective natural enemies in relation to soybean aphid infestation patterns in time and space.
- Develop conservation biological control strategies for effective natural enemies.
- Conduct foreign exploration in Asia for new biological control agents . Screen, introduce, and evaluate the impact of candidates for biological control introductions, based on host specificity and climatic tolerances.

Control, Host Plant Resistance

- Develop and evaluate host plant resistance mechanisms and management tactics.
- Determine how aphid-resistant soybeans can be integrated with other management strategies, such as biological control.

Control, Organic Systems

- Develop organic management systems for controlling insect pests in soybeans.

Control, Fundamental Biology or Biological Controls

- Conduct research on behavioral and genetic determinants of host specificity.

3. Brown Marmorated Stink Bug and Other Stink Bugs

Importance: Several species of stink bugs are increasingly of concern as pests in soybeans and peanuts in southern states. Brown marmorated stink bug is a new invasive species of Asian origin with the potential to impact soybeans in the United States as its range continues to expand. The red-banded stink bug has been shown to cause 'flat pod' syndrome and delayed maturity. Stink bugs also occur in peanuts, where their impact is not yet clear.

Research Gaps: The biology and ecology of key stink bugs that occur in soybeans and peanuts need to be fully understood prior to the establishment of effective new or modified scouting methods and injury thresholds. This knowledge also is essential to the development of new environmentally sustainable management practices such as the introduction of biological control agents, conservation of native naturalized natural enemies, and establishment of effective cultural and host plant resistance-based management tactics. The status of brown marmorated stink bug a developing pest of soybeans needs to be monitored and prospects for its biological control evaluated.

Actions: ARS will:

Biology and Ecology

- Develop improved and novel methods for understanding the biology and ecology of stink bugs.
- Determine the impact of agricultural landscapes on populations of stink bugs and their natural enemies.
- Characterize dispersal and seasonal phenology of stink bugs and their natural enemies.
- Collaborate with plant pathologists to determine the ability of stink bugs to vector plant pathogens.

Attractants

- Identify and synthesize promising semiochemicals with activity for brown marmorated stink bug.

Monitoring

- Improve sampling and monitoring methods for stink bugs using traps baited with an attractant.

Control, Chemical

- Investigate the efficacy of lethal and sub-lethal doses of insecticides on management of stink bugs.

Control, Novel Methods

- Develop neuropeptide mimics that may be formulated as novel control agents for pest management.

Control, Biological

- Assess the impact of current pest intervention strategies on stink bugs and their natural enemies, and develop strategies that are less disruptive to natural enemies.
- Develop and enhance biological control strategies for suppression of stink bugs in area-wide pest control systems for southern row crops.
- Conduct foreign exploration in Asia for new biological control agents of brown marmorated stink bug and evaluate new agents for host specificity and efficacy.
- Determine the impact of resident biological control agents on brown marmorated stink bug populations in the Mid-Atlantic region.
- Cooperate in programs to establish new agents of brown marmorated stink bug and evaluate their impact on the target and monitor for impact on selected nontarget species.

Control, Germplasm Resistance

- Evaluate soybean germplasm for resistance to stink bugs.

Control, Organic Systems

- Develop organic management systems for controlling stink bugs in peanuts.

4. Sporadically and Regionally Important Pests

Importance: Various native and long-established pests are increasing in soybeans. Populations of soil pests (such as slugs, grubs, and millipedes) and foliar feeders (such as bean leaf beetle) are increasing in many regions. This is also true for the stemborer, *Dectes*. In addition, pyrethroid-resistant corn earworm abundance and distribution appears to be increasing in the eastern United States. Other legume crop pests are sporadically or regionally important, including several aphid species, leafhoppers (alfalfa) and planthoppers (alfalfa), alfalfa weevil, thrips (important as disease vectors), and various species of Lepidoptera.

Research Gaps: New or modified scouting methods, injury thresholds and management tools need to be develop that are able to adjust to changes in pest impact and distribution. Many of the pests in this category are not being actively addressed by ARS programs.

Actions: ARS will:

Control, Minor Use Pesticides

- Provide data to support registration/re-registration of minor use pesticides for legume forage crops.

Control, Organic Systems

- Develop organic management systems for controlling insect pests in peanuts and soybeans.

Anticipated Products:

- Increased knowledge of pest biology, ecology, behavior, genetics, and biological control agents, and of plant traits conferring pest resistance.
- Discovery, characterization, and synthesis of insect attractants, repellents and behavioral disruptants.
- New biological control agents.
- Increased knowledge of the genomics and basic biology and ecology of biological control agents.
- Identification of plant traits that might be used to develop pest-resistant plants.
- Development of crop plants with pest resistance.
- Novel methods of reducing the impact of insect pests of soybeans, peanuts and alfalfa.
- Information on trap crops as potential tools for pest management.

- Improved pest sampling and detection methods.
- Improved understanding of determinants of viral vector competency for pests.
- Mating disruption.

Potential Benefits (Outcomes):

- Strategies for improved IPM for insect pests of soybeans, peanuts and alfalfa.
- Reductions in crop losses to insect pests of soybeans, peanuts and alfalfa and the plant diseases they transmit.
- Reductions in expenditures to manage insect pests.
- IPM tactics that are ecologically sound.

USDA ARS Resources:

- Areawide Pest Management Research Unit, College Station, Texas
- Arid-Land Agricultural Research Center, Maricopa, Arizona
- Beneficial Insect Introduction Research Unit, Newark, Delaware
- Biological Control of Insects Research Unit, Columbia, Maryland
- Biological Control of Insects Research Unit, Stoneville, Mississippi
- Crop Protection and Management Research Unit, Tifton, Georgia
- European Biological Control Laboratory, Montpelier, France
- Fruit and Vegetable Insect Research Unit, Wapato, Washington
- Insect Behavior and Biocontrol Research Unit, Gainesville, Florida
- Insect Genetics and Biochemistry Research Unit, Fargo, North Dakota
- Integrated Cropping Systems Research Unit, Brookings, South Dakota
- Invasive Insect Biocontrol and Behavior Laboratory, Beltsville, Maryland
- Sino-American Biological Control Laboratory, Beijing, China
- Southern Insect Management Research Unit, Stoneville, Texas