CROP PROTECTION RESEARCH

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EDUCATION
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AGRICULTURAL
RESEARCH

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FOREWORD

Crop Protection

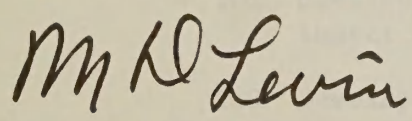
Research included in this report is conducted to improve crop protection technology including biological and chemical methods to control insects, diseases, weeds, nematodes, and other pests while at the same time retaining or improving the quality of our environment.

New multidisciplinary concepts for pest management and control include the development and integrated use of conventional pesticides; behavior control chemicals such as pheromones and attractants; genetic techniques, parasites, predators, pathogens, and weed-feeding insects; disease and insect resistance in host plants and plant growth chemicals.

The research workers in the Science and Education Administration (SEA)/ Agricultural Research (AR) publish the results of their investigations in the open literature as quickly as sound scientific judgment warrants. This is an administrative report to provide for those interested in the results of this work a brief overview of the scope of the activities and examples of recent findings, some of which still have not been released by publication. No attempt is made at completeness.

This report outlines the research for which the Crop Protection Staff is responsible and provides a brief description of recent accomplishments at the various locations throughout the United States. The report is organized by SEA/AR National Research Programs, each of which describes a separate subject matter area. The SEA/AR National Research Programs are subdivided into Technological Objectives which more specifically describe the objectives of each area of research.

Readers who have comments or inquiries are invited to contact either the National Program Staff or, more appropriately, scientists at the locations where the research is conducted.



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Chief
Crop Protection Staff

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SUMMARY

Crop protection research is an integral part of the total research program in the Science and Education Administration. The research is described under eight National Research Programs (NRP) and three Special Research Programs (SRP). A brief summary of each NRP and SRP is provided in the front of this volume. More detailed reports for each NRP and SRP follow with selected examples of progress and publications.

NRP 20220 Insect Control-Horticultural Crops

The mission of this National Research Program is to provide through research new or improved methods which may be used to reduce the losses to horticultural crops caused by insects and mites. The program elements are identified as research on the biology and control of insects and mites associated with citrus fruit, tropical and subtropical fruit, pome fruit, stone and small fruits, tree nuts, vegetables, shade trees, nursery stock, ornamental plants, and other horticultural crops. Research approaches employed in this work include (1) chemical control, (2) biological control, (3) attractants, (4) cultural control, (5) genetic studies, (6) host plant resistance, (7) disease vector control, and (8) integrated pest management. Providing technology for protecting horticultural crops from damage by insects and mites is an essential component for the production of steady, reliable, and safe supplies of these crops that are reasonable in cost to the consumer yet profitable to the farmer. This research is conducted at 15 locations by 53 scientists. Especially noteworthy progress has been made in the following areas: (1) synthesis of the pheromone for Comstock mealybug, (2) pheromonal control for two peach tree borers, (3) multi-insect resistant apple selections, and (4) biological control agents for vegetable, citrus, and pecan insects.

NRP 20230 Cotton and Tobacco Insects

Research is conducted to develop new and improved practices for controlling insects and mites attacking cotton and tobacco. Practices may be used alone or in integrated systems on a farm-by-farm or area-wide basis, but emphasis is placed on integration of several methods into a total production system, since this approach provides the greatest potential for improving insect control. Control technologies being developed include genetical methods, attractants, parasites and predators, microbial agents, insect and plant growth regulators, insecticides, cultural practices, and resistant varieties. Research is also conducted on survey methods, loss thresholds, and descriptive and predictive insect population models to develop a basis for implementing various control technologies and integrating them into production systems.

Recent advances include: (1) successful evaluation of plastic formulations of a sex pheromone for control of the pink bollworm; (2) utilization of radar to detect insects in flight; (3) precise quantitation of the efficacy of pheromone traps for detecting boll weevil populations; (4) isolation of an improved strain of a bacterial insect control agent; (5) development of new methods for distributing egg parasites to substantially reduce costs; and (6) successful infusion of the backcross sterility character into a native population of the tobacco budworm. Significant improvements have also been made in crop and insect models for use in setting research priorities and in pest management decision making.

NRP 20240 Insect Control-Grains, Forages, Sugar Crops, and Oilseeds

The primary objective is to develop new and improved control methods, tactics, and strategies to reduce insect related losses of corn, small grains, sorghum, grass and legume forages, sugarbeets, sugarcane, soybeans, peanuts, sunflowers, and other field crops. This research, in cooperation with State and industry scientists, is to provide the knowledge needed to protect more than 300 million acres of field crops and one billion acres of grazing land from insect attack. During 1979 significant advances were made in many areas of field crop insect pest management. Several releases were made of insect resistant germplasm and crop varieties. Advances were made in the use of insect pathogens and entomophagus insects to control pests and in the use of semiochemicals to advantagously alter the behavior of both beneficial and pest insects. Economic injury levels were determined and selective control protocols were developed for several pest/crop combinations. In addition to many technical reports and abstracts and articles in popular publications, the scientist involved in this National Research Program published more than 100 scientific papers.

NRP 20250 Basic/Noncommodity Research for Insect Control

This National Research Program includes basic research on entomological problems regardless of the affected commodity or U.S. Department of Agriculture mission. Entomologists, chemists, physiologists, ecologists, and behaviorists work together in teams to provide the in-depth fundamental knowledge needed in applied research programs in insect management. Significant progress has been made in the development of new and improved principles and practices of arthropod control based on the selective disruption of growth, development, and reproduction. Insect control practices based on behavior and ecology have been improved along with improvements in the methodology of insecticide use.

NRP 20260 Biological Agents for Pest Control

Research on biological control of agricultural pests and insect taxonomy is carried on at more than a dozen locations by approximately 70 scientists and is reported in more than 130 scientific publications. Several potentially important parasites of injurious insects and weeds have been successfully established and progress has been made on the production and registration of several viruses. Progress has been made on insect diets for insect parasites and predators that do not contain insect host material, pointing the way for eventually dispensing with the need for hosts when rearing their parasites and predators. New insecticides have been identified which cause minimal mortality to biological control organisms, thus promising improvements in the feasibility of integrating biological control into integrated systems of pest management. Significant progress in the taxonomy of several groups of insects has been made and several other taxonomic works of importance have been completed.

NRP 20270 Crop Disease Control and Noncommodity Research on Plant Pathogens and Nematodes

Research efforts of scientists in this National Research Program continue to aid in extending our knowledge concerning basic aspects of plant pathogens and nematodes. Scientists seek to answer questions about the nature of resistance

to nematodes and diseases, how pathogens and nematodes cause damage, and how to improve procedures for their control and/or management. These studies have the ultimate goal of reducing losses in agricultural production caused by diseases and nematodes. The research is conducted by 69 scientists at 26 locations.

Significant progress has been achieved in several areas. Intensive cropping sequences have been developed using integrated pest management systems for optimum yields, maximum return to the producer, and minimum buildup of pest problems. For example, a two-year intensive cropping sequence of sweet corn-soybean-wheat-soybean-spinach suppressed nematode numbers, but nematodes increased rapidly on peanuts and cucumber in a turnip-peanuts-cucumber-turnip-cucumber-soybean sequence. Tomato yields were increased 50% by improved management practices. A beneficial fungus has been isolated and identified which can be used for biological control of the disease organism which causes lettuce drop. Applications of the beneficial fungus to field plots have resulted in significant disease control for two years. Pickle fruit rot and root diseases of beans and peppers have been reduced using a combination of cultural, biological, and chemical methods. No other accepted control measures are known for these particular diseases. An example of the fundamental information obtained through research pertains to the mechanism of resistance of plant cells to attack by fungal disease organisms. Scientists have shown that the hypersensitive collapse and death of resistant plant cells caused by attack of a fungus was preceded two hours earlier by a complete and abrupt halt in cytoplasmic streaming. This shows that the host cell reaction is not limited to the outer membrane of the cells but is expressed throughout the cytoplasm. Obviously a basic process within the cells is affected.

The purpose of this program is to determine new and improved procedures for controlling diseases and nematodes for use in crop protection to decrease crop losses.

NRP 20280 Weed Control Technology for Protecting Crops, Grazing Lands, Aquatic Sites, and Noncropland

In 1979 progress was reported in 124 scientific publications. This included developing a basic understanding of the life cycle of weeds, such as germination of seeds, growth, reproduction, allelopathic relationships, and competitiveness with crops in relation to development of control technology. Research results also indicated how allelopathic effects and the effects of naturally occurring secondary chemicals in weeds and crops can be used in developing weed control technology. More than 75 new chemicals were evaluated for their weed control effectiveness and safety in about 70 crops, aquatic sites, and rangelands. Controlled-release technology for herbicides was improved in 1979. Basic research in understanding the penetration, absorption, translocation, sites and mechanisms of selective action, and metabolic fate in plants, soil, water, and the environment has increased the performance efficiency and safety of herbicides. Several plant pathogens are being developed for weed control and some are now ready for widescale use in rice, soybeans, and other crops. More than 20 species of insects are being developed for weed control in crops, rangelands, and aquatic sites. Unique herbicide application equipment, such as the rope

wick applicator, recirculating sprayer, endless belt applicator, and roller wipers, that applies herbicides to weeds in crops without getting the herbicides on crops or soils is being developed and several designs are in widescale use. A technique for applying herbicides directly on crop seeds in the row and obtaining excellent weed control without crop injury was discovered in 1976 and was extended and improved in 1978 and 1979. Outstanding progress was made in developing new weed control components technology that will increase the effectiveness and safety of integrated weed management and pest management systems.

NRP 20290 Agricultural Chemicals Technology for Crop Protection and Modification

Progress in 1979 was reported in 67 scientific publications. More than 165 new chemicals were evaluated for their effectiveness and safety as herbicides, fungicides, nematicides, insecticides, and plant growth modifiers. Improved methods for the synthesis of strigol, the witchweed seed germination stimulator, were developed. The larger quantities, up to one pound, expected to be available in 1981 will facilitate field evaluation research to develop improved witchweed control technology and to determine the effects of strigol on the germination of other weed seeds. Outstanding progress was made in improving techniques and systems for the discovery, evaluation, and development of new, improved, selective, biodegradable, and safe pesticides and plant growth modifiers. Progress was also made in developing a basic understanding of their penetration, absorption, translocation, sites of action, mechanisms of action, role of membranes in herbicidal action, and their metabolic fate and effects in plants, soil, water, and other components of the environment. Improved application equipment and controlled release formulations of agricultural chemicals were developed that will increase their performance effectiveness and safety, reduce the need for excessive use, and reduce the risks to nontarget organisms and other components in the environment.

SRP Integrated Pest Management Systems

This SRP focuses on the systems approach to integrating advanced proven technology into more cost effective, environmentally acceptable, and energy conserving pest management. This SRP was established to: (1) strengthen coordination of IPM systems research conducted by SEA/AR, (2) further increase use of the systems approach in pest management research, and (3) provide a more visable point of contact for U.S., foreign, and international organizations interested in SEA/AR research on IPM systems.

The SRP encourages cooperation not only with ESCS, APHIS, Extension, and Universities, but also private industry and NASA, NOAA, DOD, etc. Research results and knowledge applicable to IPM systems include pest biology and ecology, individual control components, models of commodity growth and pest population changes, electronic technology (computers, electronic pest detection methods, meteorological survey systems, aircraft and satellite data acquisition methods, etc.), economics, and systems research.

The Administrator of SEA/AR has established an annual allocation of $1.1 million to fund this Program. Now in its first year, the Program consists of seven multidisciplinary projects each of 3-5 years duration. Each project is described herein.

SRP Minor Use Pesticides

The mission of this program is to assure availability of pesticides for minor and special uses by the agricultural community to provide a continuation of crop and livestock production technology for production, storage, distribution, and marketing of food, feed, seed, and fiber. Federal scientists cooperated with State scientists to develop data leading toward registration of pesticide use patterns on 101 food requests and 499 ornamental requests in 1979.

SRP Pilot Testing of Alternative Methods of Pest Control

The Administrator of SEA/AR has established a rotating discretionary fund of roughly $1.6 million to support a developmental research program on alternative methods of pest control. The purpose of the fund is to enable scientists to conduct the developmental research needed to determine whether an emerging or a potential pest control technology is either technically feasible (Category I) or technically and economically feasible (Category II) for implementation by the private or public sectors. Thus, the primary intent of the Program is strongly to develop potential alternatives to the sole reliance on broad spectrum pesticides. The funds are not to be used to shore up ongoing base programs.

Most pilot research projects are conducted with a strong inhouse component, and this is particularly true if the project will have to be followed with additional research. All projects involve developmental research on alternatives to sole reliance on broad spectrum chemical pesticides for managing insects, nematodes, weeds, and plant pathogens which cause losses during production, and in postharvest processing and handling. However, proposals are not included in this program if they focus on control methods for other classes of pests such as vertebrates and microorganisms which cause animal or human diseases. The use of broad spectrum pesticides is included in projects if appropriately integrated with alternative control methods. The status of 29 projects is described.

National Research Program 20220

INSECT CONTROL - HORTICULTURAL CROPS

Technological Objective: New and improved methods to reduce losses caused by insects and mites to fruits, vegetables, nut trees, and nursery stock.

This National Research Program is composed of seven subelements which have as their collective objective to provide through research new or improved methods which may be used to reduce the losses to horticultural crops caused by insects and mites. The program subelements are identified as the control of insect pests of citrus, tropical and subtropical fruit, pome fruit, stone and small fruit, tree nuts, vegetables, and shade trees, nursery ornamental, and other horticultural crops. Providing technology for protecting horticultural crops from insects and mites is an essential component for the production of steady, reliable, and safe supplies of these crops that are reasonable in cost to the consumer, yet profitable to the farmer.

NPS Contact: M. L. Cleveland

Research Locations:

Riverside, California
Miami, Florida
Orlando, Florida
Byron, Georgia
Hilo, Hawaii
Honolulu, Hawaii
Kimberly, Idaho
Vincennes, Indiana
West Lafayette, Indiana
Beltsville, Maryland
Wooster, Ohio
Charleston, South Carolina
Brownwood, Texas
Weslaco, Texas
Yakima, Washington
Kearneysville, West Virginia

Examples of Recent Progress:

Synthetic pheromone for Comstock mealybug is now available for use - Riverside, California. The identification and synthesis of the Comstock mealybug sex pheromone represents a significant contribution to the basic knowledge of pheromones because it is the first mealybug pheromone to be elucidated. In addition, its synthesis is very timely because it has immediate application in the field. The mealybug has become established in the San Joaquin Valley of California. The citrus, pomegranate and horticultural industries have united to form a common interest group that will use the pheromone detection system

to intercept the dispersing mealybug and delimit its distribution for as long as possible. This action is beneficial to consumers and the environment because the cost and environmental impact of this program is minimal in comparison to controlling a generally distributed insect. This work was in cooperation with the Organic Chemical Synthesis Laboratory, Beltsville, Maryland.

California citrus threatened by virus - Riverside, California. The demonstration that "seedling yellows" strains of tristeza virus can be efficiently transmitted by Aphis gossypii, a species found commonly on citrus in California, indicates that the potential for rapid spread of disastrous proportions exists in California.

Further progress reported in pest resistance studies - Riverside, California. Four new cantaloupe breeding lines with various combinations of resistance to insects and virus diseases have been made available to plant breeders and seed producers. These breeding lines should eventually aid in the development of a sound IPM program for cantaloupe production.

Research data on fruit fly attractants released - Miami, Florida. A total of 1320 chemical compounds have been tested in an outdoor cage olfactometer to evaluate their effectiveness as attractants for the Caribbean fruit fly. Of these, 97 were rated as promising and worthy of further testing. Complete results of these tests have been published. This is the first comprehensive list of chemicals tested as attractants for fruit flies since 1963 and the first ever published for a species of the genus Anastrepha.

Infested grapefruit drop from trees - Miami, Florida. Three grapefruit trees were covered with temporary cages and approximately 40,000 sexually mature Caribbean fruit flies were released in each cage. A 'Marsh White' tree caged in October dropped 25.3% of its fruit within 2 weeks. The dropped fruit averaged 3.1 pupae per fruit. A second 'Marsh' tree caged in January dropped 52.3% of its fruit, which averaged 14.1 pupae per fruit. A 'Ruby Red' grapefruit tree caged in late February dropped 48.1% of its fruit, which averaged 3.5 pupae per fruit. Fruit that did not drop from the trees averaged 0.04 pupae per fruit. These results indicate that within 3 days after Caribbean fruit flies oviposit in grapefruit on the tree, the fruit begin to turn yellow, soften, and fruit drop shortly thereafter. These data show that drop fruit should never be picked up by fruit pickers for shipment as fresh fruit.

Established parasites keep citrus blackfly below economic levels - Orlando, Florida. Sampling for citrus blackflies and their parasites in south Florida have demonstrated the continued efficacy of parasites in holding citrus blackfly populations down.

Promising parasite discovered - Orlando, Florida. A parasitic nematode, Heterorhabditis sp., was found infesting 47-60% of larvae of root weevils in 10 citrus groves.

Alternative treatments for postharvest control of weevils in inshell chestnuts and pecans explored - Byron, Georgia. Radiofrequency treatments at 43 megahertz with an average field intensity of 0.7 kilovolts per centimeter for a 25-second exposure gave 100% mortality of pecan weevil larvae in inshell

pecans. Loose pecan weevils surrounded by pecan kernel pieces also suffered 100% mortality after exposures of 8 and 15 seconds to 40 megahertz fields of 1.3 and 1.0 kilovolts per centimeter respectively. High carbon dioxide (CO_2) atmospheres controlled inshell pecan weevils in pecans stored under accelerated storage conditions of 7 C and 65% relative humidity. After five months in atmospheres of 21% oxygen (O_2) and 30% CO_2, pecan weevil mortality was 100%.

Survey made for phony peach leafhopper vectors - Byron, Georgia. Two years of trapping in peach orchards over the entire state of Georgia is now completed. Data is sufficient to provide new and updated information on seasonal distribution patterns of major vectors as well as vector/orchard cultural practice relationships which can be used in control research strategies for the future.

Reduction of reproduction of lesser peachtree borer and oriental fruit moth by permeating the air with pheromones in peach orchards has been demonstrated - Byron, Georgia. The three year pilot test was completed at the end of the 1979 season. Data from three evaluation methods was highly correlated to produce positive evidence of effective control of lesser peachtree and peachtree borers using pheromones. Oriental fruit moth suppression was achieved to some degree; however, not as impressive as borer suppression.

Biology and control studies initiated for oriental chestnut gall wasp - Byron, Georgia. The oriental chestnut gall wasp has only one generation per year in Georgia. Adult wasps (females only in the species) emerge from the galls from mid-May until mid-June with 80% emergence during the first two weeks of June in 1978 and 1979. During June and July adult wasps deposit eggs in the axillary buds which became next year's shoots. The larvae hatch in about 40 days and overwinter in these axillary buds. Hand defoliation in 1978 resulted in 99% reduction of galls in 1979.

Mediterranean fruit fly pupae can be irradiated and shipped in the same containers - Honolulu, Hawaii. Sexually competitive adults resulted when medfly pupae in a rigid container were subjected to a partial vacuum and backflushed with nitrogen then irradiated. The more competitive adults are less likely to be damaged during transit in the rigid shipping containers. The risk of escape of preemerged flies from a rigid container is minimal.

Patent obtained for new medfly lure - Honolulu, Hawaii. A public patent for MEN (methyl (E)-6-nonenoate) has been issued and the compound is now ready for commercial production. Although the residual effectiveness of MEN is better than trimedlure, the addition of the perfume fixative phantolid extended the residual effectiveness of MEN. This new medfly lure is another tool which may be used to detect and monitor medfly populations.

The Peru and Waimanalo varieties of tomatoes are resistant to the melon fly - Honolulu, Hawaii. The Healani and N-52 (large tomatoes) and Tiny Tim, Yellow Plum, Peru, and Waimanalo (cherry tomatoes) were studied to assess their resistance to melon fly attack. All were severely damaged except the cherry tomatoes, Peru and Waimanalo.

Cutworm research pays off - Kimberly, Idaho. USDA research with black light traps established the relationship between western bean cutworm moth catches and subsequent damage to dry edible beans. The survey and warning system is now conducted by the Idaho Extension Service in cooperation with USDA and funded by the Idaho Bean Commission and industry. Savings in control costs to bean growers advised of low moth populations was $600,000 at a program cost of $6,000 in 1979.

Disruption of mating of lesser peachtree borers demonstrated - Vincennes, Indiana. Male capture was reduced 97.5% and counts of cast pupal skins showed that adult emergence was significantly lower in the treated orchard.

New natural chemicals show promise - Vincennes, Indiana. A total of 196 repellent and/or antifeedant candidate materials derived from natural products were screened against striped cucumber beetle adults. A few of these materials, including derivitives of the neem tree, appear to have some promise as antifeedants. Eight synthesized materials were tested against codling moth larvae and 2 possess excellent growth regulator qualities.

Insect resistant apple selections to aid IPM program - West Lafayette, Indiana. Of 44 new apple selections 13 have resistance to codling moth, 23 to apple maggot, 6 to plum curculio, and 2 to redbanded leafroller. Some of these selections show resistance to more than one insect.

Better ways to control flies in mushroom culture developed - Beltsville, Maryland. Several casing treatments were found that provide excellent long-lasting fly control. The effect on yield was determined of the most efficacious chemicals used as compost treatments. A strain of Bacillus thuringiensis was found to control the flies when incorporated into the compost. Supplemental nutrients added to mushroom compost to increase production in the compost were found to increase fly production in the compost also. A method for extracting fly eggs, larvae, and pupae from the compost was developed. Use of this method will provide insight into fly biology, e.g., larvae were found to commonly move from the compost to the casing and pupate. The type and age of spawn growth had appreciable effect on fly population size.

Female bagworm pheromone confirmed and site identified - Beltsville, Maryland. In laboratory wind tunnel tests the female bagworm was confirmed to produce a pheromone to which males responded agressively. The pheromone was recovered from heptane washes of setal hairs cast off by the female at the time of partial eclosion.

Japanese beetle trap marketed by industry - Wooster, Ohio. A Japanese beetle trap containing a dual lure (synthetic female sex pheromone and phenethyl propionate + eugenol, 7:3) developed at this laboratory was test marketed by industry during 1979 in several geographic areas with plans to mass market in 1980. This demonstrates a transfer of knowledge and technology from SEA to the private sector for use by the general public.

Automatic, intermittent sprayer reduces spray usage - Wooster, Ohio. A photo-electrically-operated, automatic, intermittent sprayer using pulse-modulated infrared sensors to detect plants and programmable electronic circuitry to

regulate the release of sprays on individual plants controlled insect pests of cabbage, cauliflower, and peppers, as well as a conventional sprayer, but used 30-50% less pesticide. These results indicate the extent to which excessive pesticide applications can be reduced by precisely applying pesticides onto desired targets.

Important parasite of diabrotica larvae reared - Charleston, South Carolina. Successful parasitism of the banded cucumber beetle larvae with a parasitic nematode has been accomplished in the laboratory. The parasite is being reared successfully in large numbers and basic biological studies are underway. This work could open the way for developing a national biological control program against larvae of the banded cucumber beetle and corn rootworm complex as these insects cause millions of dollars in losses yearly to such crops as sweetpotato and corn. Since there are no effective means of chemically controlling these pests, this parasite may have tremendous potential for protecting crops vital to our economy.

Johnson pecan damaged less by weevils than other varieties tested - Brownwood, Texas. Adult pecan weevils given a free choice of pecan cultivars with various nut maturity dates laid significantly fewer eggs in the extremely early maturing Johnson cultivar. This information may suggest an approach for developing pecan cultivars that would escape damage by the weevil.

Advances made in remote sensing - Weslaco, Texas. An aerial survey of citrus groves using color infrared photography was developed providing data concerning insect infestations, diseased trees, dead or dying trees, vines growing on trees, soil problems, tree growth, and weed infestations. The use of this data gathering system which is now being utilized by private industry will aid in the maintenance and improvement of citrus groves. A survey method was established using color infrared aerial photography to detect host plants of the Mediterranean fruit fly in the southern part of Mexico bordering Guatemala and the Pacific Ocean. Host plants of the medfly, including coffee, avocado, mango, citrus, and banana were identified from the photography. A computerized map of the area was developed to show the location of host concentrations and those factors affecting the dispersal of the Mediterranean fruit flies. Areas with a high probability of becoming infested and optimum trap placement can be determined from this survey method.

New method for evaluating effectiveness of citrus blackfly parasites - Weslaco, Texas. The closed and open leaf cells and cage systems employing hydroponic plants developed for evaluation of citrus blackfly parasites provide a direct measure of within-generation mortality resulting from each of the principal seasonal mortality factors. The hydroponic cage systems utilized permit removal from the field for a periodic census which was impossible using the classical sleeve method technique. This allows evaluation of reproductive rates in the presence and absence of natural enemies, thus providing a direct measure of their impact.

Control of codling moth through establishment of trap trees shows promise in apples - Yakima, Washington. Individual trees sprayed with insecticide and then trapped with a sex pheromone trap serve as trap trees attracting male moths and then killing them through contact with the insecticide or through catching in the trap. Combined with border sprays and adequate population

monitoring, cover sprays may be eliminated in orchards with very low codling moth populations. Such a program would reduce the use of pesticides and encourage biological control of the other pests.

Low-temperature fumigation schedule for control of codling moth in cherry fruit fly in cherries for Japanese market developed - Yakima, Washington. Based on earlier research, the Japanese quarantine against importation of fresh cherries has been modified to allow the importation of U.S.-produced cherries treated with methyl bromide. The existing treatment requires fumigation at fruit pulp temperatures of 70°F or higher, which can create problems in market quality of the fruit. A schedule allowing fumigation of the fruit at temperatures as low as 40°F has been developed and has been presented to the Japanese for their consideration. Acceptance of this fumigation schedule will allow the U.S. cherry industry greater flexibility in conducting the necessary treatments and greatly assist them in shipping a high quality product to Japan. This market had an estimated value of $6.1 million in 1978 and 1979. (In cooperation with Tree Fruit Research Laboratory, Wenatchee, Washington, and Stored Products Insects Laboratory, Fresno, California, and USDA-APHIS and USDA-FAS).

Codling moth control through mating disruption with the sex pheromone allows satisfactory biological control of the pear psylla on pears in the Pacific Northwest - Yakima, Washington. On blocks of pears treated with pheromone for control of the codling moth, effective biological control of the pear psylla was achieved where a reservoir of native parasites and predators existed. Downgrading of the fruit due to pear psylla injury was less than 1% in the pheromone-treated blocks and much greater in standard chemical control blocks. To establish effective biological control under commercial conditions, supplemental releases of parasites and predators must be made. Biological control of the pear psylla using native parasites and predators would result in considerable savings as control costs have been as high as $250/acre. (In cooperation with Oregon State University, Medford, Oregon).

Chemical control of Lygus substantially increases yield on beans - Yakima, Washington. The use of insecticides to control Lygus on red beans in Quincy, Washington, increased yields from 628 to 1139 lb/acre over the nontreated beans. This experiment shows that Lygus is a potentially damaging pest on beans. The cost of chemical control of Lygus is well below the economic benefits received from the increase in bean yield.

Successful rearing of tachinid parasite of the Colorado potato beetle - Yakima, Washington. In the field the tachinid parasite attacks the Colorado potato beetle in the fall of the year after the potato foliage has been heavily defoliated. We have developed a technique to rear the tachinid in the laboratory to study its biology and ecology in an effort to learn to manipulate the parasite to become more effective earlier in the growing season.

PUBLICATIONS
NRP 20220

Riverside, California

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National Research Program 20230

COTTON AND TOBACCO INSECTS

This National Research Program involves research to develop new and improved control practices that may be used alone or in integrated systems on a farm-by-farm or area-wide basis. Control technologies being developed include: genetical methods; attractants; parasites and predators; microbial agents; insect and plant growth regulators; insecticides; cultural practices; and resistant varieties. Research is also conducted on survey methods, loss thresholds, and descriptive and predictive insect population models, to develop a basis for implementing various control technologies and integrating them into total crop production systems. Application of research findings will result in insect control at reduced real costs and in improved environmental quality, thus benefiting growers and consumers.

Technological Objective 1: New and improved ecologically acceptable methods to reduce losses caused by insects and mites attacking cotton.

NPS Contact: R. L. Ridgway

Principal Research Locations:

Phoenix, Arizona
Tucson, Arizona
Baton Rouge, Louisiana
Mississippi State, Mississippi
Stoneville, Mississippi
Raleigh, North Carolina
Brownsville, Texas
College Station, Texas
Florence, South Carolina

Examples of Recent Progress:

Recovery of pink bollworm sex-linked lethal mutations - Phoenix, Arizona. Sex-linked recessive lethal mutations are readily induced in the pink bollworm by ionizing radiation; several strains carrying such induced lethals are now being maintained. These tests produced the unexpected result of demonstrating crossing over within the X-chromosome of the male pink bollworm, again illustrating the value of genetic markers in research on economically important species.

Pink bollworm sex pheromone response in major cotton producing areas of the world - Phoenix, Arizona. Pink bollworm male moths in major cotton growing areas of the world (Egypt, India, Brazil, Australia) utilize the same 1:1 blend of Z,Z- and Z,E- isomers of gossyplure that is typical of moths in the Southwestern United States.

Pink bollworm sex pheromone formulations - Phoenix, Arizona. Three new formulations (water base microencapsulation, solvent base microencapsulation, and PVC extrusion) were tested at 1, 5 and/or 20 mg load rates as gossyplure

baits in live traps for pink bollworm. One mg load rate of the solvent base formulation captured as many and as long as 1 mg load of gossyplure in a rubber septa (standard bait). The other load rates and formulation, except for 1 mg powder formulation of PVC, captured fewer pink bollworms but lasted as long as the standard. Applications of the water soluble formulation at 3 gm ai/A and the solvent base formulation at 3±1 gm ai/A against a high density population reduced trap capture by over 90% for 8 days after treatment. In the field, mating was reduced by 69%. Mating increased by 50% in the check. Trap capture was reduced by 100% at a distance of 446 feet from the application of the solvent base formulation on the first night of treatment, but, in the field, mating was not reduced.

Plastic laminate formulations of sex pheromone controlled pink bollworms - Phoenix, Arizona. Significant reduction of pink bollworm male moth catches in gossyplure-baited traps occurred in gossyplure-flake treated fields when populations of pink bollworms began to increase in mid-July. During the period July 14-September 11, trap catches in pheromone-treated fields were reduced by an average of 93% (range 78-99).

Higher number of pink bollworm larvae were found in bolls on each sampling date, except July 26, from the control plots than were found in boll samples from gossyplure-treated plots. The differences were statistically significant on 9 of 20 sampling dates. The total numbers of larvae found in bolls during the season were reduced 68% in plots treated with gossyplure. During the season, infestations ranged from 0-5.3 larvae per 100 bolls from gossyplure-treated fields and 0-21 larvae per 100 bolls in control fields.

In the single untreated check plot, 14% of the bolls were infested on July 30. Beginning in late August, populations increased progressively to the end of the season and reached 58 larvae per 100 bolls with 38% of the bolls infested. More pink bollworm moths were caught in flight traps and higher percentages of mated females, as well as spermatophores per female, were found in control plots than in the gossyplure-treated plots.

Flight trap developed for cotton insect parasite research - Phoenix, Arizona. Modified Malaise traps were developed to sample cotton insect parasites. The method provides data on certain beneficial species heretofore difficult or impossible to obtain.

Pink bollworm resistant cottons - Phoenix, Arizona. A number of tests were carried out with AET-5..., a desirable upland-type breeding stock previously demonstrated as resistant to pink bollworm. It was combined with other known resistant characters, nectariless, smoothleaf, okra-leaf, super okra-leaf, and early maturity. In yield comparisons, AET-5... yielded 113-122% of 'Deltapine' checks and 92-102% of 'Stoneville' checks. The resistance mechanisms were identified in free-choice and no-choice tests as antixenosis or non-preference for oviposition and antibiosis in the boll content.

Radar used to detect insects in flight - Phoenix, Arizona. Individual insects could be detected when densities were low and detection distance depended upon insect size and density. Density of insects was generally greater near the ground and decreased with altitude; however, insect layers did occur on several occasions. Insect activity was greatest 30-90 minutes after sundown, and insects generally flew to greatest altitudes during this period.

A subsequent increase of flight activity often occurred 3-4 hours after sunset. Insects were detected just prior to and after a light rain shower and they were probably flying during the rain. Insect concentrations associated with nocturnal wind shifts were detected twice.

Brief daytime radar observations (during maintenance) revealed some insect activity during afternoon in May but almost none during July and August. When the radar was operated during sunrise, the insect activity stopped approximately 15 minutes before sunrise and started again approximately one hour after sunrise. These early morning flying insects were smaller, stayed closer to the cotton canopy, and had different flight behavior than pre-dawn insects. A column of insects were detected leaving 2 cotton fields during the last week of September and the first week of October.

Adjuvant developed which improved efficacy of biological control agents - Phoenix, Arizona. A feeding adjuvant that increases control of certain lepidopterous insect pests when used with microbial insecticides was marketed as COAX®. This unit cooperated with various federal, state, and commercial scientists and field personnel, in trials of the adjuvant across the cotton belt to determine the efficacy of this product. Results were positive, and approximately $500,000 worth of the adjuvant was marketed in the 1979 season. The presence of this product on the market may result in increased use of registered microbial insecticides in cotton insect control programs, and thus, less use of hard chemical insecticides that are damaging to the environment. Other research indicated that certain mixtures of Bacillus thuringiensis and a nuclear polyhedrosis virus may give variable results in insect pest management programs. Further, an 87% reduction of cotton leafperforators on greenhouse plants treated with B.t. demonstrated feasibility of utilizing this pathogen for controlling this pest.

Parasitization of Lygus eggs continues high in wild hosts - Tucson, Arizona. Parasitization of eggs of Lygus bugs by the wasp Anaphes ovijentatus on a wild mustard was 60-80%, but only averaged 7-20% during May and June on alfalfa. Cutting of the alfalfa was very detrimental to the parasite. These results indicate this parasite can have significant impact on Lygus populations, but additional measures are needed for it to be fully effective on alfalfa hay.

Native egg parasite prefers Lygus bugs - Tucson, Arizona. The native egg parasite, Anaphes ovijentatus, has been shown to attack eggs of Lygus, Nabis and the 3-cornered alfalfa hopper. Recent studies show the parasite attacks the latter 2 species at only a very low level, even in the absence of Lygus eggs. This high degree of specificity for Lygus suggests the parasite might be a promising candidate for augmentation programs.

Lygus desertinus and L. elisus are very closely related species - Tucson, Arizona. Morphometric, allozyme and interbreeding studies show these 2 species are very closely related and can interbreed. Two other Lygus bugs, L. hesperus and L. lineolaris, are less closely related. This information will be of value when planning studies on biological control agents for these economically important insects.

Artificial diet improved for parasitic fly - Baton Rouge, Louisiana. The cost of the artificial diet for the parasitic tachinid fly, Eucelatoria sp., has been reduced from $9.72 to $1.52 per liter and is approaching a level that would be economical for the mass production of parasites. It could ultimately result in the end or negligible use of insecticides on a group of insects (Heliothis spp.) that causes at least $1 billion of damage per year to crops in the U.S. Insecticides are not very effective on these insects.

Host food plant is the source of a volatile attractant for parasites - Baton Rouge, Louisiana. This is the first report that volatile attractants, obtained when the host feeds on an attractive plant (cotton and okra), cause an otherwise unattractive host (Heliothis virescens) to become attractive to its parasite (Eucelatoria sp.).

It means that other hosts, host food plants, and parasites should be examined for a similar response and that additional research emphasis should be placed on the identification of volatile chemicals from plants in order that synthetic chemicals could be used to manipulate and increase the effectiveness of parasites in the field.

Simple, new bioassay for contact chemicals - Baton Rouge, Louisiana. The new bioassay provides the first unequivocable evidence that a contact chemical from the host affects other than ovipositional behavior of a tachinid parasite. It has the potential of eventually increasing the effectiveness of parasites in the field. The bioassay itself is significant because it is much more efficient and reproducible than our previous techniques and also because it will increase the efficiency and effectiveness of researchers working on other species of parasites.

Intensive studies provide better understanding of the cotton field arthropod community - Mississippi State, Mississippi. We assess the cotton field arthropod community as it is stratified vertically, horizontally, by daily rhythm, and according to trophic levels. We measure the activity of pest, beneficial, and other arthropod species. We study the influence of peripheral habitats as they support species important to cotton. This project was initiated in the North Carolina BWE program and the Mississippi OPM program and the support of graduate students at Mississippi State University. The study is significant in that it potentially encompasses a broader knowledge of the cotton field community quantifying feeding relationships of pests, parasites, and predators.

Biological evaluation of the optimum pest management and boll weevil eradication trials progressing - Mississippi State, Mississippi. The impact of current insect control, optimum pest management, and boll weevil eradication on pesticide use and yield of cotton is being measured in trial programs. Results are being summarized and analyzed. Simulation modeling is being used to compare results in trial areas and check areas as well as to extrapolate beltwide. The project is possible because of a composite effort involving USDA research teams from Raleigh, North Carolina, and Stoneville, Mississippi, and through modeling efforts at North Carolina State University and Mississippi State University. The project should demonstrate relative advantages of the different alternatives for boll weevil management in cotton.

Modified covering material for diet improves mass rearing of boll weevil - Mississippi State, Mississippi. Sand and corn cob grits, containing 2 water soluble antibiotics and one fungicide, were added to the surface of an insect diet. The adults which emerged were uniform, of very high quality, and had extremely low bacterial counts. In addition, the yield of adults was increased. This improvement is very important in control programs requiring mass rearing of insects.

Additive to boll weevil attractant increases trap capture - Mississippi State, Mississippi. Hop oil added to traps containing the boll weevil sex attractant captured more boll weevils than traps containing only the sex attractant. Hop oil is closely related to essential oils found in cotton, but is cheaper than the cotton oils, and is commercially available. This improvement is important in programs utilizing trap catches for detection, monitoring and suppression of weevil populations.

New procedure for sterilizing boll weevils proves highly effective - Mississippi State, Mississippi. Over 600,000 (mixed sex) boll weevils sterilized by feeding diflubenzuron medicated diet for 6 days followed by 10 Kr irradiation were released in 6 acres of cotton in south Florida. Egg hatch data followed by pheromone trapping showed that no reproduction occurred.

More than 13 million boll weevils were mass reared, sterilized, and shipped to the Boll Weevil Eradication Trial in the summer of 1979. The sterilization method of feeding 100 ppm of diflubenzuron to adults for 6 days in slab diets with antibiotics and then irradiated with 10,000 rad in a nitrogen atmosphere sterilized both sexes. This method is the most significant advancement in technology in boll weevil research and has proven successful in the laboratory, in the field and now in large scale releases of adults.

Candidate insecticides effective against Heliothis spp. - Stoneville, Mississippi. Several candidate insecticides; AC 222,705; ZR 310; dithiocarb; and RH 0994 gave good control of Heliothis spp. in field tests. AC 222,705 is the first effective pyrethroid produced by a domestic company. Some of these compounds may become available to producers for use in controlling these pests.

Data developed for biological evaluation of optimum pest management trial - Stoneville, Mississippi. The second year of the 3-year optimum pest management (OPM) trial in Panola County, Mississippi, conducted concurrently with the boll weevil eradication trial in North Carolina-Virginia was completed in 1979. In 1979, as in 1978, 44 fields were monitored weekly and 20 fields were monitored semi-weekly in Panola County. In Pontotoc County, a current insect control practice county, 22 fields were monitored weekly and 10 fields were monitored semi-weekly. Dynamic and static crop information was recorded each year. All information was made available to the biological evaluation team for its analysis of the impact of the program on populations of the boll weevil, nontarget pests, and beneficial insects, and insecticide use, for its preliminary report. Results of this research will have considerable impact on management of insect populations on cotton in the future.

Heliothis sterile backcross competitive in field - Stoneville, Mississippi. Heliothis sterile backcross (BC produced by crossing female H. subflexa with male H. virescens and backcrossing to male H. virescens and released into the field in May and June 1978 infused with the native population and was detected in succeeding generations until fall. Collections of males in 1979 following spring emergence of the overwintered population revealed that the sterile BC had been able to diapause and emerged in the spring. BC males were collected on mating tables and in live traps at a distance of 4-6 miles from the 1978 release point. These data indicate that the BC will infuse into the native population and carry over from one year to the next, increasing the potential of releases of the Heliothis sterile BC as a suppression measure for the tobacco budworm.

Precise quantitative information on efficiency of boll weevil pheromone trap obtained - Raleigh, North Carolina. The probability of detection of the F1 progeny of one mated overwintered female boll weevil with infield traps spaced 210' apart was ca. 94%. With the same spatial arrangement of infield traps, there was a 100% probability of detecting these reproducing clumps during the F2 generation. Also, the probability of detection increased as the distance between traps was decreased. Under the test conditions (20 infested squares placed in each field), more than 90% of the F1 female weevils were captured when traps were spaced 105' apart. These data strongly indicated that synthetic pheromone placed in the traps is several times more attractive than the natural pheromone emitted by the males. If these findings can be verified by future quantitative field research, a new non-insecticide suppression system (as well as monitoring system) could be developed based on pheromone-baited traps.

More efficient and less expensive boll weevil pheromone trap designed - Raleigh, North Carolina. The existing boll weevil trap was redesigned (in cooperation with APHIS personnel) to improve manufacturing procedures, reduce costs, and improve efficiency. The new trap was found to be 1.42 times as efficient as previous traps, and cost 52 cents each (labor and material). More than 80,000 were made in 1979. An improved method of killing captured weevils was also devised.

Nutron activation analysis shows promise for determining origin of boll weevils - Raleigh, North Carolina. Preliminary studies with a neutron activation analysis indicate that geographic origin of insects can be determined by definitive element profiles of the test insects.

Chemical termination of cotton fruiting - Brownsville, Texas. Mature boll weevils migrated from cotton 7 days after the plots had been treated with chlorflurenol or with chlorflurenol + TD-1123. No weevils migrated from cotton that had been treated with azinphosmethyl, but small numbers of weevils migrated from untreated cotton 7 days after the test was commenced. Equal numbers of immature weevils migrated from the test plots 3 days after the compounds had been applied. Migration was measured by the numbers of weevils caught in grandlure-baited Mitchell traps.

High altitude migration potential of the boll weevil - Brownsville, Texas. Reduced barometric pressure as a single environmental factor seemed to have no significant effect on mortality or longevity of either wild or laboratory-reared weevils treated in hypobaric chambers at equivalent pressures found at 2,000-38,000 feet. Mortality did increase significantly when weevils were transported via an airplane up to 4,000 ft/2 h, 8,000 ft/2 h, and 14,000 ft/1 h. Results indicate that high altitude temperature and air quality (oxygen content) are dominant factors that would restrict boll weevil migration to low altitude, less than 1,000 feet, for example.

Determine relative effects of sex pheromone components, formulation, and survey trap design on Heliothis capture success - Brownsville, Texas. Virelure formulations, in laminate plastic dispensers, containing the 2 major components (V-2) were compared with a 7-component formulation (V-7) at 4 locations in Cameron County, Texas, in a paired inverted double-cone trap comparison. Numbers of male H. virescens caught during 320 trap-nights by V-2 exceeded catches by V-7, 21,380:13,643. Total dosage/dispenser was 20 mg and traps were rebaited every 2 weeks. Catches by V-2 exceeded catches by V-7 62.3% of the nights during the test. These results indicate that from the Hercon® dispenser, not all 7 components are needed and one or more saturated components actually may be inert and act as dilutents to an otherwise attractive chemical mixture. A new polyvinyl chloride (PVC) maxi-capsule has been developed as a dispenser for several insect species sex attractants, including the pheromones of Heliothis spp. Preliminary winter field trials indicate that the new dispenser may be expected to perform as well, or better than Hercon laminated dispensers, Courel® fibers, rubber stoppers, or cigarette filters. The maxi-capsules are readily available and may be prepared for use as a pheromone dispenser in traps for 2 cents/dispenser/2 weeks.

Effect of high altitude barometric pressure and temperature on survival and migration capabilities of tobacco budworms - Brownsville, Texas. Laboratory tests run in hypobaric chambers showed no apparent adverse effects on viability, longevity, or reproduction after moths were held for 24 hours or 7-day periods at pressure equivalents of 2,000- to 15,000-foot altitudes. Even after hypobaric chamber exposure was extended to altitude equivalents of 32,500 feet for one week, both sexes mated and females laid viable eggs. Temperature was 27®C and air quality and oxygen content was the same as that found at 37 feet above sea level. Both mated and virgin female H. virescens moths were actually taken aloft via an airplane and exposed at 4,000-, 8,000-, and 14,000-foot altitudes for 2-hour periods. Egg hatch was significantly reduced after the high altitude exposure of previously mated females, but egg hatch from the treated virgin females was not significantly influenced. These results indicate that air quality and temperature at high altitudes would severely affect the potential fecundity of high flying, migrating gravid females.

New knowledge on fate of tobacco budworm attractant will be used to increase its effectiveness - College Station, Texas. Studies of the oxidative decomposition of virelure, a synthetic pheromone used to attact tobacco budworm moths to traps, indicated 12 degradation products were formed from each of the 2 components [(Z)-11-hexadecenal and (Z)-9-tetradecenal]. All

but one have been identified by mass spectroscopy, NMR, and GLC analytical techniques. This information is essential in the development of formulations that will protect such attractants from premature decomposition in the field. Also, such information will be required to support eventual registration of the attractant by the U.S. Environmental Protection Agency.

Increased understanding of host-parasite relationships increases potential of using parasites to manage populations of the bollworm and tobacco budworm - College Station, Texas. Studies of interspecific competition among the hymenopteran parasites Chelonus insularis, Telenomus heliothidis, and Trichogramma pretiosum indicated that each species marked the host egg, an act which definitely inhibited parasitization of the same egg by conspecific species. Chelonus (an egg-larval parasite) fared badly in tests of competition among immature stages within the host egg; the order of competitiveness in paired comparisons was Telenomus> Trichogramma>> Chelonus. This type of information is very important in understanding the field behavior of natural enemies of pest insects, and also in the selection of effective parasite species for use in integrated pest management programs that feature augmentative releases of mass-reared beneficial species.

New methods developed for storing egg parasites substantially reduces costs - College Station, Texas. By manipulating the temperatures at which Trichogramma pretiosum is held during different times in the development of immature life stages in host eggs, a set of conditions has been established which allows the parasite to be held in cold storage for as long as 4 weeks without any apparent adverse effect. This is an encouraging development that could facilitate stockpiling large numbers of these parasites for use in augmentative field-release control programs. Also, further extension of the storage period would result in significant reductions in the total costs of mass producing the parasites.

New plant growth regulators show promise for cotton insect management - Florence, South Carolina. A preconditioning application of thidiazuron at 0.11 kg ai/ha, plus 0.22 kg ai/ha applied 7 days later as a full defoliation rate was more effective in removing larvae and squares and reducing regrowth development than DEF. This also had the effect of reducing population densities of boll weevils and bollworms. Yield, seed germination, and fiber properties were not adversely affected by the treatments. Thidiazuron should be a boon to cotton producers because it is an effective defoliant and its effectiveness in preventing regrowth of cotton, which deprives the boll weevil of feeding and oviposition sites, may make thidiazuron a valuable adjuvant in a fall diapause program by reducing or eliminating insecticide applications.

Minimum tillage does not increase bollworm/budworm populations - Florence, South Carolina. A 3-year study indicates minimum tillage systems in cotton and tobacco do not develop abnormal insect populations nor significantly affect yields. Thus, the number of land preparation operations could be substantially reduced.

Improved stragegies for deployment of boll weevil pheromone traps developed - Florence, South Carolina. It was determined that 5 boll weevil pheromone traps/ha would have a high probability of detecting the progeny of one female

boll weevil. Immature boll weevils were marked inside the flower bud with a red dye so that the adults emerging in the cotton field could be identified. The reliability and accuracy of a detection method is the most important factor in evaluating the boll weevil eradication trial. Trap density was found to be a more important factor than the grandlure concentration at a trap for capturing boll weevils. Combinations of trap density and lure concentrations were compared in a large lespedeza field where marked laboratory-reared weevils were released on the ground and permitted to respond to the treatments. The cost of a trapping program could be reduced if more lure/traps but fewer traps could be used.

Isozyme techniques improved for use in characterizing boll weevil populations - Florence, South Carolina. Polyacrylamide gel electrophoresis techniques were developed for an isozyme program in which one or two trained technicians can study 24 different enzyme systems per boll weevil, in groups of up to 24 weevils per day, at a total material cost of about $25. With a "standard" boll weevil strain, more than 140 isozymes were detected in the 24 enzyme systems tested. Of the 44 loci tentatively identified, 73% were polymorphic and 27% were monomorphic.

Technological Objective 2: New and improved methods to improve safety of tobacco through improved insect control.

Principal Research Location:

Oxford, North Carolina

Examples of Recent Progress:

Pirimicarb (Pirimor®), a specific aphicide, continues to provide outstanding results - Oxford, North Carolina. In initial tests pirimicarb applied at 2 oz ai/A resulted in 99% control of the green peach aphid without reducing the beneficial insects: stilt bugs; coccinellids; and syrphids. In subsequent tests, 1 oz ai/A gave 97.5% control, again with no effect on beneficials. Pirimicarb tank mixed with Dipel, and Dipel plus maleic hydrazide (sucker control agent), gave 93.6 to 100% control of aphids and 88.9 to 91.8% control of hornworms with no significant effect on stilt bugs.

Large area pest management project increases use of selective insect control agents on tobacco - Oxford, North Carolina. Releases of stilt bug predators, use of the selective bacterial agent, Bacillus thuringiensis, and application of the selective aphicide, pirimicarb, provides an improved insect management system which has resulted in the reduction in the use of broad spectrum insecticides.

Natural and/or synthetic sex pheromones of adult tobacco budworms as bait in grid-type traps - Oxford, North Carolina. Seven chemical fractions containing sex pheromones were tested for their effects on the attractiveness of 2 virgin females to native males. Reductions in the catch of males ranged from 25 to 67% when 5 of the fractions were placed with females as bait in electric grid traps. Two fractions, (Z)-11-hexadecenal, increased male catch by 21 and 15%, respectively. Similarly, when placed with virelure, 6 of the fractions reduced male catches by 6 to 78%. The remaining fraction, (Z)-11-hexadecenal, increased the male catch by 56%.

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National Research Program 20240

INSECT CONTROL - GRAINS, FORAGES, SUGAR CROPS, AND OILSEEDS

Technological Objective: Reduce losses in field crops by conducting research to develop new and improved control of insects and mites.

This National Research Program involves research in developing new and improved control methods, tactics, and strategies which may be used singly or combined into integrated systems to reduce pest insect populations and losses to corn, small grains, sorghum, millets, grass and legumes, forages, sugarbeets, sugarcane, soybeans, peanuts, and other field crops.

NPS Contact: Robert D. Jackson

Research Locations:

Tucson, Arizona
Canal Point, Florida
Tifton, Georgia
Kimberly, Idaho
West Lafayette, Indiana
Ankeny, Iowa
Manhattan, Kansas
Crowley, Louisiana
Houma, Louisiana
Beltsville, Maryland
East Lansing, Michigan
Mississippi State, Mississippi
Stoneville, Mississippi
Columbia, Missouri
Bozeman, Montana
Lincoln, Nebraska
Fargo, North Dakota
Wooster, Ohio
Stillwater, Oklahoma
Corvallis, Oregon
University Park, Pennsylvania
Brookings, South Dakota
Bushland, Texas
Yakima, Washington

Examples of Recent Progress:

Corn:

New insect resistant corn inbreds released - Tifton, Georgia. Two new corn earworm resistant sweet corn inbreds, GTS1 and GTS2, were released. In hybrid combination, they produce an excellent earworm resistant sweet corn of high quality.

Environmental factors influence level of resistance chemical - Tifton, Georgia. The recently discovered flavone glycoside, maysin, causing some of the resistance in corn to the corn earworm, appears to be adversely affected by environmental factors such as age of silk, location, and date of planting, as well as by plant-to-plant variability.

Pathogens can be applied in irrigation water for the control of insect pests - Tifton, Georgia. It was shown that pathogenic insect viruses and protozoans could be applied to corn through an overhead irrigation system to kill the fall armyworm. This technique will reduce the cost of application and conserve energy while reducing the amount of toxic chemicals used in insect control.

Hybrids selected for corn double-cropping system - Tifton, Georgia. Seven corn hybrids have shown fall armyworm resistance, adequate grain and silage yields, and other performance characteristics suitable for summer planting in a corn-corn double-cropping system. Insect control in the second or summer corn is achieved by treating in accordance with the development of the plant. This requires a minimum use of insecticides and, with the use of irrigation systems, a minimum cost for application.

Insect control achieved by utilization of irrigation systems - Tifton, Georgia. Studies have shown that effective insect control can be achieved when insecticides are metered into sprinkler irrigation systems. This allows large volumes of irrigation water to be used for applying insecticides and the cost is less than applications made with aerial and ground equipment. Applications are made with a closed system, do not require the use of labor, and can be made during conditions unfavorable for conventional application.

Insecticide resistance in fall armyworm populations - Tifton, Georgia. Isolated individual collections of fall armyworms in 1978 and 1979 were resistant to methomyl, in addition to carbaryl, trichlorfon, and methyl- and ethyl-parathion, as reported previously. Should these resistant insects become the dominant type in the U.S., no approved insecticide is available for area-wide control.

Factors determined for variation in aflatoxin contamination - Tifton, Georgia. Studies indicate that the incidence of aflatoxin contamination is high and fairly consistent from year to year, but insect and weather conditions during ear development are principal factors in determining the variable levels of contamination. Improved inoculation and sampling techniques have enabled achievement of more reliability in screening for resistance to A. flavus infection and aflatoxin production. Existence of genetic variability for resistance to aflatoxin development has been verified and corn diallels are being evaluated to determine types of inheritance.

Heliothis pheromone active in field - Tifton, Georgia. The sex pheromones identified for Heliothis zea (corn earworm) and Heliothis virescens (tobacco budworm) in 1978 were field tested in 1979. The tobacco budworm pheromone is a combination of 7 chemicals, 4 of which comprise the pheromone of the corn earworm. The full-complement pheromone of each species caught more males per trap per night than 4 virgin females used as bait.

Heliothis pheromones fail to inhibit mating under caged conditions - Tifton, Georgia. It was anticipated that if minute quantities of one or more of the chemicals comprising the pheromones of the corn earworm or tobacco budworm were evaporated into the atmosphere, mating would be inhibited. In 30' x 100' cages covering cotton, or tobacco, 75 micrograms, 7.5 grams, or 75 grams per acre of single components and combinations of components were evaporated from 750-5000 cigarette filters per acre. From 50-200 pairs of lab-reared insects were separated by sex and released in opposite ends of the cages. No significant adverse modifications in behavior or mating were observed.

Pheromones show potential for pest management - Tifton, Georgia. Evidence of response by Heliothis zea females to chemical components in larval frass of its species suggests a management potential through oviposition deterrence. The

epideictic pheromones in larval frass prevent the female moths from ovipositing in plants already infested with larvae.

Exposure to host prior to release increases effectiveness of parasites - Tifton, Georgia. Feeding and exposure of Trichogramma pretiosum to host prior to release increased their retention time in the target environment following release. Improved retention of Trichogramma spp. in target environments substantially increases the probability of their utilization against pest species.

Possible control of aflatoxin in corn - Tifton, Georgia. An exciting possibility for the control of aflatoxin in corn has been discovered. Innocuous compounds naturally present in corn ears at low levels, inhibit the growth of A. flavus which produce the acutely toxic and extremely carcinogenic aflatoxins. Thus, breeding could presumably enhance levels of these compounds so that the aflatoxin problem in these corn varieties may be significantly reduced.

Certain acids found to alter insect behavior - Tifton, Georgia. A new class of chemical compounds (acids) have been identified and shown to have kairomonal activity in laboratory bioassays. The acids are commercially available and can be tested in the field for efficacy in the control of H. zea by parasitic wasps of the Trichogramma species. Because of the small amounts of acids needed and their compatibility with irrigation equipment, the economics of the envisioned pest control are quite favorable.

Corn borer resistant germplasm released - Ankeny, Iowa. Two germplasm sources of resistance to European corn borer (B85 and B86) were released. B85 is highly resistant to leaf-feeding by 1st-generation European corn borers; consequently, it is a good source of resistance in an early maturity breeding program. B86 is the first inbred stock of U.S. Corn Belt origin known to combine into one genotype good resistance to leaf-feeding by first-generation borers and sheath-collar feeding resistance by second-generation borers.

Nuclear polyhedrosis virus reduces corn borer populations - Ankeny, Iowa. A nuclear polyhedrosis virus from Rachiplusia ou substantially reduced populations of the European corn borer when the virus was applied to corn in the whorl and pollen shedding stages. This indicates an additional pathogen that can be used to control this perennial pest.

Criteria for timing insecticide applications for suppression of second-generation borers - Ankeny, Iowa. Restricted examinations of three leaves (leaf above and below the ear and ear leaf) as opposed to examining all leaves on the plant for corn borer infestations suggests insecticides should be applied when 30-40% of the plants are infested. This technique will save time for corn producers and can be implemented into pest management programs against the European corn.

Information developed for integrated pest management of black cutworm in corn - Ankeny, Iowa. Immediately after the 1st peak capture of male black cutworms in pheromone traps, a critical period for larval damage exists. This period extends over 156 degree days celsius, or, in 1979, mid- to late-May. Organic bait stations to monitor larval activity are effective only until corn emergence. Black cutworm damage thresholds show that, similar to 1978, regardless of size of larval populations, the corn plant outgrew the capacity of larvae to inflict damage. Removal of weeds after corn emergence enhances black cutworm damage.

Automation reduces cost of rearing the southwestern corn borer - Mississippi State, Mississippi. Each step in the rearing of the southwestern corn borer has been automated. This includes (1) diet dispensing, (2) infesting diet-filled cups with larvae and capping of cups, and (3) removing of pupae from the cups. A newly designed oviposition cage requires a minimum of adult handling, and requires much less time to remove and replace oviposition substrates than the previously used procedures. This equipment can be used for rearing many of our lepidopterous pests. Approximately 20 million eggs of the southwestern corn borer were provided through this rearing program for SEA/AR plant resistance programs.

Southwestern corn borer and fall armyworm resistant germplasm released - Mississippi State, Mississippi. MP703, a dent corn inbred with leaf-feeding resistance to the southwestern corn borer and the fall armyworm, was released in December 1979.

Two composite corn populations have been established for 1st generation southwestern corn borer resistance - Columbia, Missouri. A 4-year screening program combining 7 and 8 sources of resistance into populations has resulted in establishment of 2 composite populations with 1st-generation resistance to the southwestern corn borer. When released these will provide maize breeders with several sources of resistance.

Small Grains and Rice:

Location and identification of two genes in wheat for resistance to Hessian fly in the eastern soft wheat region - West Lafayette, Indiana. Two new genetic factors for resistance to Hessian fly were found in Elva wheat, CI 17714 (Triticum turgidum). We transferred two linked factors to two common wheat lines and one factor to another common wheat. The latter has been designated Hg. These genes provide new sources of resistance to all known biotypes of Hessian fly and increase our gene pool of resistance to be drawn upon in the future.

New Hessian fly biotypes found in greenhouse and field - West Lafayette, Indiana. Two new biotypes of Hessian fly, L & J, have been identified in the field and laboratory. Biotype J has the capability of attacking wheats having the H_7H_8, H_3 & H_5 genes for resistance whereas biotype L has the capacity to attack wheats having the H_7, H_8, H_3, H_5, & H_6 genes for resistance. With increased acreages grown to wheats having the H_5 gene for resistance in the Eastern Soft Wheat Region it is believed that these biotypes may become a problem in the next 10 years unless new sources of resistance are utilized.

Wheat surveys in Illinois, Indiana, and Michigan show slight infestations of Hessian fly - West Lafayette, Indiana. Mean percent infestation for 1330 fields of wheat cultures in Illinois, Indiana, and Michigan showed less than 3% infestation. The economic threshold level where damage amounts to a bushel or more loss in yield is 20%. These surveys show that although Hessian fly infestations occur they are not high enough to cause economic damage, due to the protection provided by resistant varieties.

Barley yellow dwarf resistant wheat germplasm released - West Lafayette, Indiana. A barley-yellow-dwarf virus (BYDV) resistant wheat germplasm, P6376, was released by the Purdue University-USDA-SEA-AR small grains breeding team. P6376 is similar to Arthur, Arthur-71, Abe, Oasis, Sullivan, Beau, and Hart in that it is a soft red winter wheat. However, it has a more effective level of resistance to BYDV than other soft wheats. This resistance has been expressed as a lower degree of visual symptom expression and less yield reduction with BYDV infection compared with other cultivars. Also, P6376 has powdery mildew and biotype B Hessian fly resistance.

Resistant plants return to breeders in Kansas, Nebraska, Missouri, Oklahoma, and South Dakota - Manhattan, Kansas. Cooperative research is ongoing with breeding programs in Kansas, Nebraska, Missouri, Oklahoma, and South Dakota to develop Hessian fly resistant wheats having Marquillo, H_3, H_5, or H_6 resistant genes. Approximately 3000 early and advanced generation lines and bulks of hard red winter, soft red winter, and hard red spring wheats were evaluated for resistance to various Hessian fly biotypes. Resistant plants of early generation lines were selected for combined resistance to greenbug, soilborne mosaic, wheat streak mosaic, or leaf and stem rust. Resistant plants were returned to the breeders for further selection and crossing.

Preflood application of insecticides control rice water weevil - Crowley, Louisiana. Preflood applications of Amaze and Terbufos performed better than postflood applications. Carbofuran gave good control with both types of application. Terbufos 15 G, Carbofuran 3 G, and Amaze 5 G applied preflood and Carbofuran 3 G applied postflood significantly increased yields.

Stocks of greenbug resistant wheat distributed to plant breeders - Stillwater, Oklahoma. Seed stocks of the greenbug-resistant 'Amigo' have been sent to over 50 plant breeders in the U.S. and 11 foreign countries, including the People's Republic of China. Several lines developed from crosses of 'Amigo' with commercial wheats are being increased at several locations in Colorado and Oklahoma. Data obtained thus far indicate these greenbug resistant strains of wheat have acceptable quality characteristics and equal present commercial wheats in yield potential. One or more of these strains may be released for commercial production in 1981.

Important wheat germplasm released - Stillwater, Oklahoma. This new germplasm line (Exile) provides a vehicle for storing genes for disease resistance in a winter wheat agronomically similar to modern varieties and adapted to the Southern Great Plains. These characteristics facilitate wheat breeding by minimizing undesirable traits that may be inadvertantly transferred into new varieties with the genes for resistance.

Grain Sorghum and Millet:

Progress in developing midge resistant sorghums - Tifton, Georgia. Significant progress has been made to incorporate the highest known midge resistance into usable breeding lines. Therefore, in the foreseeable future, farmers should be able to plant midge-resistant sorghums. Techniques that are presently being developed and evaluated at SGIRL should provide a significant breakthrough for the plant resistance program that will greatly enhance progress to develop and release insect-resistant germplasm for eventual use by the grower.

Grasses and Legumes:

Three multiple-aphid resistant, non-dormant alfalfa germplasm populations released - Tucson, Arizona. Three alfalfa populations with multiple-aphid resistance were released to the public for breeding purposes. These alfalfas known as BAA-15, BAA-17, and BAA-20 have high levels of resistance ranging from 75-84% to the blue alfalfa aphid, 65-70% to the pea aphid, and 62-81% to the spotted alfalfa aphid. They were developed in the second cycle of selection from broad based germplasms utilizing field screening techniques. The alfalfas will provide significant protection against the major aphid pests of alfalfa.

Alfalfa plants within and among cultivars differ in susceptibility to the potato leafhopper in laboratory tests - Beltsville, Maryland. Flats with seedlings in the second trifoliate leaf stage were infested with 200 adult leafhoppers. Upon severe damage to the susceptible entries included in each flat, the individual seedlings were scored for feeding damage. Antibiosis was measured by caging eight 3rd instar nymphs on individual plants and recording nymphal and adult mortality along with injury damage to the plant after 7-14 days. These methods appear promising for identifying resistant alfalfa plants to be used for breeding potato leafhopper resistant germplasm.

Improved method for rearing sod webworm larvae provides insects for laboratory resistance studies - Beltsville, Maryland. Sod webworm larvae were reared on a combination of grass bouquets and artificial diet to provide a rapid means of supplying insects for test purposes and propagation of colonies. Eggs were incubated on moist filter paper and when nearly mature were placed on grass bouquets to which hatching larvae moved. When approximately 7 days old larvae were transferred individually to cups of diet and reared to pupation. This method eliminated the need to handle very young larvae and reduced the amount of plant material required for rearing purposes by incorporation of the artificial diet.

Perennial ryegrass cultivars evaluated for antibiosis and nonpreference to the hairy chinch bug in the laboratory - Beltsville, Maryland. The survival of hairy chinch bug nymphs was not significantly different on cultivars selected for 'resistance' and 'susceptibility' in field plots. The response of adults to the 'resistant' cultivars in laboratory preference tests was not consistent from test to test except to Pennfine, which was always less preferred. Results suggest that much of the resistance expressed in the field may be related to chinch bug response to micro-environmental differences associated with plant density, etc., although some cultivars, such as Pennfine, may demonstrate non-preference resistance to adults.

Model predicts efficacy of grasshopper bait - Bozeman, Montana. A mathematical model predicted grasshopper control provided by carbaryl-treated wheat bran bait to within 2 percentage points. The model essentially recognized that only about 85% of a typical rangeland infestation will be comprised of species that eat wheat bran, that about 1/7 of susceptible species will be physiologically nonvulnerable to bait, and that mortality among the remaining 70-75% will be a function of the amount of bait consumed and the efficiency of the bait. The

model will allow us to adjust proportions of insecticide bait and Nosema bait in an integrated management program to assure maximum short-term relief without elimination of grasshoppers needed for production of Nosema inoculum for long-term suppression.

Sex pheromone of the cranberry girdler used in pest management program - Corvallis, Oregon. A secondary pheromone component of the cranberry girdler was discovered that synergized the primary component and increased trap captures sixfold. This potent bait was successfully used to monitor grass fields for infestation of the girdler. Dense infestations were then sprayed with 1 lb. AI Diazinon per acre for adult control. Trap captures of adults were reduced 96 percent, and thus reduced the subsequent larval infestation in the fall an estimated 75 percent. Attempts to control larvae infestations when damage appears in the field have not been successful.

Sex attractant for the plume moth discovered - Corvallis, Oregon. A sex attractant was discovered for the plume moth, Oidaematophorus monodactylus, a beneficial insect for biological control of bindweed. The pheromone should be of use in monitoring the insects in areas of new introduction, especially in the southern United States.

One clone of highly resistant reed canarygrass found palatable to sheep - University Park, Pennsylvania. Reed canarygrass clones having high concentrations of certain indole alkaloids are unpalatable and diarrhetic to grazing animals. Thus, plant breeders are attempting to improve the quality of reed canarygrass by developing cultivars with low indole alkaloid content. Several clones with resistance to frit fly were found to be unpalatable to sheep in Minnesota and Indiana. If palatability of reed canarygrass to sheep were positively correlated with susceptibility to frit fly, then efforts of plant breeders to develop highly palatable cultivars could lead to development of cultivars that are highly susceptible to frit fly. However, clone 6332, which was highly resistant to frit fly, was also moderately to highly palatable in sheep grazing trials. Therefore, it should be possible to select for frit fly resistance without sacrificing palatability.

Slugs found to be serious pests of legumes in minimum tillage pastures - University Park, Pennsylvania. Two of three species of slugs common in pastures and hayfields are serious pests of legumes seeded with minimum-tillage equipment. In the field, more slugs were found in plots containing legumes than in plots with grass alone. Mesurol bait, which effectively controls slugs, was usually associated positively with density of legume seedlings, which suggested control of slugs increases the establishment of legumes in grass plots. Research indicates for successful legume establishment in sods, slugs must be controlled, especially in wet soils or in cool, wet springs.

Sugar Crops:

White grub causes severe losses in sugarcane roots - Canal Point, Florida. Eight adults of Ligyrus subtropicus were added to 5 gallon cans containing growing sugarcane plants. The containers were covered with net to prevent the escape of the adult beetles. Eggs were distributed through the muck sand mixture with about 70% of them in the first 6 inches of soil. After 20 days, 25% of the eggs

had hatched, and at 26 days 75% of the eggs had hatched. After 51-55 days 80% of the larva were in the 1st instar stage after 71-76 days 80% were in the second instar stage, and after 102-107 days all the larva were in 3rd instar stage. Nine weeks after the plants were infested, the root weights of infested plants were reduced 14%, and after 26 weeks the root weights were reduced by 64%. Ligyrus subtropicus has now been reared through its complete life cycle.

Southwestern corn borer not expected to be severe pest of sugarcane - Houma, Louisiana. Results from a replicated trial indicated a low survival plus delayed development of southwestern corn borer larvae on sugarcane. Thus, this severe pest of corn apparently does not threaten sugarcane production in south Louisiana.

System for developed for forecasting intensity of beet western yellows virus spread - Yakima, Washington. A forecasting system was developed to alert the growers before scheduled insecticide applications take place, whether the potential spread of virus early in the season warrants chemical control. The system is based on several inspections of the drainage ditches in spring to determine the survival rate of the viruliferous aphids near commercially grown beets.

Oilseed Crops:

High levels of Mexican bean beetle resistance maintained in F_4 and F_5 soybean backcross populations - Beltsville, Maryland. Selected resistant crosses were subjected to one or two cycles of backcrossing to the agronomic parent. Single plant selections for resistance were made in the F_2 and F_3 generations. F_4 and F_5 lines have been identified which appear agronomic and are as resistant as the resistant parents. High levels of resistance must be maintained in a search for agronomic types if insect resistant varieties are to be developed and released.

System developed for mass producing eggs of the tobacco budworm suitable for use in mass producing bollworm eggs for infesting soybean field plots - Stoneville, Mississippi. The system developed for mass producing tobacco budworm eggs was found suitable for producing bollworm (corn earworm) eggs. The availability of eggs and means for applying these makes possible the artificial infestation of soybean plots for development of economic action levels and for evaluation of effectiveness of recommended and candidate insecticides.

Resistance to several sunflower insect pests found in wild species - Bushland, Texas. Eighteen species of Helianthus exhibited significant levels of resistance to larvae of the sunflower beetle, Zygogramma exclamationis. Adults failed to lay eggs when confined on 4 wild sunflower species. Twelve species of Helianthus were significantly more resistant to the aphid, Masonaphis masoni, than was sunflower 'hybrid 894'. Root damage by the carrot beetle, Bothynus gibbosus was significantly less on 11 species of Helianthus than on hybrid 894. Seven species of Helianthus exhibited significant resistance to the leafhopper, Empoasca abrupta. These wild Helianthus have potential sources for multiple host resistance to major insect complexes of sunflowers.

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National Research Program 20250

BASIC/NON-COMMODITY RESEARCH FOR INSECT CONTROL

This National research Program includes basic research on entomological problems regardless of the affected commodity or U.S. Department of Agriculture mission. Chemists, physiologists, ecologists, and behaviorists work together in teams to provide the in-depth fundamental knowledge needed in applied research programs in insect management.

NPS Contact: Waldemar Klassen

Technological Objective 1: Develop new and improved principles and practices of arthropod control based on the selective disruption of growth, development and reproduction.

Research Locations:

Gainesville, Florida
Beltsville, Maryland
Fargo, North Dakota

Following are some examples of recent progress:

Ecdysone increases the organization of microtubules in cell lines from the tobacco hornworm- Gainesville, Florida. The CHI Manduca sexta cell line was cloned to improve the elongation response to 20-hydroxy ecdysone. The GVI clone has been tested with pharmacological agents known to affect cytoskeletal structures, including colcemid, vinblastin, and cytochalasins. Of these agents, colcemid and vinblastin reverse the cell elongation of microtibules in the elongation response. Electron microscopic examination of cells indicates hormonal treatment increases organization and possibly numbers of microtubules in GVI cells.

Molting hormones appear to stimulate insect metamorphosis by promoting RNA and protein synthesis during a hormone dependent phase- Gainesville, Florida. Wing imaginal discs isolated from last instar larvae of the Indian meal moth produced chitin when incubated in vitro with X 10 M 20-hydroxyecdysone. Chitin biosynthesis was initiated 8 h after the conclusion of a 24-h treatment with hormone. Simultaneous incubation of wing discs with 20-hydroxyecdysone and ether inhibitors of RNA synthesis (alpha-amanitin, actinomycin-D) or inhibitors of protein synthesis (Cycloheximide puromycin) prevented chitin ciosynthesis. We conclude from our results that RNA and protein synthesis must continue undiminshed during the hormone-contact period, and that protein but not new RNA synthesis is required during the post-hormone culture period. Our findings are consistant with the hypothesis that ecdysteroids stimulate insect metamorphosis by promoting the synthesis of new RNA and protein during a hormone-dependent phase followed by hormone-independent protein synthesis.

Storage proteins in greater wax moth last larval instars are synthesized in fat body, released to the blood and reabsorbed into the fat body just prior to pupation- Gainesville, Florida. Storage proteins were identified in the blood of last-instar larvae of wax moths. These proteins are synthesized (indicated by 3H-leucine incorporation) by the fat body and exported to the blood throughout the feeding period. Just prior to pupation these proteins are reabsorbed and deposited as granules in the fat body. Histological examination indicates that the granules persist throughout metamorphosis. Four electrophoretically pure storage proteins have been isolated from both, the blood and fat body. They all contain carbohydrate and have molecular weights around 80,000.

Biochemical genetic markers differ in Mediterranean fruitfly populations from various geopraphic locations-Gainesville, Florida. Enzymes encoded by an estimated 24 gene loci have been surveyed for genetic variation. Populations from Africa, Europe, Central America, Australia and Hawaii (USA) have been sampled. Fourteen of these loci are genetically variable in Africa, whereas less than 5 are polymorphic in most other localities. The abundance of genetic markers in African population will provide excellent material for the study of linkage groups (chromosome mapping), the development of genetic sexing systems, and the investigation of the effect of genetic bottlemecks on introduced populations.

New synthetic brassinosteroid enhances vegetative growth and crop yields-Beltsville, Maryland. A new synthetic brassinosteroid has been found to increase vegetative growth and crop yield in a wide diversity of plants under both greenhouse and field conditions. These results demonstrate that the brassinosteroids significantly enhance plant growth and plant crop yield and that the use of these plant growth regulators offers outstanding potential for increasing plant growth and yield of economically important crops. (Cooperative research with Dr. W. J. Meudt).

Twelve ecdysteroids isolated from embryonated tobacco hornworm eggs- Beltsville, Maryland. New surprising discoveries continue to be made in the hormonal control of insect growth and development. A total of 12 steroids were isolated from 4-to-18 hour embryonated tobacco hornworm eggs. Six compounds were conclusively identified; ecdysone, 20-hydroxyecdysone, 20,26-dihydroxyecdysone, 26-hydroxyecdysone, 3-epi-20,26-dihydroxyecdysone and the new ecdysteroid 3-epi-26-hydroxyecdysone. The remaining six steroids, also new, are in the process of being characterized. 26-Hydroxyecdysone, the major ecdysteroid in 24-to-44 hours old and 48-to64 hours old embryonated hornworm eggs was the major ecdysteroid at this age also, indicating that this molting hormone possesses a specific functional role in this stage of development.

Insect growth regulators are highly toxic to root knot nematodes- Beltsville, Maryland. A number of insect growth regulators containing amine or amide moieties are more active in the Panagrellus assay than any compounds previously evaluated in this test system, including the best commercial nematicides. The most potent of these chemicals when tested in the greenhouse in a direct-contact test against an economically important plant parasitic root-knot nematode, were approximately 10-times more effedtive than the most potent commercial nematicide. (Cooperative research with Nematology Laboratory).

Four major hydrocarbons from post-pharyngeal glands of fire ants identified- Beltsville, Maryland. The hydrocarbon fraction of the post-pharyngeal glands of red imported fire ant has been show to contain four major components. Two of these hydrocarbons have been unequivocally identified by synthesis and comparison of mass spectral data of thd natural and synthetic compounds, and the other two components have been identified and are currently being synthesized. Synthetic samples of the two hydrocarbons are presently being evaluated in four fire ant assay ststems for their effects on behavior and sunction(s) in maintaining the social organization in fire ant colonies and the hydrocarbons being synthesized will be similarly tested. (Cooperative research with Insects Affecting Man Research Laboratory).

Honey Bees unable to Convert C28- or C29-Phytosterols to Cholesterol- Beltsville, Maryland. Radiolabeled campesterol, sitosterol or 24-methylenecholesterol were included in diets fed to honey bees. No measurable amount of any of the labeled dietary sterols was converted to cholesterol by workers, queens or larvae and accumulation of labeled sterol did not exceed 30% of the total sterol in any stage. Further metabolic studies of the unique mechanism of sterol utilization in honey bees are being pursued to determine the extent to which the workers are capable of utilizing their sterol reserves to provide these essential nutrients to the brood. (Cooperative research with Bioenvironmental Bee Laboratory).

Chitin synthesis inhibitors prove to be potent female sterilants for house flies- Beltsville, Maryland. Relative potencies of diflubenzuron, penfluron, and Bay Sir 8514 (2-chloro-N-(((4-(trifuluoromethoxy)phenyl)amino)carbonyl)=benzamide) were evaluated as female sterilants against the house fly, Musca domestica L. by injection. Penfluron and Bay Sir 8514 were more than twice as potent sterilants as diflubenzuron. Penfluron was as potent or more potent than Bay Sir 8514. Moreover, female house flies injected with penfluron or Bay Sir 8514 remained sterile for more than 3 wks., but those injected with diflubenzuron regained fertility partially or completely 10 days posttreatment. All 3 compounds prevented egg hatch whether the flies received the injection while they were virgins, after they were inseminated, or after they laid their 1st batch of eggs.

Small peptides isolated from brains of tobacco budworm, face flies and house fly- Beltsville, Maryland. The extremely important roles of peptides as neurohormones in the brain of man and of vertebrates is rapidly being clarified. Central nervous system receptors for these peptide hormones are readily occupied by non-peptide synthetic organic chemicals. For example the receptors for the human brain's built-in pain killers-endorpnins and enkephalins- are complexed by morphine and its derivatives. The study of brain peptides in insects may lead to as useful developments as those derived from studies in the human brain.

A method has been developed for isolation and analysis of peptides for the brain tissue of insects by use of Reverse Phase High Performance Liquid Chromatography (RP-HPLC). New equipment has permitted the maximization of the ability to detect these peptides on line by use of computerized baseland correction gradient runs at extremely low wavelengths (195 nm). In addition, use of a Radial Compression Module permits maximum column sensitivity and separation of peptides. A new water system for ultrapure Type 1 water and a new buffer system, KH2PO4 (pH 4.5), which is easier to obtain a pure state as compared to the TEAP buffer previously used made it possible to easily detect 15 ng of peptide. Latest results show presence of small peptides in tobacco budworm, face fly, and house fly brain extracts.

Microtubular polymerization in some insect embryos is inhibited until activated during membrane assembly- Fargo, North Dakota. Tubulin, a universal structural protein in the major constituents of microtubules in insect cells. Thus tubulin have a very significant role in the shaping of cells as well as in transport of metabolites. Early insect embryos offer excellent opportunities for the study of the genetic control and regulation of tubulin. It is not yet known whether subunits exist in the egg; or if tublin results from mRNA synthesis after synthesis after fertilization of the egg has occurred. In other words what is the extent of maternal influence on early development and differnetiation?

The distribution of membrane receptor sites for tubulin polymerization were found to differ amongst insects. Moreover, electron microscopy studies indicate that the rate of nuclear division in early embryogenesis of the screwworm (5-10 minutes) and the milkweed bug (30-45 minutes) could be related to microtubules. Microtubules are present in the nucleoplasm of the screwworm early embryo and absent from the nucleoplasm of a similar stage in milkweed bug develpment. Microtubular polymerization in the milkweed bug is inhibited until membrane assembly. The integrity of these polymerization sites is conserved on the inner membrane of the screwworm during the cleavage division process.

Boll weevil strain selected which can better tolerate exposure of the midgut to gamma rays- Fargo, North Dakota. In cooperation with the University of Minnesota a genetic selection experiment for 14 day post-irradiation survival of boll weevil is now in its 4th generation. In the select population each male is mated to two females under perfect conditions. The procedure provides data on 60 full-sib and 30 half-sib families each generation. Four males and four females are saved from each full-sib family and all other individuals are irradiated with 10,000 rads as 2-day-old adults. The criterion for choosing parents for the next generation is the mieio survival for the inadiated half sib-family. Thus unirradiated individuals whose irradiated sibs that had the greatest survuval as chosen to the parents for the next generation. Results thus for indicate that (1) the average survival at 14 days postirradiative of the base population is 35% (2) a selection differential of 11-19% accurs each generation and (3) After 3 generations the 14 day postirradiation survival of the selected population has improved to 57%.

House flies become adapted to various larval rearing media through Darwinian selection- Fargo, North Dakota. House fly populations possessing given enzyme alleles at equal frequencies in the heterozygous condition were derived. Subsequent larval generations were challenged by varying pH levels in the same or different kinds of food. Allele frequencies of each adult generation were monitored via electrophoretic methods. The systems under examination include Tetrazolium oxidase (To), Octanol dehydrogenase (Odn), and Glutamate oxaloacetate transaminase (Got). Tests with the To system were completed through and F5 generation using two variants designated as To11 and To12. The latter is the most common variant in field samples examined from the North Central U. S., whereas To11 has been observed only in the heterozygous condition at a frequency of 2-5 percent in comparison with other forms (A third variant To13 exists). By the F5 generation there were significant deviations from expected genotype ratios in favor of the To12 allele in 3 of the 4 larval foods (alfalfa meal with adjusted pH, cow manure, and chicken manure). In the fourth food (regular alfalfa meal) there were no significant deviations from expected ratios, suggesting that flies possessing the To11 variant were better able to survive to adulthood. The regular alfalfa meal pH was less alkaline than the other 3 foods.

Chromosomal differences observed in taxonomically related boll weevil entities- Fargo, North Dakota. The chromosome karyotype of Anthomous hunteri appears similar in number to that of the thurberia weevil found in the mountains of Arizona. From a very few determinations, A. hunteri appears to have 21 II + Xy which is the same n number as found for the thurberia weevil. On the other hand, the common Southeastern U. S. boll weevil A. grandes has 20 II + Xyp. Based on a few good gonial cell preparations the two species, A. hunteri and A. grandis, have many chromosomes of identical or similar morphology. The X-chromosome of both species are indistinguishable when viewed in aceto-orcein squashs. There are at least a half a dozen autosomes that are indistinguishable between the two species. Boll weevils taken from cotton in the southern tip of Mexico (Tampico) cross readily with each other in the laboratory and are fertile. The chromosome complement of these weevils appears to be 20 II + Xy with some individuals displaying possible B chromomes. However, when weevils taken from Hampea nutricia are crossed they are fertile but the F1 adults die from 7-10 days following emergence. Taxonomic identification of the parents used in these crosses has not yet been made, nor has the chromosome complement of the weevils collected from Hampea nutricia been determined. (In cooperation with Texas A&M University).

Specific bioassay developed for oostatic hormone- Fargo, North Dakota Vitellogenin synthesis in ovariectomized flies can be used as a bioassay for the oostatic hormone. This is a specific bioassay and will be a definite improvement over the egg development bioassay used in the past. The old assay was not specific and gave false-positive results because the extract-injected insects were stressed, and the rate of egg development was slowed down. In the new assay, vitelloginin synthesis is not induced by stress but only by specific hormones.

Rocket immunodiffusion electrophoresis was developed to monitor vitellogenin production in house flies. Vitellogenin was purified by reacting egg extract with male fly extract to remove nonspecific proteins. This results in single, well-defined rockets on the gel after electrophoresis.

The concentration of vitellogenin increased from 0 ug/ul in hemolpymph at stages 2 and 3 to a maximum of 8.7ug at stage 6 and then decreased to 5.5ug at stage 10. Vitellogenin in the fat body increased from 0 ug/ul to a maximum of 4.9 ug at stage 6 and then decreased to 1.91ug at stage 10. Vitellogenin incorporation into the oocyte started at stage 4 and continued throughout oogenesis. Most vitellogen was incorporated during stage 7.

Ovariectomized flies contained 0.4 ug vitellogenin per ul of hemolymph, and this level was increased to 4 ug 24 hr after 1 ug of ecdysterone was injected. Thus, the developing ovary is required for vitellogenin synthesis, and ecdysterone can substitute for the developing ovary. To date, no ovarian extracts have been able to induce vitellogenin synthesis in ovariectomized flies.

When the ring gland was removed, females did not produce vitellogenin, and vitellogenin synthesis could not be induced by ecdysterone injections. Therefore, either juvenile hormone (JH) or EDNH is required to "prime" the fat body to respond to either the ecdysterone or the oostatic hormone.

Completely accurate method devised to separate sexes of sunflower stem weevils- Fargo, North Dakota. All previous attempts were unsuccessful, short of sacrificing the insect. The stem weevil may be sexed during the last 2 days of the pupal stage. The structure used for sexing is the apodeme of the eighth aternite, which can be seen with black lighting and stereomicroscope. Sexing is 100% accurate when done at the proper time. This successful sexing method has allowed research to progress on several projects, such as the study of environmental factors affecting mating and oviposition and six pheromone studies.

Micropyle cap of housefly egg shown to be protein-polysaccharide complex- Fargo, North Dakota. Continuing studies on the physical and chemical characteristics of the micropyle cap hydrolase enzyme(s) contained in the accessory reproductive gland secretion revealed that the activity is sulfhydryl dependent. Cap removal activity is also inhibited by the presence of ovomucoid, mucin, heparin, and Concanovalin A. The inhibitory action of these compounds strongly suggests that the substrate (micropyle cap) consists of a proteinacious substance complexed with a carbohydrate such as found with muco- and glycoproteins. Heparin, a sulfated mucopolysaccharide, has been shown to bind and inactivate such enzymes as trypsin, chymotrypsin, and hyaluronidase, as well as inhibit fertilization of sea urchin eggs. Several synthetic substrates were tested in the bioassay system as competitive inhibitors to cap removal activity and the relative effectiveness of a number of ethyl or methylesters and amides as inhibitors indicates that the accessory gland secretion also contains esterase and amidase activity.

Cuticular hydrocarbons of cowpea weevil determined- Fargo, North Dakota. The composition of cuticular hydrocarbons of cowpea weevil, Callosobruchus maculatus, was determined by using combined gas chromatography-mass spectrometry. The hydrocarbons constituted 88% of the cuticular lipids and were composed of 4 homologous series of alkanes. Mono- and dimethyl-branched chain alkanes made up 83% of the hydrocarbon fraction. A bimodal distribution of hydrocarbons was obtained: a group with 27 to 35 total carbon atoms and a group with 42 to 49 total carbon atoms. The dimethyl-alkanes generally had isoprenoid spacing between the methyl groups, but dimethylheptacosanes and nonacosanes were found with the methyl groups separated by 3, 5, 7, and 9 methylene units. These dimethylakanes eluted at the same GC retention times as N-octacosane and n-triacontane, respectively.

Mode of action of ecdysone and cell membranes partially elucidated- Fargo, North Dakota. The effect of ecdysone on the K+, Na+ ATPase of cultured lepidopteran cells has been further examined by using cell membrane preparations and a pseudo substrate. 20-Hydroxyecdysone (10-8M) produced a 5-fold increase in K+, Na+ ATPase activity. This increase is entirely eliminated in the presence of ouabain, a specific K+, Na+ ATPase inhibitor.

Chemicals differing widely in molecules configuration inhibit chitin synthesis- Fargo, North Dakota. In cooperation with Univ. of California, Berkeley, we have continued our evaluation of compounds that inhibit chitin synthesis. We have identified 21 compounds that are specific chitin synthesis inhibitors, most of which are reversible and non competitive in action. A wide varitey of molecular configurations show activity. At least one group, the azidotriazines, show promise as insecticides.

Mode of action of chitin synthesis inhibitors partially elucidated- Fargo, North Dakota. In cooperation with University of California, Berkeley, we have shown that diflubenzuron, like tumicamycin, interferes with the carrier system leading to phosphorylation and polymerization of N-acetylglucosamine, and thus inhibits chitin synthesis. This action alone cannot account for the extremely high level of activity of diflubenzuron. The action of this compound as a serum protease inhibitor (which prevents activation of the chitin synthetase zymogen) would provide the biological amplification necessary to account for this high level of activity. Preliminary evidence from our work indicates that this is the case.

Chemical ionization mass spectrometry proves useful not only in identifying molecular weight of alkanes but also for locating double bonds in alkenes- Fargo, North Dakota. In collaboration with the Forest Service, APHIS, and the University of Nevada, GC-CI-MS was the method of choice for determining the molecular weight of every component in complex alkane mixtures found on the insect cuticle. It also provided branch point information. The technique was applied to a number of normal and methyl-branched synthetic alkanes as well as to the hydrocarbons from the termite, Reticulitermes flavipes (Kollar), the cricket, Gryllus pennsylvanicus Burmeister, and the cigarette beetle, Lasioderma serricorne (Fabricius).

Also, a method was developed in which the positions of double bonds in olefins can be readily determined by a sodium borohydride reduction of their methoxymercuration products, followed by mass spectrometry. Fragmentation of the methoxy derivative in the mass spectrometer resulted in cleavage on either side of the methoxy group to give intense fragment ions which are characterixtic for each isomer. This simple and convenient microanalytical technique was applied to several synthetic standards and insect derived olefins, including the alkenes from the cuticular lipids of the honey bee, Apis mellifera L.

Technological Objective 2: Develop new and improved principles and practices of insect control based on behavior and ecology.

Research Locations:

Albany, California
Gainesville, Florida
Beltsville, Maryland
Otis AFB, Massachusetts
Fargo, North Dakota
Wyndmoor, Pennsylvania
Yakima, Washington

Following are some examples of recent progress:

New program initiated on feeding and oviposition attractants of highly destructive insect pests- Albany, California. The outstanding capabilities in separation technology of the Western Regional Research Center have been engaged to study the interactions of insect pests with crop plants. The volatile components of several corn plant parts (husk, kernel, silk, and tassel) have been concentrated and tested with gravid female Heliothis zea moths for attractiveness. Testing results with whole concentrate are inconclusive to date. The concentrates have been examined by capillary gas chromatography-mass spectrometry, and numerous constituents have been identified (husk-56; kernel-34; silk -63; tassel-35). Such unusual compounds as cis-hept-4-3n-2-ol, hept-4-en-2-one, geosmin, alpha-ylangene, geranylacetone, beta-lonone, and the methyl and ethyl phenylacetates were cooperators at Tifton, GA. Sunflower head volatiles have similarly been

been concentrated and examined. These volatiles are primarily terpenoid in nature. Approximately 20-25 compounds have been identified. Bioassays with several sunflower insect pests have been arranged with a cooperator in Bushland, TX. Sunflower extrafloral nectar composition is also under study because of the possibility of it attracting insect predators. Several other plant-pest combinations are being investigated, including almonds/navel orange worm, and cereal plants/ cereal leaf beetle.

Compounds in sorghum identified which deter feeding by greenbugs- Albany, California. The bioassay for greenbug was improved by adjusting the pH of the synthetic diet to 8.8 and working under aseptic conditions. Over 95% of the aphids will feed on this improved synthetic diet. Using the improved bioassay procedure, the major feeding deterrents to compounds in sorghum have been determined to be p-hydroxybenzaldehyde, dhurrin (s relative of amygdalin), and prodyanidin.

Feeding deterrents identified for Colorado potato beetle- Albany, California. In cooperation with Dr. Tibor Jermy, Hungarian Institute of Plant Protection, Budapest and the Yakima Agricltural Research Laboratory antifeedants for the Colorado potato beetle were isolated from rabbit brush, Chrysothamnus nauseosus. These were identified as four new polyacetylenes and two diterpene acids.

Apanteles marginiventris parasite receives nutrients from host capillar's fat body- Gainesville, Florida. Various observations have shown the host's fat body to be an important source of nutrients for parasite larval growth. Specific adaptations of the parasite which facilitate release of these nutrients have been discovered and are being documented currently. Efforts are being made to improve the artificial media being employed using the observation on the altered physiology of parasitized hosts as a guide to improvement of the media. (In cooperation with Harvard University).

Resistance of citrus to Caribbean fruitfly enhanced by plant growth regulator- Gainesville, Florida. Bioassays of the susceptibility of citrus to attack by the Caribbean fruit fly revealed marked resistance by all types of citrus fruit tested. Resistance varies among cultivars and according to fruit senescence. Lemons displayed virtual immunity while oranges were intermediate and overripe grapefruit were most susceptible. Resistance was attributed to volatile peel oil constituents that are toxic to fly egga and newly-hatched larvae.

Field tests showed that resistance can be enhanced or at least sustained by use of the plant growth regulator gibberellic acid, which selectively inhibits senescence of the fruit peel and thereby prevents loss of initial resistance. Thus, grapefruit treated prior to colorbreak with 5PPM GA3 were significantly less susceptible than control fruit tested later in the season. (In cooperation with the U. S. Horticluture Research Laboratory, Orlando and Citrus and Subtropical Products Research Laboratory, Winter Haven).

Moderate-scale production system devised for fall armyworm- Gainesville, Florida. A production system has been developed to mass-rear fall armyworm larvae in ca. 7 liter reusable containers. Each unit is filled with 1150 g of diet and stocked with 500 eggs. Developing larvae remain on the diet for 14 days at 27 C, days 1-7 at 80% RH and the remainder at 60% RH. On day 15, the diet is removed and 0.5 liter of bran is added to provide a pupation substrate. Even though fall armyworms are cannibalistic, these containers each produce an average of 378.9±8.5

pupae (n=14) that weigh 214.8±0.7 mg. An average of 3 g of diet is required per pupae, whereas the old system required 6.3. Moreover, 2.1 of the 7 liter units replaced 20 of the 16-oz. disposable containers.

Laboratory rearing and gamma irradiation cause cellular changes in eyes of Mediterranean fruitfly- Gainesville, Florida. In a further effort to evaluate and implement the visual assessment test for quality monitoring of the mass-reared med-fly, visual and spectral sensitivity tests were made on wild, laboratory-reared and irradiated laboratory-reared medflies in Costa Rica in cooperation with the OIRSA staff. The tests showed that the wild flies collected from tropical almonds had visual and spectral sensitivites equal to those tested in Hawaii. However, a decline in visual sensitivity was measured in the laboratory-reared fly. Irradiated lab-reared medflies of both sexes had spectral sensitivites reduced below the lab medflies with the ultraiolet peak most markedly reduced.

Histological examination of the compound eye of the medfly using light and transmission electron microscopy showed that the rhabdomere (photoreceptor structure) tends to be somewhat smaller in size in lab-reared flies and markedly reduced in size and number of rows of rhabdomeric microvilli in irradiated lab flies. Absence of rhabdomeres and/or entire retinular cells occurs occasionally in laboratory and irradiated flies and the orientation of their rhabdomeric microvilli is often asymmetrically arranged when compared to that of the wild fly. These and other structural differences in the cellular organization of the compound ete of the medfly tend to confirm and explain the decline (slight) in sensitivity of the lab-fly eye and the additional decline in the irradiated medfly eye as determined in earlier electrophysiological studies.

Plexiglass #2037 and Boller (bright yellow) traps most effective for Mediterranean fruitfly- Gainesville, Florida. Based on spectral sensitivity characteristics of the medfly, a set of 5 color traps was selected for testing in several Mediterranean Sea area locations through the cooperation of Swiss scientists and members of the International Organization for Biological Control. The Plexiglass #2037 and Boller (bright yellow) traps proved to be the most effective visual attracants for the med-fly while the olive fly was attracted to Plexiglass colors #2038 and #2465 as well as the Boller trap. Plexiglass #2564 (orange) was not an effective attracant for either species. The Boller trap is the best visual attractant for both species according to studies to-date.

Courtship of velvetbean caterpillar involves 15 stereotyed behaviors- Gainesville, Florida. Preliminary analyses of video tape records and 35 mm photographs of velvetbean caterpillar moth courtship indicated that at least 15 sterotyped behaviors are involved and that they may be accomplished in less than 5 seconds ($\bar{X}$= 27.3 seconds, n=30). The primary elements of this courtship sequence are as follows: 1. female selects calling location (vertical surface preferred, head up); 2. female assumes calling posture; 3. female releases pheromone (covert); 4. male flies upwind toward female; 5. male extends abdominal hair pencils at the base of segmens 5 and 7, and on the external genitalia; 6. male approaches female from below; 7. male hovers over dorsum of female; 8. male antennates female forebody (generally 1 antenna on each side of female thorax); 9. male moves to a position with his forebody slightly above the female; 10. male thrusts his foretibiae upwards exposing massively pubescent freely articulatory forecoxae; 11; male descends on female, engulfing her entire forebody (head, antennae, and

proximate thorax in his pubescence; 12. male positions his midlegs around the prothorax of the female and projects expansive tibial "hair pencils across the entire female thorax and associated anatomy; 13. male and female overlap and elevate their wings forming a "tent-like" slope; 14. male clasps female genetalia; 15. male drops to an opposing position (head down). Communication during courtship bouts includes both chemical and tactile cues originating from and perceived by both sexes.

Antennal enzymes most active in breaking down pheromone molecules are acetylases Gainesville, Florida. Esterases isolated from olfactory sensilla on the antenna of Trichoplusia ni were analyzed by disc gel electrophoresis and characterized by their sensitivity to enzyme inhibitors. Enzymes from the antennae hydrolyzed the pheromone more rapidly than those from cuticle and several other tissues. The esterases most active on pheromone catabolism were identified as acetylesterases. A major portion of the enzymes were solubilized from the nerve membrane fraction. The antennae of newly emerged male moths have little pheromone degradative capacity; however, a marked increase in pheromone catabolism occurs when the moths are 2-3 days old and begin to respond to the pheromone.

Minimal pheromone concentration needed to evoke response determined by surface area of sensillae and by spontaneous activity- Gainesville,Florida. A model of olfactory perception has been derived which examines three major hypothesis of processes which govern olfactory perception and behavior. It appears that a reasonably accurate estimate of the minimum pheromone concentration at the threshold of behavior can be ascertained from measurements of inter alia, the surface area of pheromone-sensitive sensilla and spontaneous activity.

Two pheromone production sites on ovipositor of tobacco budworm involved in its sexual isolation from related species on groundcherry- Gainesville, Florida. The courtship sequence for 125 pairs of Heliothis virescens has been analyzed and differs only in the absence of prominant hair pencilling displays for H. subflexa (20 pairs). H. virescens males are attracted to the vicinity of calling H. subflexa females but fail to find them (N=30). Male H. subflexa are not attracted to calling H. virescens females (N=28). Two sites of pheromone production have been identified in the H. virescens ovipositor. Each site elicits a somewhat different series of reproductive behavior. Preliminary GC analysis indicates the presence of different component ratios in each glandular site.

Oviposition deterrence pheromone of apple maggot consists of two polar heat stable components- Gainesville, Florida. The crude concentrates of the pheromone obtained from methanolic washes of apples exposed to ovipositor dragging were fractionated by various extractive, chromatographic, and other purification techniques. Activities of these fractions were monitored by bioassasy conducted by R. J. Prokopy, Univ. of Mass., Amherst.

Procedures developed for synthesizing intermediates of chiral pheromones- Gainesville, Florida. A program of asymmetric synthesis in which common chiral aminoalcohols are emplyed as the basis for the generation of new chiral centers has been instigated. Amides of (S)-(-)-prolinol and (1)-(-)-ephedrine have been converted to dianions at low temperatures. These react with alkylhalides to produce diasteromeric a-alkylamides whose analyses (uniquely by liquid crystal GC) reveal that the new center has been created (S). Enantiomeric excesses were 80% (i.e., 9:1 ratio of S to R). The methylethers of these chiral auxiliaries, on the other hand induce asymmetry equally and in the opposite sense. This is

the first time anyone has been able to so thoroughly reverse the asymmetry induced. Using a single configurationally pure substrate and same reagents (acid halide from which to make amide, and alkylhalide) one can generate the new center in either configurational sense. The prolinol and ephedrine-based products are hydrolyzed to the a-alkylalkanoic acids which will serve as synthetic intermediates for chiral pheromones.

Previously unseparable pheromone isomers can be resolved by means of high resolution glass capillary gas chromatography- Gainesville, Florida. High resolution glass capillary gas chromagraphic columns coated with a polar liquid phase, Sp 2340, and with liquid crystal phse, have been developed that allow separation of pheromone isomers that were previously not capable of being resolved. Empirical formulas have been developed that allow the prediction of elution order and resolution of isomers of certain types of compounds on several liquid phases coated on capillary calumns. A new method for coating silica high resolution liquid chromatography columns with AgNO3 in situ was developed.

Stereospecific synthesis devised for white peach scale pheromone- Gainesville, Florida. A very steroselective synthesis of all four isomers of the pheromone 3,9-dimethyl-6-isopropenyl-3,9-decadien-1-ol propionate, was completed. A useful extension to Christmann-Schlosser modification of the Wittig reaction was discovered which is uniquely applicable to the tri-substituted allylic alcohol structure incorporated in this insect's pheromone. Gram quantities of very pure (R,Z)-isomer have been synthesized and all four isomers and appropriate mixtures thereof have been made available for biological tests.

Mating communication of tomato pinworm disrupted for 60 days by single high rate application of pheromone- Gainesville, Florida. The tomato pinworm sex attractant was applied in packets of Conrel hollow fibers to the stakes in 29 acres (3 plots) of commercial tomatoes near Ruskin, Florida. Mating communication was disrupted for 60 days by a single application at a very high rate. Failure of a formulation applied early in the growing season precluded any demonstration of damage reduction as insecticidal controls had been implemented before the effective disruptant formulation was applied. (In cooperation with Conrel, Inc. and the University of Florida).

Significant correlations established between pheromone-baited traps of tobacco budworm, larval infestations and damage levels in tobacco- Gainesville, Florida. For 2 years significant correlations were found between pheromone-baited trap catches of H. virescens males and (1) larval infestations and (2) damage levels in tobacco when trap catches were compared with larval and plant damage counts made 1 and 2 weeks later. There was also significant correlation between larval infestation and plant damage involving counts made teh same week.

Literature on parasites of Spodoptera computerized- Gainesville, Florida. A classification system encompassing taxonomy, disciplines, keywords, location, agricultural crop, and comments was developed and then implemented using a computer program called FAMULUS. To date over 1000 reprints have been classified on magnetic computer tape. These reprints can be searched using Boolean logic. Individual searches cost less than $1.00 and take less than 2 seconds.

This literature documented that 53 species of parasites from 43 genera and 10 families have been reared from larvae of the fall armyworm. Only 24% of these larval collections identify the plant from which the fall armyworm larva was collected.

Apanteles marginiventris and Chelonus texanus are the most frequently recovered parasites. The distributions of these parasites indicate that additional importations of parasites from South America into the United States are feasible.

Substantial progress made in further improving rearing of gypsy moth- Otis AFB, Massachusetts. Mechanization and automation of infesting diets with immature stages as well as other rearing operations are dependent upon synchronous egg-hatch and subsequent development. A newly constructed high humidity chamber capable of maintaining 80% RH improved the rate and synchrony of egg hatch particulary in selected non-diapause and short-diapause strains of the gypsy moth.

Sex differences in the time of hatch of larval gypsy moths is dependent on the extent to which the egg masses are chilled. Males tend to hatch first from egg masses that are chilled at 6 C for 120 days or less. This phenomenon is being further evaluated for reducing rearing costs for sterile male production.

Prospects for relatively homozygous non-diapause and short-diapause colonies of the gypsy moth are encouraging. It is expected that working colonies will be available within a year or two.

Potent feeding deterrents discovered for several insects- Beltsville, Maryland. Two feeding deterrents highly active in laboratory bioassays were discovered for the boll weevil. The deterrents were identified as (Z,E,E)-9,11,13-octadecatrienoic (a-eleostearic) acid, mp. 49 , and erythro-9,10-dihydroxy-octadecanyl acetate, mp. 54 . The former is more effective than the latter in preventing weevil damage to cotton bolls but is less stable. A simple, one-step low-temperature crystallization method was developed for isolating 50 grams of pure a-eleostearic acid from 100 grams of tung oil. The second deterrent was synthesized by converting pure oleyl alcohol to the acetate and oxidizing the latter with H_2O_2 catalyzed with OsO_4. Field tests will be carried out in Mississippi or in Mexico by the USDA Boll Weevil Research Laboratory.

Azadirachtin (I), the potent antifeedant from Azadirachta indica was found to have no mutagenicity or growth inhibition of tester strains in the "Standard" Ames tests. Salannin, the house fly feeding deterrent from neem, gave similar test results. I showed antifeedant activity for navel orangeworm, Amyelois transitella (Walker), at 0.1 ppm in the diet and gave satisfactory protection against feeding by black carpet beetle larvae, Attagenus megatoma (F.), and webbing clothes moth larvae, Tineola bisselliella (Hummel), at the 0.5% calculated deposit level. I showed excellent antifeedant activity with house crickets, Acheta domesticus(L.), and a detailed experiment was carried out to determine effects on growth and development of this insect as well as the large milkweed bug. A large quantity of I was also sent for hotbed and field tests on striped cucumber beetle, Acalymma vittatum (F.). An acetone extract of the ground fruit of chinaberry, Melia azadarach, was fractionated on C-18 Hi Flosil, Florisil, and then Bondapak C-18. Antifeedant tests with fall armyworm, Spodoptera frugiperda (J. E. Smith), indicated I to be the active component. A number of available conpounds (a-ionone, B-ionone, juglone, lawsone, helenin, lanosterol, phlorizin, nerolidol, and gossypol-related compounds) were tested for antifeedant activity against fall armyworm and striped cucumber beetle. A-Ionone and juglone showed marginal activity with fall armyworm, but juglone was toxic to large milkweed bug at 50 ug/insect. B-Ionone showed activity at 0.1 and 0.5% on leaf discs for 6 hrs., and juglone was active at 0.1% for6 hours. and at 0.5% for 20 hrs. on leaf discs against the striped cucumber beetle. Lawsone, also a naphthoquinone, was even more active that juglone on this beetle at 0.25% for 20 hrs. with 2% feeding.

Numerous ether and methanol extracts of local plants were made for antifeedant testing. Bloodroot and Ailanthus extracts looked promising for both fall armyworm and striped cucumber beetles. Juniper, pine cone, and rose extracts looked promising for fall armyworm; holly, dogwood, and Japanese honeysuckle looked looked promising for striped cucumber beetle.

Several simplified fragments of azadirachtin were synthesized and purified for biological testing.

Sex Attractants identified and synthesized for Comstock Mealybug and Citrus Mealybug- Beltsville, Maryland. A sex attractant pheromone from female Comstock mealybug has been isolated, identified, and synthesized. This compound, the first pheromone identified from a mealybug, is very attractive to adult males and is expected to be extremely valuable as a lure in monitoring and survey traps.

The Comstock mealybug is a serious pest of many fruits, particularly in California, where it was accidently introduced in 1967. Detection, survey, and monitoring of populations of this pest are vital to efforts to minimize economic losses and to guide measures taken to prevent further spread. Traps baited with virgin females have been used for survey and monitoring, but rearing of sufficient insects for this purpose is difficult and expensive. The newly discovered pheromone is very effective; a trap baited with 0.2ug captured more males than baited with 40 virgin females. It is anticipated that the pheromone will be used in 30,000 monitoring traps in Califormia in 1980.

A sex pheromone of the female citrus mealybug has also been isolated, identified and synthesized; its chemical structure is quite different from that of the Comstock mealybug. (In cooperation with Riverside, California).

Formulation of An Attractant for the Screwworm Fly- Beltsville, Maryland. A solid formulation using a low cost wax has been developed for the screwworm fly attractant, "swormlure-2". The unformulated attractant is a corrosive liquid mixture with a very unpleasant odor. The solid formulation is much easier to work with and makes it possible to combine the lure with a feeding bait and an insecticide in a solid pellet. These pellets can be spread by air over large areas to reduce populations of this major pest of cattle in the southern United States and Mexico. (In cooperation with Mission, Texas).

Sex Pheromone identified and synthesized for the Asian Corn Borer- Beltsville, Maryland. Cooperation with scientists in the Peoples Republic of China has led to the confirmation of the structure of the sex attractant pheromone of the Asian corn borer. This pheromone was isolated for identification from insects emerging from pupae sent by a cooperator in the Philippines. Traps baited with this pheromone should serve as more convenient monitoring tools than the light traps that are now used.

Further improved Insect Repellents synthesized- Beltsville, Maryland. Repellents synthesized here that have showen good activity in tests against stable flies, mosquitoes, deer flies, and black flies have now been shown to be effective against two species of biting midges. Two of these compounds are now undergoing advanced toxicology testing prior to further development. (In cooperation with Gainesville, Florida and DOD).

Parameters more clearly defined for suppression of gypsy moth by means of sex attractant- Beltsville, Maryland. Gypsy moth mating reduction was com-

pared for 2 disparlure formulations (NCR microcapsules and Hercon flakes) at 2 doses (4.99 gm/ha. and 19.86 gm/ha.) in 16.2 ha. forest plots in Northeast Maryland. Efficacy was measured by reductions in trap catch (mating communication disruption) and in mating frequency of sentinel females (actual mating disruption). The Hercon flakes out-performed the microcapsules. The high rate was clearly more effective than the low rate. But the most important factor proved to be the density of the resident population. Substantial mating disruption was recorded in all treated plots.

New potent feeding attractants discovered for tropical fruit flies, European corn borer, and corn earworm- Beltsville, Maryland. Potent feeding attractants have an advantage over potent sex pheromone attractants. The same percentage of individuals of a population are believed to responded to feeding attractant regardless of population density. By contrast the percentage responding to the an artificial source of an attractant decreases with increasing population density because the artificial source must compete with increasing numbers of "calling" individuals

Isolation and identification of insect attractants from plants. Ether extract of Trichilia maynasiana leaves and fruits was highly attractive to male medflies (3,516 attracted, index 502) in the olfactometer and ether extract of Bocconia frutescens woody stems was exceptionally attractive to female medflies. Column chromatography of these extracts gave a number of fraction several of which, obtained from T. maynasiana, were attractive to female melon flies and female oriental fruit flies in addition to male medflies. A red solid, mp 182-185 , obtained from 45 pounds of B. frutescens. was extremely attractive to female medflies in the olfactometer.

Chromatographic fractions obtained from green coffee berries with polar solvents and found to be highly attractive to female Mediterranean fruit flies and female melon flies were rechromatographed on silica gel to obtain a number of subfractions. Commercial samples of the purines adenine, guanosine, hypoxanthine, xanthine, and a mixture of these, all of which are known to occur in coffee berries, were completely devoid of attractancy to Mediterranean fruit flies, melon flies, and oriental fruit flies.

Phenylacetaldehyde, a component found in many species or plants (especially the flowers and foliage), was stabilized by mixing 10 mg with 0.2 mg of either 2, 5-di-tert-pentylhydroquinone or 2,6-di-tert-butyl-4-methylphenol and placed around a Beltsville corn field; it captured large numbers of European corn borers and corn earworm moths. The aldehyde was also isolated from fresh corn silks.

Proteus bacteria in screwworm infested wounds produce indole, a powerful attractant- Fargo, North Dakota. Bacteriological isolates from screwworms and screwworm infestation sites are being characterized in cooperation with Dr. Mary Bromel of North Dakota State University Department of Bacteriology. Identification criteria and idenities are incorporated into a computer program that facilitates the establishment of a data base that can be used in conjunction with a rapid morphological and biochemical method for bacterial classification. In addition, studies were conducted to determine if 1) microbes that reside in screwworms influence their fitness, 2) there are screwworm strain specific microbes, and 3) any products of microbial cultures that influence wound attractancy and/or egg deposition response. Indole was identified as a powerful attractant produced.

Sex pheromone identified for avodado leaf roller- Yakima, Washington. The avocado leafroller, Amorbia cuneana was found to consist of novel compounds in a 3:1 ratio. One of these components was synthesized. (Cooperator: Bailey, UCR).

Attractant components discovered for several economically important moths-Yakima, Washington. The trap catch of the cranberry girdler, Chrysotenchia topiara males in traps baited with Z-11-hexaderenal(1000/ug) or virgin females was increased sixfold by the addition of Z-9-hexadecenal (30ug). Potential secondary sex pheromone components of the armyworm, Psendoletia unipuncta, have been identified in the field. The primary component was attractive by itself. (Cooperator: Kamm, Corvallis, OR.).

Both laboratoryand field studies have been successfully completed on the two-component pheromone of the alfalfa looper, Autographa Californica. Two components of a three component pheromone have been shown to be attractive for the Western yellowstriped armyworm, Spodoptera pruefica. These can be used for monitoring. A moderately attractive compound was discovered for the alfalfa seed cholcid, Bruchophagus roddi. A powerful male attractant was discovered for the filbert-worm moth, Melissopus latiferreanus.

Technological Objective 3: Develop new principles and practices in insecticide use.

Research Locations:

Beltsville, Maryland
Otis AFB, Massachusetts
Yakima, Washington

Following are some examples of recent progress:

Automation of analytical multiresidue pesticide methodology substantially improved. Beltsville, Maryland. Analysis of one sample for pesticide residues by standard manual methods costs $150.00. By contrast analysis of one sample in a newly developed automated continous low system costs about $10.00. Such advances are of critical importance in underpinning the work of FDA, FSQS, APHIS, and EPA. For example monitoring of pesticide residues on imported products is a Herculean task. About 50 different pesticides are use on a commodity such as coffee. Foreign countries use pesticides on fruits and vegetables that are not registered in the U.S. In response to consumer safety concerns, EPA now frequently requires data not only on major pesticide metabolites, but also on minor metabolites.
Automation modules were purchased from Technicon Corp. which include an electronically operated injection valve with a LC cartridge assembly, and a microprocessor for operating valves and time sequences for the total procedure.

The voltametric detector was modified so that the same cell could be used for reduction or oxidation. The upper part of the cell contains the amalgamated gold electrode for reduction, and the bottom portion of the cell contains the glassy carbon electrode used for oxidation. It was found that operation in the reduction mode produced a higher background current than in the oxidation mode. The bucking current from the LC-2A controller was not sufficient to zero the base line when high sensitivity settings were used for

reduction. Buffers were not necessary when aqueous organic solvents, or alcohols were used as the eluting solvent. Without buffer the half wave potential selectivity was lost, since it is highly dependent on the pH of the solution. The stability of the detector was improved by substituting the KCl or NaCl saturated water solution around the Ag/AgCl reference electrode with a saturated solution of the eluting solvent composition.

Fluorsecence detection system is useful analytical tool for trace amounts of pesticides- Beltsville, Maryland. An indepth study was undertaken to assess the usefulness of a unique flourescence detection sustem as an analytical tool for measuring trace amounts of pesticides during high performance liquid chromatography (HPLC). Indeed, it was found that many pesticides fluoresced sufficiently when excited at 254nm, that the intense 253.7nm emmission of a mercury lamp could be used advantageously as an excitation source in a HPLC fluoresce monitor. Studies included practical agricultural samples fortified with trace amounts of pesticides. Oftentimes a change in polarity of the mobile phase was required to resolve pesticide peaks from interfering peaks. Highly significant is the finding that the fluorsecence efficiency confirm and mutually support data obtained when placed in series with an absorbance detector. However, any comparison of some pesticides (and therfore peak areas when in the fluorescence detection mode) varied dramatically with a change in polarity of the mobile phase. A fluorescence monitor can conveniently confirm and mutually support data obtained when placed in series with an absorbance detector. However, any comparison of the relative sensitivity/selectivity of the absorbance mode vs the fluorescence mode depends on the spectrochemical nature of both the co-extracted co-elutants found in the agricultural product extracted.

Metabolism and fate of chitin synthesis inhibitory established for house fly and boll weevil-Beltsville, Maryland. 14C-Penfluron was used in the study of its metabolism in Musca domestica L. After injection of 298,000 dpm (11 ug/female), the distribution of radioactivity was determined and percentages were calcuated on the basis of the total injected amount. At 72 h posttreatment, the recovery was 95.2% in treated flies, 94.6% as unchanged penfluron, 0.57% as conjugates, and 2% as conjugates in the excreta. At one wk posttreatment, recovery was 87% in treated flies, 86.2% as unchanged penfluron, 0.82% as conjugates, and 5.6% as conjugates in the excreta. The conjugates consisted of 4 metabolites that upon acid hydrolysis yielded a single relatively nonpolar metabolite which was assumed to be a hydroxylated derivative of penfluron.

The metabolism of 14C-penfluron was studied in Anthonomus grandis grandis Boheman. Recoveries of radioactivity of 99 and 94.36% were obtained after 4 days and 1 week, respectively, from weevils that had been injected with 124,970 dpm (4.61 ug/weevil). on the basis of the total injected amount, 97.74% of the label recovered from the extract of weevils 4 days posttreatment were unchanged penfluron and 0.16% was conjugates. Similarly at 1 week posttreatment, 99.56% were unchanged penfluron and 0.2% was conjugates. Less than 1% of additional radioactivity was recovered from weevil residues in both experiments. Four days posttreatment, recovery from excreta extract was 1.02%; 0.33% was unchanged penfluron; 0.06% was 2,6-difluoro-benzamide; and 0.63% was conjugates. Similarly, at 1 week posttreatment, the recovery from excreta extract was 3.41%; 1.33% were unchanged penfluron; .20% was 2.6-difluoro=bexzamide; and 1.87% were conjugates. The conjugates consisted of 2 metabolites which upon acid hydrolysis yeilded a single relatively nonpolar metabolite that was assumed to be a hydroxylated derivative of penfluron.

14C-labeled diflubenzuron or penfluron injected into female Musca domestica L. was deposited without degradation in the flies'eggs; as a result, hatch and F1 emergence were reduced. Eggs containing 10pg/egg of either compound hatched normally but eggs containing ca. 680 pg/egg of diflugenzuron or 370 pg/egg of penfluron sis nor hatch. At equal doses, more penfluron that diflubenzuron was deposited in eggs, but the residues of both compounds increased with the dose and decreased in successive egg batches. The practical usefulness of this type of reproduction inhibitor apparently depends not only on its intrinsic activity but also on its metabolic and excretion characteristics.

Honeybee medication disappears from honey in 6-9 weeks- Beltsville, Maryland. Degradation of two concentrations of oxytetracycline hydrochloride (OTC) in medicated syrup and honey in store in colonies of honeybees (Apis melifera) was followed using a spectrofluormetric technique. The rate of degradation was similar in syrup and honey, and most of the OTC had gone 6-9 weeks after the end of feeding medicated solutions. However, a small residual fluorescence appeared to persist indefinitely; it was presumed to be due to a product of the degradation and might be useful as an indicator of previous medication with OTC.

Eighty-six new candidate chemicals for insect management submitted to SEA/AR by industrial laboratories for cooperative research- Beltsville,Maryland. During the 15 months covered by this report, 24 companies submitted 184 samples of 86 new candidate insect control chemicals for cooperative evaluation in AR laboratories. Included were 75 toxicants, 10 growth regulators, and 1 repellent. The increased number of candidate toxicants was largely due to intensified testing against imported fire ants. Otherwise, the major classes of insecticides were still organophosphates (18) and carbamates (10). There were but two new pyrethroids and six ureides.

Computer-assisted techniques developed for the recognition and/or design of improved insect control chemicals- Beltsville, Maryland. For insect control chemicals, about 37, 600 open-file structures are sufficiently well-defined for coding in Wiswesser notation. Of these, about 93% are now coded and 83% printed; two request searches have been made using the printed listing. Also, another 6,000 chemical records on insecticides, including code number, empirical forumla, Chemical Abstracts name, and CAS registry number, have been prepared for input to the computer. Full chemical records for 148 experimental herbicides,fungicides, nematicides, and plant growth regulators from industry were computerized. A format for storage, retrieval and calculation of pesticide residue dissipation data was tested and modified in cooperation with R. G. Nash, Pesticide Degradation Laboratory. (No data held on a confidential basis are included in this system.)

Computerized storage and retrieval system being pilot tested for biological response data of chemicals for managing pests and for regulating plant growth- Beltsville,Maryland. Because of cutbacks in data process services, the pilot grogram to test storage and retrieval of research data was extended for an additional year with 27 cooperating scientists. Tabular input was revised to conventional format for ease of reading and satisfactory printouts have been produced in a test run; a demonstration run is in preparation. The file of 816 records on insect growth regulators evaluated at Beltsville prior to 1976 was completed, and a file of 10,000 records on coumpounds tested against fire ants is ready for input and analysis.

Agriculture worker exposure to pesticides is highest for mixer/loaders- Yakima, Washington. Agricultural worker exposure to carbaryl was evaluated as a function of formulation (80W, 80S, Sevimol-4, 50W, and XLR Sevimol), application method (ground sprayer, boom sprayer, handgun sprayer, and helicopter sprayer), application level (0.8 to 3 lb AI/acre), crop type (peas, potatoes, apples, and corn), exposure subjects (mixer/loader, applicator, bystander, re-entry person, and helicopter flag person), and parts of the body (hands, arms, chest, back, legs). Measurements were made on mixer/loaders, applicators, re-entry workers, and bystanders. In general, the mixer/loader received the highest deposit and the highest levels were found on hands and arms. A worker re-entry study in apple orchards showed long persistence of the residues on leaves (over 2 weeks) and an excellent correlation of residues on hands and arms of re-entry workers with residues in leaves.

New cleanup procedures developed for trichlorfon residue analysis- Yakima and Prosser, Washington. The most difficult step in pesticide residue analysis is the cleanup of crop extracts. Often this step prevents successful analysis. A new cleanup method utilizing reverse phase chromatography was developed for determining trichlorfon residues in nectar, pollen, and cells of leafcutter bees. (A method was also partially developed for use on mint oil). Further residues of systemic insecticides, aldicarb, demeton-O and trichlorfon and their toxic metabolites were determined in alfalfa pollen, nectar, leaf, leafcutter bee cells, pollen-nectar balls from bee cells and leaves from bee cells. The insecticides had been applied at commercial rates. In general, significant residues were found e.g., 1-5ppm. were common in leaf samples and 0.05-0.3 ppm. were common in pollen-nectar balls.

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BIOLOGICAL AGENTS FOR PEST CONTROL

Technological Objective 1: New and improved technology for discovery and evaluation of biological agents in foreign countries and introduction for control of insects, weeds, plant pathogens and other pests.

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Research Locations:

Hurlingham, Argentina
Albany, California
Newark, Delaware
Gainesville, Florida
Sevres, France
Rome, Italy
Sapporo, Japan
Beltsville, Maryland
Frederick, Maryland
Columbia, Missouri
Temple, Texas

Examples of Recent Progress:

Computer storage of shipment records installed - Newark, Delaware. A simple system of summarizing records of insect shipments from the Newark quarantine facility is now in operation. Using a computer at the University of Delaware on a time-sharing basis, quick access to essential facts concerning any shipment or release of beneficial organisms which pass through the quarantine are available. Fourteen years of data (4638 shipments) are now on file.

Three introduced parasites may soon produce complete biological control of the alfalfa blotch leafminer - Newark, Delaware. Three species of European parasites of the alfalfa blotch leafminer, an accidentally introduced pest, have been established in 4 States (DE, PA, NJ, NY). Releases of large numbers of parasites have been made in 8 other States or provinces. During 1979, the parasites averaged 60% weekly parasitism at the Delaware study field, resulting in a substantial decline in leafminer populations when compared to control fields. The parasites appear capable of complete biological control of the leafminer.

Alfalfa weevil parasites continue to reduce damage in the Northeast - Newark, Delaware. Parasites of the alfalfa weevil continue to spread and increase in the northeastern States, reducing insecticide use by 75% in 1979, with direct savings to agriculture of $8 million. This is approximately 8 times the total cost of this project to USDA over its 20-year duration. In addition, the possibilities of insecticide contamination of dairy products and the environment were also reduced. Efforts continue, in cooperation with various States and with APHIS, to obtain similar benefits in other sections of the country where parasites are established in only a few locations and their benefits are less significant.

Natural enemies of important U.S. noctuids located in South America - Gainesville, Florida. A survey for natural enemies of important U.S. noctuids was made in Argentina, Uruguay, Paraguay, and Peru. Two parasite species were successfully colonized in quarantine. The ichneumonid, Campoletis flavicincta was obtained from fall armyworm in Uruguay and after rearing for a generation it was released to another researcher for mass rearing. A polyembrionic Argentine encyrtid, Litomastix sp. prob. truncatella, from a looper in soybeans was reared and sent to a researcher for comparative studies with a U.S. population.

Central American mite shows promise as biocontrol agent for adult Mexican bean beetles in the U.S. - Beltsville, Maryland. A mite from Central America that is ectoparasitic on the Mexican bean beetle, a serious pest of soybeans and garden legumes, has been demonstrated to be capable of surviving the winter in Maryland. Laboratory studies also indicate that the mite significantly reduces the number of eggs laid by the beetle females and reduces the longevity of both sexes. Releases of mite-infested beetles have now been made in West Virginia and Maryland.

Biological control exchange between the U.S. and the P.R.C. and the USSR - an initiation and improved communication - Beltsville, Maryland. The U.S. and P.R.C. exchanged Biological Control Delegations in 1979. As a result, programs have been initiated to exchange biological control agents between the two countries, and visiting scientists interested in various aspects of biocontrol (taxonomy of natural enemies and biocontrol quarantine procedures) will be exchanged in 1980. A Joint American-Soviet Conference on the Use of Beneficial Organisms for Control of Crop Pests was organized and chaired by the Beneficial Insect Introduction Laboratory in August 1979. This conference brought a number of Soviet and American biocontrol specialists into closer contact which hopefully will result in improvement in exchange of natural enemies and biocontrol information between the U.S. and the USSR.

European seed weevil established on thistles in Maryland and Pennsylvania - Beltsville, Maryland. A European weevil that feeds only on the flowers and seeds of certain thistles (musk and plumeless thistles) has now been firmly established and is dispersing at 8 sites in Maryland and Pennsylvania. This weevil, Rhinocyllus conicus, is established in other areas of the U.S., such as Virginia, Montana, and California.

Effective agent found for rust fungus - Frederick, Maryland. The rust fungus, Puccinia chondrillina, has been shown to be an effective agent for the biological control of rush skeletonweed, Chondrilla juncea. Enviromental requirements for germination of spores of the pathogen and for infection of the host have been determined. Impact studies indicate that the organism can reduce the biomass of the host by 85% within two years following inoculation and reduce the seed set by 40%. The organism has been released and established in CA, OR, WA, and ID. Control of the weed has been observed in CA and ID. The pycnia and aecia of the organism have been observed and described. It was determined that the pathogen attacking yellow starthistle also attacks safflower, thereby eliminating this pathogen from further consideration as a biocontrol agent. Preliminary screening of pathogens on musk thistle has been initiated. Preliminary screening of pathogens on curly dock and on leafy spurge is in progress at the Institute of Specialized Botany, Zurich, Switzerland.

Introduced weevil, Rhinocyllus conicus, shows promise in the biological control of musk thistles - Columbia, Missouri. Sixty percent reduction in musk thistle population was achieved at a study site in Webster Co., Missouri, where the weevil was introduced 4 years earlier. Weevil populations are increasing with dispersal of up to 10.4 km. Weevils were recolonized at new sites.

Apanteles plutellae introduced against Plutella xylostella - Columbia, Missouri. A laboratory colony of A. plutellae was established from pupae received from Trinidad. Field releases were made at four locations in Missouri. Recovery of the F_1 generation was made at three locations and at least through the F_3 generation at one location.

Testing began in Argentina for insects to control broomweed and whitebrush - Temple, Texas. Candidate insects from Argentina were selected for testing and introduction to control broomweed and whitebrush. The top candidates are the moth, Carmenta sp., the weevil, Helipus mendozencis, and two buprestic beetles for control of broomweed, and a bark-feeding lepidopteran and a buprestic stem borer for control of whitebrush.

Technological Objective 2: New and improved technology for increase and conservation of introduced and native biological agents for control of insects, weeds, plant pathogens and other pests.

Research Locations:

Tucson, Arizona
Fresno, California
Tifton, Georgia
Peoria, Illinois
Beltsville, Maryland
Columbia, Missouri
Ithaca, New York
Brownsville, Texas
College Station, Texas

Examples of Recent Progress:

Parasitization of Lygus eggs continues high in wild hosts - Tucson, Arizona. Parasitization of eggs of Lygus bugs by the wasp, Anaphes ovijentatus, on a wild mustard was 60-80%, but only averaged 7-20% during May and June on alfalfa. Cutting the alfalfa was very detrimental to the parasite. These results indicate that parasites can have significant impact on Lygus populations, but additional measures are needed for it to be fully effective on alfalfa hay.

Native egg parasite prefers Lygus bugs - Tucson, Arizona. The native egg parasite, Anaphes ovijentatus, has been shown to attack eggs of Lygus, Nabis, and the 3-cornered alfalfa hopper. Recent studies show the parasite attacks the latter 2 species at only a very low level, even in the absence of Lygus eggs. This high degree of specificity for Lygus suggests the parasite may be a promising candidate for augmentation programs.

Lygus desertinus and L. elisus are very closely related species - Tucson, Arizona. Morphometric, allozyme, and interbreeding studies show these 2 species are very closely related and can interbreed. Two other lygus bugs, L. hesperus and L. lineolaris, are less closely related. This information will be of value when planning studies on biological control agents for these economically important insects.

RNA virus (TRV) was found as a contaminant in ACMNPV - Fresno, California. A small RNA virus was found as a contaminant in four ACMNPV preparations through the use of enrichment serial passages and ELISA technique. TRV was found to cause only slight mortality but severe stunting of larvae, thus the depression of larval weight and ELISA may be used as TRV detection methods. Antibody adsorption may provide a method for eliminating TRV from contaminated preparations; temperature inactivation was found to be an unsatisfactory elimination method. These findings are an important step toward the identification and production of contaminant-free NPV preparations.

Nematodes control Colorado potato beetle - Fresno, California. Laboratory studies indicate that 5th instar larvae of Colorado potato beetle may be controlled by applying insect-parasitic nematodes to the soil in which they pupate.

Insect parasitic nematode isolated and cultured - Fresno, California. An undescribed insect-parasitic nematode, isolated from the sugarbeet wireworm, Yakima, Washington, has been successfully cultured monoxemically with a crystaliferous strain of Bacillus thuringiensus variety Soto. The invasive stages of this nematode float on top of the water surface and actively parasitize mosquito larvae. This and its ease of rearing make it readily adaptable to commercial utilization.

Insect parasitic nematode controls wood borer - Fresno, California. Field tests indicate that applications of an insect parasitic nematode, Neaplectana carpocapsae, to the moist galleries of an indigenous wood boring Lepidopteran, Prionoxystus macmurtei (Guerin-Meneville), may provide long-term control of this damaging pest from agricultural, ornamental, and native stands of susceptible tree hosts.

Host plant species significantly affect host-searching efficiency - Tifton, Georgia. Previous studies have demonstrated that body odors (B.O.) emanating from plant-feeding insects are a primary means by which parasitoids and predators of egg and larval stages locate their hosts for attack and that control of these plant-feeding pests by their natural enemies could be enhanced by a better understanding of and developing procedures for manipulation of these odors (kairomones). The earlier studies resulted in discoveries that the host-searching behavior consists of a sequence of behavioral acts involving a variety of kairomones as mediators; a demonstration that the host plant species significantly affects the B.O. and consequently the natural enemies' host-searching efficiency; and the development of a procedure for field application of a kairomone-host egg package that results in improved performance of Trichogramma. The concept was significantly advanced this year as a result of three accomplishments: (1) Advancements in deciphering the host-searching behavior by Trichogramma among and at host oviposition sites which consists of complex interaction of the density and distribution of encounters with kairomones, host eggs,

and marking pheromones left on the substrate, and host eggs; (2) The discovery that application of the commercially available virus, Elcar(R), increases the incidence and level of parasitization by larval parasitoids and the determination that the formulation fortuitously contains intermediate range kairomones that attract M. croceipes from 2-3 ft, thereby opening a potential pathway for systematically integrating the use of pathogens, natural enemies, and behavioral chemicals into a pest control package; and (3) The discovery of a new class of compounds (a series of closely related acids) having kairomonal activity for Trichogramma and offering excellent potential for field use in that they are very inexpensive, water soluble, and quite stable.

Endotoxin effects upon tissue culture - Peoria, Illinois. Cultured insect tissue cells, when treated for 60 minutes with activated parasporal protein from Bacillus thuringiensis, undergoes massive swelling of the cytoplasmic and nuclear membranes, followed eventually by complete lysis. Studies support the hypothesis that activated endotoxin acts as an ionophore upon gut tissue, thereby disrupting the normal distribution of cations on either side of the gut wall.

Flightless insect predators can be produced by X-irradiation - Columbia, Missouri. Previous work conducted at this laboratory has shown that flightless Podisus maculiventris (wings mechanically removed) more effectively controlled caterpillar pests of soybeans than did normal-winged individuals. It has now been demonstrated that flightless individuals can be produced by X-irradiation.

Artificial system developed for rearing the piercing-sucking predator, Podisus maculiventris - Columbia, Missouri. Podisus has been successfully reared from egg to adult on homogenized Trichoplusia ni larvae presented in vials covered with Parafilm(R) membranes. Homogenate, unlike larvae, can be frozen for long periods, eliminating the necessity for maintaining continuous host colony. Development of an artificial diet is now possible using this artificial rearing system.

An autodissemination technique whereby adult H. zea moths (and other insects) are contaminated with ELCAR WP (H. zea NPV) was effectively used to control H. zea larvae in small-plot sweet corn - Columbia, Missouri. Modified New Jersey light traps were used to contaminate night-flying insects (but not trap them). In the autodissemination plot, 85% of the ears had no damage. In a plot sprayed 10 times (every 2 days) 42% had no damage, while 38% of the ears had no damage in the control plot.

Detection of baculovirus DNA replication in mammalian cells - Columbia, Missouri. A very sensitive fluography technique was employed to determine possible baculovirus replication in inoculated mammalian cells. No evidence for baculovirus replication was obtained. This may be partially due to the low incorporation of tritiated thymidine into viral DNA. This test shows that no appreciable viral DNA replication occurred in mammalian cells under the defined experimental conditions.

Additions of adjuvants significantly increased the effectiveness of Baculovirus heliothis - Columbia, Missouri. Adjuvants consisting of soy flour and soy oil

or cottonseed flour and cottonseed oil mixed with Baculovirus heliothis were significantly better than other formulations and consistently resulted in 7-8 times increase in larval mortality when compared with a water-virus formulation. Persistence was also increased. The original activity remaining at the end of 3 days was 90% for the cottonseed adjuvant, 87% for the soy flour, and 37% for the water virus formulation.

A fungus (Entomophthora phytonomi) causes significant mortality of alfalfa weevil larvae - Columbia, Missouri. The incidence of disease in alfalfa weevil larvae was similar for each of 3 years. Mortality was high at peak populations, eliminating the need for a pesticide to control the weevil on the first cutting of alfalfa.

A new concept for maintaining insect colonies provides greater efficiency and protection - Columbia, Missouri. Fractional colony propagation is a method of rearing insects without mixing progeny from different dates. This method of colonization provides a mechanism for immediate and continuous upgrading of colonies through selection. It also provides a mechanism to delay spread of an introduced pathogen throughout a colony before it can be detected and eliminated.

Establishment of a lepidopteran cell line resistant to baculovirus infection - Columbia, Missouri. A Spodoptera frugiperda cell line has been developed which does not replicate the normally pathogenic homologous baculovirus. The cell line is persistently infected with S. frugiperda nuclear polyhedrosis virus (NPV), but only 3% of such cells show the presence of polyhedral inclusion bodies (PIBs). In contrast, 69% of the persistently infected cells were found positive for viral antigens by the immunofluorescent test. The development of this line will facilitate the study of viral resistance at the cellular level.

Predators can introduce looper virus to initiate epizootics - Columbia, Missouri. The predator Podisus maculiventris mechanically transmitted cabbage looper virus for 2 weeks in laboratory studies and in field cage tests initiated epizootics which caused the collapse of looper populations. This suggests that beneficial insects can be used to initiate epizootics to regulate field populations of pest insects.

Soybeans can tolerate high levels of insect feeding during vegetative growth - Columbia, Missouri. Soybeans can tolerate levels of insect defoliation by the cabbage looper as high as 86% during vegetative growth with no significant effect on yield.

Indirect benefits derived from parasitization - Columbia, Missouri. Host parasitized by species of Euplectrus consumed 86-91% less foliage than those unparasitized. Economic thresholds for feeding damage thus should be reevaluated to account for anticipated reduction in food consumption due to parasitism.

Apanteles plutellae introduced against Plutella xylostella - Columbia, Missouri. A laboratory colony of A. plutellae was established from pupae received from Trinidad. Field releases were made at four locations in Missouri. Recovery of the F_1 generation was made at three locations and at least through the F_3 generation at one location.

Looper virus persists on lower surface of cabbage leaves - Columbia, Missouri. Studies conducted on field cabbage established that cabbage looper virus applied to the lower surface of leaves still retained 50% activity after 3 weeks, whereas activity on the upper surface was reduced to less than 50% within 3 days of application. Because the three lepidopteran pests of cabbage spend 6 to 10 days after hatching on the lower leaf surfaces, they could be effectively controlled by viruses applied to the lower surfaces.

The predatory bug, Orius insidiosus (Say), is most numerous in soybeans during late flowering - Columbia, Missouri. Populations of Orius adults in soybeans peaked during late flowering in 1974 and 1976, regardless of planting date. When corn was planted next to soybeans in 1976, the adult population decreased in the soybeans and increased in the corn during pollination and silking. The adult population in the soybeans increased again as the silks dried.

Artificial oviposition substrate for Plutella xylostella provides greater rearing efficiency - Columbia, Missouri. Crumpled aluminum foil coated with water extract of collard leaves produced dramatic increase in yield of eggs, compared with egg yield on fresh leaves. The extract can be sterilized and stored for long periods, eliminating the need for continuous culture of collard plants. Sterilization reduces incidence of general contaminants and the possibility of accidentally introducing pathogen into the colony. This significantly reduces rearing costs and increases rearing reliability.

Ratios derived for converting number of soybean arthropods collected by sweep-net to number per unit area - Columbia, Missouri. Conversion ratios have been computed for 41 kinds of soybean insects and spiders. This allows a sampler to estimate the population per unit area by use of sweeping, a simple and inexpensive method. The ratios vary greatly from species to species and from one plant growth stage to another. For most species, the same ratios can be used in wide-row and narrow-row soybeans.

Storage life of agar-base wheatgerm diet determined - Columbia, Missouri. Agar-base diet was found to be nutritionally stable when refrigerated up to 6 weeks and when frozen 1 year--and possibly longer. Advantages afforded from storing diet for long periods include reducing rearing costs by operating more efficiently with less labor, equipment, and smaller facilities. Intermittent, high production demands can be met without an excessive increase in cost. Storage of diet provides greater flexibility and reliability in management of an insectary.

Aphid pathogen introduced into Australia - Ithaca, New York. The aphid pathogen, Entomophthora sphaerosperma, was successfully introduced into Australia for the control of the newly introduced spotted alfalfa aphid, Therioaphis maculata. Numerous entomopathogenic fungi from the USDA-SEA-AR Insect Pathology Research Unit's repository were tested for pathogenicity. Isolates from New York and Israel were found highly active against the Australian aphid. Field introduction techniques were devised and the Israeli isolate established in both arid and irrigated alfalfa fields. This is the first clear evidence that foreign derived insect pathogens are more effective than those obtained from local populations.

Grasshopper pathogen culture - Ithaca, New York. Results of field and laboratory studies indicate that the fungus pathogen, Entomophthora grylli, may be developed as a biological control agent for grasshoppers. New cultural techniques have allowed isolation of this pathogen in pure culture.

Technological Objective 3: New and improved principles and practices of insect and mite identification.

Research Location:

Beltsville, Maryland

Examples of Recent Progress:

Biosystematic studies initiated on an important group of parasites of insect eggs - Beltsville, Maryland. For many years, tiny non-stinging wasps of the genus Trichogramma, parasites of eggs of moths and other insects, have been utilized in programs to attempt control of such insect pests as the cotton bollworm, sugarcane borer, cabbageworm, and other pest caterpillars. Results of these programs have been highly erratic. One reason for this is believed to be because species of Trichogramma have been difficult to impossible to differentiate, and the wrong species may have been used in the wrong control situation. Studies have identified, either by morphological examination or cross-breeding tests, 3-4 entirely new species of Trichogramma of potential importance as biocontrol agents of Heliothis and other caterpillar pests of cotton and other crops.

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National Research Program 20270

CROP DISEASE CONTROL AND NONCOMMODITY RESEARCH ON PLANT PATHOGENS AND NEMATODES

Technological Objective 1: Acquire fundamental knowledge and develop basic concepts relative to plant diseases, nematodes, and causal agents.

Technological Objective 2: Develop systems for economical control of plant diseases and nematodes with maximum beneficial effects on yields and quality, and with minimum undesirable effects on the environment and public health.

Protection of crops from the ravages of diseases and nematodes becomes increasingly important as production costs soar. Scientists in this National Research Program study the nature of resistance to diseases and nematodes, how pathogens and nematodes cause damage, and how to improve existing procedures for disease and nematode control and/or management. Research team efforts are designed to develop effective systems for crop production. These systems are designed to implement the most effective combinations of improved resistant varieties, biological control, judicious use of chemicals, and cultural practices. These studies have the ultimate goal of reducing losses in agricultural production caused by diseases and nematodes.

NPS Contact: W. M. Dowler

Research Locations:

Salinas, California
Shafter, California
Miami, Florida
Orlando, Florida
Byron, Georgia
Tifton, Georgia
Urbana, Illinois
Baton Rouge, Louisiana
Beltsville, Maryland
Frederick, Maryland
St. Paul, Minnesota
Bozeman, Montana
Ithaca, New York
Corvallis, Oregon
Charleston, South Carolina
Brookings, South Dakota
Jackson, Tennessee
College Station, Texas
Lubbock, Texas
Weslaco, Texas
Logan, Utah
St. Croix, Virgin Islands
Prosser, Washington
Pullman, Washington
Kearneysville, West Virginia
Madison, Wisconsin

Following are some examples of recent progress:

Biological soil amendments have little effect on Fusarium wilt and on nematode numbers - Shafter, California. The addition of some biological control agents appears to enhance cotton plant growth and vigor. However, there was no indication of drastic changes in nematode numbers, and Fusarium wilt was not reduced by the treatments.

*New methods developed for propagation and preservation of papaya germplasm - Miami, Florida. Protoplasts have been isolated enzymatically from papaya leaves and cell cultures are being recovered from protoplast suspensions. The fusion of protoplasts from sexually incompatible species offers the possibility of transferring desirable characteristics such as papaya ringspot virus resistance. Principal Investigator: R. A. Conover, University of Florida.

Two cultures of the nematode Radopholus similis give differing response in rootstock study - Orlando, Florida. Two cultures of R. similis (Conway and Orlando) were tested against six commercial sources of Milam rootstock used for citrus. The Conway culture increased on the rootstocks, but the Orlando culture was reduced to nondetectable levels. This is strong evidence that we are working with two different biotypes.

Swingle Citrumelo does not support increasing populations of citrus nematode - Orlando, Florida - Populations of the citrus nematode (Tylenchulus semipenetrans) declined steadily on Swingle citrumelo rootstocks, whereas they increased on a susceptible rootstock.

Nematodes affect growth of peach seedlings - Byron, Georgia. Peach seedlings grown in soil infested with the ring nematode were noticeably chlorotic and stunted relative to seedlings grown in non-infested soil. The elements aluminum, magnesium, calcium, and potassium were lower in the nematode-infested soil than in non-infested soil, although both soils were fertilized alike.

Integration of intensive crop rotation using resistant varieties and nematicides suppresses populations of root-knot nematodes - Tifton, Georgia. The choice of cropping sequence and management practices has significant effects on nematodes. A two-year intensive cropping sequence of sweet corn-soybean-wheat-soybean-spinach suppressed nematode numbers, but nematodes increased rapidly on peanuts and cucumber in a turnip-peanuts-cucumber-turnip-cucumber-soybean sequence. The integration of a root-knot nematode resistant southern pea suppressed nematode populations and increased yields comparable to treatment with a nematicide.

Tomato yields increased 50% by improved management practices - Tifton, Georgia. Broad spectrum biocides used in combination with film mulch and trickle irrigation resulted in significantly increased yields of tomatoes. These results will be of particular benefit to small farmers interested in production systems for maximum yields from minimal land area.

Tomatoes resistant to root-knot nematodes - Tifton, Georgia. Twenty-six entries of 114 evaluated were highly resistant to Meloidogyne incognita, the root-knot nematode. This resistance to M. incognita may be incorporated into tomatoes grown for processing; therefore, the amounts of nematicides presently used in transplant and fruit production for nematode control could be reduced.

Postplant nematicide treatments are as effective as preplant treatments - Tifton, Georgia. Maximum yields of peanuts were obtained with either a preplant application of a nematicide or a postplant application when nematodes and the fungus Sclerotium rolfsii, causal agent of southern blight, were present. This information gives the producer added flexibility.

Nematicides are useful for controlling nematodes on vegetable crops - Tifton, Georgia. Two nematicides, aldicarb and phenamiphos, were evaluated for nematode control on eggplant, pepper, cabbage, tomato, carrots, and lettuce. Results have been submitted to IR-4 Headquarters to assist in obtaining registration of these nematicides for use on vegetable crops.

Economic threshold levels have been determined for the soybean cyst nematode - Urbana, Illinois. The damage threshold for soybean cyst nematode under southern Illinois conditions is 60-100 eggs and larvae per 250 cc soil sample taken at planting. The economic threshold, the point at which treatment becomes an economic feasibility, is 300-500 eggs and larvae. This information is important in the development of integrated pest management approaches for soybean pest control.

Soybean selections evaluated for resistance to soybean cyst nematode - Urbana, Illinois. A soybean selection from Maturity Group III has shown good resistance to races 1, 3, and 4 of the soybean cyst nematode. This line will be increased for possible release. Other advanced entries from Maturity Groups II, III, and IV were evaluated for resistance to race 3 of the nematode.

Publication of Plant Disease Reporter by the USDA ceases after 60 years - Beltsville, Maryland. The Plant Disease Reporter, an AR monthly scientific journal, served American agriculture for more than 60 years by publishing results of research in plant pathology and related disciplines. Beginning with the January 1980 issue, the journal has been renamed Plant Disease and will be published by the American Phytopathological Society.

Significant differences and similarities shown among European and North American brown rot fungi - Beltsville, Maryland. Brown rot fungi from Europe and North America were compared. Two previously undescribed American species were revealed, but there were no significant differences between the European and the North American isolates of each species.

Computerization of rust fungi continues - Beltsville, Maryland. Rust fungi are important pathogens on nearly all species of plants everywhere in the world. The collection of rust specimens in the herbarium of the National

Fungus Collections numbers about 160,000. Information regarding the identity, geographic occurrence, plant hosts, seasons of appearance, and other significant data is being prepared for entry into a computer so that specific information on individual species will be readily available.

Claviceps phalaridis, a fungal pathogen of pasture grasses, is not closely related to other ergot fungi - Beltsville, Maryland. Claviceps phalaridis grows on pasture grasses in Australia but has not been found in the United States. Some recently discovered unique characteristics of this species show that it is considerably different from other ergot fungi and that it probably does not belong in the genus Claviceps.

Some experimental and commercially available potato clones are resistant to the reniform nematode - Beltsville, Maryland. Commercial clones La Rouge and Red La Soda were found to be resistant to the reniform nematode. Several white potato clones with resistance to potato cyst nematodes were reported to have reniform nematode resistance as well.

Discovery of rickettsia-like microorganisms in larval stages of the soybean cyst nematode - Beltsville, Maryland. A rickettsia-like microorganism was found in larval stages of the soybean cyst nematode which may have a role in the natural biocontrol of the soybean cyst nematode. This nematode is a major pest in soybean production in the United States. Major nematode infestations occur in the southeastern states and part of the midwest.

Ammonium has an inhibitory effect on nematode development - Beltsville, Maryland - Root-knot nematodes were grown on two different cultures of tomato roots. Roots cultures on a medium containing complete inorganic and organic fractions had normal growth and nematode infection sites. Roots cultured on a medium with high salt concentrations were less vigorous and did not support complete nematode development. A high concentration of ammonium inhibited giant cell formation and nematode development. The action of ammonium is of interest because of its possible practical application.

New parasite has potential as biological control agent for corn rootworms and Colorado potato beetle - Beltsville, Maryland. The mermithid nematode parasites from corn rootworms from Peru have parasitized our corn rootworms and Colorado potato beetles. These may become useful biological control agents.

A new root-knot nematode species has been found on potatoes in the Pacific Northwest - Beltsville, Maryland. Morphological studies of nematode specimens from an infected potato from Idaho revealed the presence of a previously unknown species of root-knot nematode. Widespread distribution suggests that the nematode has been present in the Northwest for some time but had not been previously detected or recognized as a new species. It appears that this nematode might be more destructive to potatoes than the northern root-knot nematode which was previously known to be in those areas. Unlike the northern root-knot nematode, this new species attacks corn and wheat, crops which are commonly used in rotation with potatoes to reduce populations of the common root-knot nematode.

Potential biocontrol agent of plant-parasitic nematodes - Beltsville, Maryland. Information obtained on the bacterium Bacillus penetrans will be useful in initiating field studies on the bacterium as a potential control agent of the root-knot nematode. The information on its ultrastructure and the laboratory tests suggest the organism has affinity with the actinomycetes. This may be helpful in the selection of a medium and the physical condition necessary to grow this organism in culture.

Potato spindle tuber complementary DNA produced in bacteria: an important tool for further research - Beltsville, Maryland. In collaboration with the Cell Culture and Nitrogen Fixation Laboratory potato spindle tuber viroid complementary DNA has been cloned by use of recombinant DNA technology. This accomplishment is significant because it will provide unlimited amounts of complementary DNA which can be used as a tool for hybridization studies of viroid replication in hosts and other similar problems.

Mycoparasite provides biological control of lettuce drop - Beltsville, Maryland. Application of the beneficial mycoparasite, Sporidesmium, to field plots in May 1978 caused a 94% reduction in the population of the lettuce drop fungus, Sclerotinia minor, by December 1978. During 1979 the mycoparasite provided 63 and 83% disease control on two successive lettuce crops. These findings demonstrate that mycoparasitism can be a useful method to control biologically soilborne diseases of plants.

Nutritional requirements for the beneficial mycoparasite Sporidesmium were established - Beltsville, Maryland. An isolate of Sporidesmium sclerotivorum was cultured on a medium of mineral salts, glucose, amino acid mixture and the vitamin thiamine for the first time. Carbohydrates, an amino nitrogen source, and thiamine were all required for optimum growth. Previously, this unusual mycoparasite was cultured only on media derived from its host (sclerotia) or on living sclerotia.

Forecasting the severity of a soilborne disease becomes a reality - Beltsville, Maryland. Two years of research data in New Jersey onion production fields showed that white rot severity on onions is correlated with the soil populations of the pathogen that causes the rot, at the time of planting. These findings show that a disease forecasting system can be set up to predict losses before planting. When such a forecasting system is put into effect, many fields normally planted to onions, leeks, garlic, and bunching onions could be avoided to prevent losses or, if needed for planting, could be treated by chemical means.

Integrated Pest Management (IPM) breakthroughs in the control of soilborne plant pathogens - Beltsville, Maryland. Field technology has been developed for the integrated control of one major disease problem, and is showing promise for the control of two others. Pickle fruit rot and diseases of beans and peppers, all caused by soil fungi, have been reduced using a combination of field plowing, rather than disking, use of antagonistic biocontrol agents, and/or very small amounts of a fungicide. These breakthroughs represent considerable advances for solving problems for which no other accepted control measures are known.

Lime reduces damping-off of peas - Beltsville, Maryland. Field studies at Beltsville demonstrated that lime applied in-furrow significantly increased pea stand from 34 to 68% in a soil heavily infested with the damping-off pathogen, Pythium ultimum. This demonstrates disease control with a non-toxic, easily available material already used in agriculture which may be incorporated within an integrated management system.

Technique developed for direct study of antagonism of oospores in soil - Beltsville, Maryland. A simple, convenient technique was developed to study the effect of biological antagonism on the survival of oospores (or other survival structures) of important plant pathogens in soil. Spores were mounted in nylon fabric, available with microscopic pore sizes the same diameter as the spore. The firmly held spores were buried in soil on the nylon for various intervals of time, were easily recovered from the soil, and their condition and behavior in soil readily assessed.

Resistance found to potential threat from downy mildew to American corn - Frederick, Maryland. American maize varieties and breeding lines are highly susceptible to downy mildew caused by Peronosclerospora sacchari. Moisture and temperature conditions in the continental U.S. are apparently favorable for sporulation and for infection of maize, and potential hosts exist in the U.S. which might allow the pathogen to overwinter. These attributes suggest that downy mildew might be a problem to maize production should this pathogen enter the United States and become established. Partial disease resistance has been identified in some southeast Asian maize varieties.

Certain fungal species react with unique specificity to stimulators - Frederick, Maryland. Several species of rust fungi were evaluated for their response to chemical stimulators. Minor differences in chemical structure markedly influenced fungal stimulation. This information may be useful in developing chemicals for use in stimulating germination of rust spores, making them more susceptible to destruction.

Differences in resistance to soybean rust determined among soybean selections - Frederick, Maryland. Significant differences in the size of artifically inoculated soybean rust lesion areas were noted in seven soybean accessions including the cultivar Wayne. Lesion areas were larger on the lower than on upper leaf surfaces. The results suggest the presence of some generalized resistance to rust in soybeans.

An important new event was discovered in the hypersensitive resistant reaction of plant cells to parasite attack - St. Paul, Minnesota. The well-known hypersensitive collapse and death of resistant plant cells was found to be preceded two hours earlier by a complete and abrupt halt in cytoplasmic streaming in the cells. This shows that the host reaction is not limited in early stages to the outer membrane of the cell (the plasma membrane) as frequently postulated. Instead, the reaction is expressed throughout the cytoplasm of the cell and affects a basic process related to cytoplasmic streaming.

Factors for low receptivity to infection by stem rust found to be independent of specific resistances for infection type - St. Paul, Minnesota. Lines with ultralow receptivity to stem rust infection derived from the cross between Thatcher and Lee wheats were nearly free of rust in a severe epidemic from a mixture of races in an artificially inoculated field nursery. Crosses of these lines with highly receptive Baart wheat yielded progeny that had ultralow receptivity in a 1:63 ratio. Some of these low receptive lines gave a completely susceptible reaction as seedlings to the test races. This multigenic resistance would be an effective protection against the population of stem rust in the U.S. and may be present in Chris, a Minnesota developed hard red spring wheat.

Adult plant resistance of Thatcher wheat shown to be independent of Sr gene resistance - St. Paul, Minnesota. No relationship was found between the independent Sr genes and the adult plant resistance of the wheat cultivar Thatcher, as measured by rust severity. Pyramids of seedling resistance genes did not improve resistance to stem rust. Some progeny lines with both Sr 12 and Tc performed similarly to Thatcher, suggesting that the factor(s) involved in the adult plant resistance of Thatcher might be related to this Sr gene combination. The adult plant resistance of Thatcher was sensitive to inoculum density. The results discount the theory that pyramiding Sr genes increases resistance and show the complex response of Thatcher resistance to inoculum density.

Date of disease onset governs oat stem rust epidemics - St. Paul, Minnesota. Date of onset of rust in an area was related to the estimated yield losses, and explained about 20 to 40% of the variation in estimated loss. This relationship has value for developing models to predict epidemics and crop losses. Little relationship was found between estimated yield loss and the minimum or maximum temperatures for May, the period May through July, or the mean frequency or amount of precipitation for the same periods.

An effective source of stem rust resistance found in high yielding, foreign winter wheats - St. Paul, Minnesota. Seedling tests for genes for resistance to stem rust in 100 high yielding non-U.S. cultivars of the International Winter Wheat Performance Nursery revealed Sr 31 to be the only gene of the 17 identified that is not present in U.S. cultivars. The 6 cultivars that posses Sr 31, which is universally effective against the U.S. stem rust population, would provide useful resistance in breeding programs.

New germplasm lines for resistance to oat rusts - St. Paul, Minnesota. Germplasm lines developed from oat crosses involving the wild species of Avena have immunity to presently known isolates of crown rust and stem rust. The combined resistance will save time in the oat breeding program by providing single donors for these two traits.

Improved resistance to Septoria nodorum found in spring wheat - Bozeman, Montana. The spring wheat cultivars Shortana and Manitou were crossed and offspring selected for resistance to S. nodorum blotch disease for five generations. Based upon disease symptoms that appeared on the leaves, resistance was improved with each selected generation. At the end of five

cycles of selection, the offspring of the cross were more disease resistant than either parent. These experiments show conclusively that individual plants can be selected from the offspring of a cross that are more resistant to disease than either of the parents.

Plant pathogenic bacteria may affect rainfall - Bozeman, Montana. Pseudomonas syringae, the organism that causes bacterial leaf blight of cereals, was found in rain and snow high above infected wheat fields. Because these bacteria may serve as ice nuclei, it is postulated that the bacteria are not only spread in rain, but that they contribute to causing more rain. This "bio-precipitation" cycle may have importance in the desertification process.

Increased understanding of virus and aphid interactions - Ithaca, New York. Studies of cereal viruses within aphid vectors along with electron microscopy of aphid salivary glands have provided a working model for aphid-virus specificity. Interaction of certain virus proteins with receptor sites in the aphid salivary glands offers the best explanation thus far for the mechanism of cereal virus transfer by aphids.

Studies initiated on alternative management systems for golden nematode of potato - Ithaca, New York. Golden nematode control tactics were as effective against high densities of nematodes as against low densities. Use of a resistant cultivar reduced densities 85% which was as effective as most chemical treatments.

Phytophthora root rot protection by mycorrhizal fungi and bacteria - Corvallis, Oregon. Selected mycorrhizal fungi and rhizosphere bacteria have shown good potential in greenhouse studies to suppress infections and symptom development by the widespread root pathogen, Phytophthora cinnamomi. This fungus causes serious losses in many nurseries as well as landscape situations. Studies have demonstrated the importance of establishment of these organisms before the pathogen is introduced. In addition, some of the protectant organisms appear to enhance plant growth before exposure to the pathogen.

Regeneration of plants from eggplant callus - Charleston, South Carolina. Whole plants were regenerated for the first time from eggplant callus using a new system. This was a significant step before development of a hybrid through fusion of somatic protoplasts could be accomplished. This could permit the development of improved nematode resistance by introducing genetic material from widely varied sources.

Development of nematode resistant snap beans - Charleston, South Carolina. A better method for selecting root-knot nematode resistant snap beans was developed that will identify resistant plants without destroying the plant. A breeding line, B4175, was identified that will yield on nematode infested soil comparable to susceptible cultivars grown on noninfested or fumigated soil. This line will be released in 1980.

Program expanded to develop soybean varieties resistant to nematodes and diseases - Jackson, Tennessee. The use of resistant varieties has given soybean growers an important practical method for control of the soybean cyst nematode. Breeding lines are now being developed which combine resistance to viruses, other diseases, and insects as well as nematodes.

Nature of nematode resistance in cotton - College Station, Texas. The mechanism of root-knot nematode resistance is predicated on the ability of resistant cottons to respond to nematode infection by producing terpenoid aldehydes at the feeding site of the nematode. These chemicals inhibit the development and reproduction of the nematode and consequently reduce subsequent field populations of the parasite. This knowledge can be useful to plant breeders attempting to develop genetically resistant plants.

Use of nematicides increases cotton yields - Weslaco, Texas. Cotton yields in reniform nematode infested fields were increased by the use of the nematicides telone, aldicarb, and phenamiphos. A resistant breeding line is also being evaluated which could alleviate the reniform nematode problem.

Plant parasitic nematodes surveyed on rangeland in the western United States - Logan, Utah. Several species of plant parasitic nematodes were found associated with rangeland and pasture grasses in Utah, Idaho, Montana, and North Dakota. The amount of damage these nematodes cause is unknown presently. Varietal trials will be established to determine the significance of this problem.

Relationship of soil stresses and fungal toxins to seedling growth of beans and peas - Prosser, Washington. The nature of resistance to cold-wet seedling emergence problems is being determined. A stress tolerant bean performed well in a cold wet sand test, but oxygen or temperature stress caused decreased stands. Toxins from the fungus Fusarium solani f. sp. pisi produced lesions on pea seedlings, and no differences in host reaction have yet been found among Fusarium resistant and susceptible peas.

Crown and foot rot of Pacific Northwest wheat - Pullman, Washington. Populations of the fungus which cause crown and foot rot differ in their ability to withstand adversity in soil. They are not different enough to merit separation as a species, but probably comprise ecotypes, each adapted to its particular environment.

Fruit nematode research program began at Appalachian Fruit Research Station - Kearneysville, West Virginia. Several species of plant parasitic nematodes were found in the Appalachian fruit growing area. Moderate to high populations of Xiphinema were found associated with peach stem pitting disease. Cultures of root-knot nematodes are now available for use in evaluating selected breeding lines.

Mechanism of action of toxins - Madison, Wisconsin. Tagetitoxin is produced by the plant pathogenic bacterium, Pseudomonas tagetis. The toxin causes a rapid disorganization of chloroplasts in leaves and destruction of ribosomes. However, plants regenerated from protoplasts of severely affected leaves are normal. This indicates the specific sites of damage which may be affected by toxins.

Molecular mechanisms of disease resistance in plants - Madison, Wisconsin. Scanning electron microscopy studies show that incompatible zoospores of the fungus Phytophthora parasitica var. nicotianae penetrate only 5-8 cell layers within 48 hr. after inoculation of tobacco callus tissue cultures. In contrast, zoospores of a compatible race penetrate 50 or more layers by that time. A violent disruption and collapse of cells at the surface of callus tissues inoculated with the incompatible zoospores corresponds to the hypersensitive reaction (water soaked appearance) seen by the naked eye.

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National Research Program 20280

WEED CONTROL TECHNOLOGY FOR PROTECTING CROPS, GRAZING LANDS, AQUATIC SITES, AND NONCROPLAND

This multidisciplinary national research program emphasizes the development of principles of weed science and safe and efficient practices of weed control that can be integrated with other production and protection technology into weed management systems for improving the productivity of agroecosystems. This research is essential to the development of high-yielding food, feed, and fiber agroecosystems that will maintain the Nation's food supply and improve the quality of the environment. It supports the missions and goals of SEA and the Department. This program is organized into 130 projects at 45 locations and is conducted by 72 SEA scientists in cooperation with several Federal agencies, State agricultural experiment stations (SAES), private universities and research institutes, and industrial research organizations. In 1979, progress was reported in 124 scientific publications.

NPS Contact: W. C. Shaw

Technological Objective 1: New and improved fundamental knowledge of the biology of weeds for development of safe, new principles and mechanisms of their control by biological, chemical, cultural, ecological, physical, and integrated methods that will avoid or minimize hazards to nontarget organisms and to other components of the environment.

Research Locations:

Tucson, Arizona
Stuttgart, Arkansas
Albany, California
Tifton, Georgia
Urbana, Illinois
Lafayette, Indiana
Beltsville, Maryland
Frederick, Maryland
St. Paul, Minnesota
Stoneville, Mississippi
Columbia, Missouri
Ithaca, New York
Raleigh, North Carolina
Fargo, North Dakota
College Station, Texas
Temple, Texas
Logan, Utah
Pullman, Washington
Kearneysville, West Virginia

Examples of Recent Progress:

Weeds possess herbicidal activity - Albany, California. Russian knapweed (Centaurea repens) reported to be allelopathic was collected, ground, and extracted. Fractionation has revealed the presence of several alpha-methylene and gamma-lactones, one of which is cynaropicrin. Sesquiterpenes of this type have been shown to be both phytotoxic and cytotoxic. Plants such as leafy spurge, giant foxtail, etc., will also be collected, extracted, and evaluated for herbicidal activity.

Basic research enhances the development of slow-release herbicide formulations - Lafayette, Indiana. The rate of herbicide release from starch encapsulated granules is directly related to surface and internal structural characteristics of the granules. Scaning electron micrographs which clearly indicate the amorphous or smooth surface and degree of honeycomb internal structure, which indicate slow or fast release by diffusion, follow closely herbicide activities measured by biological assays. The use of the scanning electron microscope appears to be an excellent quality-control technique in the preparation of starch encapsulated controlled-release herbicides.

Anesthetic chemicals stimulate germination of seeds of several weeds - Beltsville, Maryland. Certain agents broadly classified as anesthetics interact markedly with phytochrome in achieving stimulation of germination of certain weed seeds. With ethanol, and in some instances chloroform and ethyl ether, stimulation occurs without activation of phytochrome. This observation, in addition to the known action of anesthetics in animals, indicates plant cell membrane(s) as a site of action and accordingly as limitations to germination in dormant seeds. Further evidence for membrane(s) as a site of action comes from experiments using pressure to overcome the effects of anesthetics on membrane expansion as observed with animals. Thus the application of a ca 10 atmospheres pressure prevents the stimulation usually observed during ethanol treatment in the germination of witchgrass (Panicum capillare).

Allelopathic effects of crop plants on the germination and growth of weeds - Frederick, Maryland. Water extracts of sunflower-leaf and -stem tissue resulted in mixed germination responses of 18 species of weed seed. Wild mustard appeared to be the most sensitive to extracts from 13 varieties of sunflower. Extracts showed plant growth regulator responses of inhibition of germination of wild mustard at high concentrations and stimulation at lower concentrations. Two chemicals in the extracts were tentatively identified as scopoletin and chlorogenic acid.

Development of weed seed germination stimulants - Frederick, Maryland. Azide, ammonium nitrate, and butylate were applied to the soil surface in water and incorporated. Sodium azide caused 168 percent more grasses and 186 percent more broadleaf weeds than the control plots. Fifty days after treatment the azide treated plots had three- to four-fold more tumble pigweed than the control plots. Redroot pigweed was not similarly affected by azide. Germination stimulants are being developed as a technique to encourage uniform emergence of weeds in order to increase the effectiveness of chemical and nonchemical methods of control.

Potential distribution and competitiveness of the exotic noxious weed cogongrass in the United States - Stoneville, Mississippi. Cogongrass (Imperata cylindrica), seventh among the world's worst weeds, was introduced into the southern United States between 1910 and 1920 and is now present in Mississippi, Alabama, and Florida. Controlled environment experiments simulating growing season temperatures throughout the United States have shown that cogongrass can reach its maximum potential growth only in the extreme south and southwest. Its growth is severely reduced by day temperatures below 29°C and night temperatures below 23°C. Therefore, it is unlikely that cogongrass will become very widespread as a weed problem outside the Gulf Coast States.

Basic research helps to more fully understand glyphosate action in plants - Stoneville, Mississippi. Glyphosate caused elevated levels of a key plant enzyme, phenylalanine ammonia-lyase (PAL) in tissues of corn, cotton, and soybeans. Increased PAL activity was correlated with: lowered phenylalanine and tyrosine levels, decreases in total secondary phenolic compounds, and increases in ammonia in treated plants. Levels of some other important amino acids were also affected. Specific PAL inhibitors caused either no reversal of glyphosate's inhibitory action or reversed growth inhibition only marginally. Thus the role of enhanced PAL activity may be only partly responsible for glyphosate's phytotoxicity. Ultrastructural analysis of glyphosate effects indicated a passible role for calcium and that the herbicide inhibits uptake of this important mineral by seedlings. Thus ion uptake and transport and important biochemically associated events may help clarify the action of this important herbicide in plants.

Basic research improves effectiveness and safety of herbicides in controlled-release polymer systems - Stoneville, Mississippi. Research on measuring controlled release of metribuzin from polyvinyl alcohol polymers has demonstrated that several such systems show promise for the controlled release of metribuzin in terrestrial systems. Research on controlled release system formed by reacting metribuzin with cotton (cellulose) fibers shows a wide range of release rates has been achieved with these cellulose systems. The residual weed control effectiveness of several herbicides has been extended without increasing initial phytotoxity to crops.

Technological Objective 2: New and improved weed control technology for use in field crops that will increase efficiency in food, feed, and fiber production, reduce losses in yield and quality, and reduce the cost of control.

Research Locations:

Stuttgart, Arkansas	Stoneville, Mississippi
Shafter, California	Columbia, Missouri
Fort Collins, Colorado	Lincoln, Nebraska
Tifton, Georgia	Fargo, North Dakota
Urbana, Illinois	Corvallis, Oregon
Lafayette, Indiana	Prosser, Washington
Houma, Louisiana	Pullman, Washington
St. Paul, Minnesota	

Examples of Recent Progress:

New chemical weed control programs improve rice production - Stuttgart, Arkansas. Two new herbicides improve weed control and safety to rice, reduce the amount of herbicides required for weed control, decrease the number of applications, and reduce energy requirement for rice production. Tank mixtures of either butachlor or thiobencarb plus propanil applied early postemergence controlled emerged weeds and those that germinated for 4 to 6 weeds after application. Butachlor and thiobencarb gave residual weed control and saved a total of three applications of herbicides, including one application each of propanil, molinate, or phenoxy herbicides. We estimate that by 1982, these new

herbicide treatments will increase grain yields of rice by 10 percent and reduce by one or two the number of herbicide applications on 500,000 acres of rice in the South. The increased grain yield and reduced application cost is valued at an estimated $25 million annually to the rice industry in the South.

Weed control in modified cotton cropping system increases cotton yields - Shafter, California. Three weed control practices including tillage alone, tillage plus a preplanting combination of trifluralin and prometryn, and tillage plus a preplanting combination of trifluralin and fluometuron were compared in cotton grown in rows spaced 102 cm apart and rows spaced 51 cm apart. Preplanting irrigation water was managed equally well in both planting patterns. Yields from plots treated with herbicides were 20 percent greater from cotton grown in 51 cm rows than in 102 cm rows. Yields also tended to be better from 51 cm rows where tillage alone was used for weed control. Regardless of planting patterns, herbicides controlled weeds better than tillage alone. In plots that received only tillage, early weed control was better in cotton grown in 102 cm rows; however by harvest, little difference between row patterns existed.

Chemical and nonchemical methods for johnsongrass control in cotton and rotational crops - Shafter, California. In a systems approach for johnsongrass control in cotton, after two seasons, fall applications of glyphosate reduced weight of johnsongrass rhizomes by 95 percent; preplant applications of fluridone by 90 percent; but 2 x rates of trifluralin failed to reduce johnsongrass rhizomes. Cotton yields (1979) for these systems were 102 percent, 80 percent, and 73 percent of the weed-free continuous cotton control.

Evaluation of six cropping systems for the control of yellow nutsedge - Shafter, California. During the second year of the study (1979), all cropping systems continued to reduce viable tuber populations of yellow nutsedge. When compared to the initial population in the fall of 1977, dry and wet fallowing with tillage following barley and double cropping potatoes treated with EPTC reduced the number of tubers by 95 percent. Applying fluridone preplant and supplementing cultivation with two handweedings reduced tuber populations 95 percent in continuous cotton.

Sugarbeets produced without the need of hand labor for weed control - Fort Collins, Colorado. Effective sequential herbicide treatments, including a preplanting treatment of ethofumesate plus diclofop, followed by various postemergence mixtures controlled 97 to 99 percent of the annual weeds all season. Root yields from these sequential treatments were not statistically different from the untreated, hand-weeded check. As herbicide usage increased, the number of weeds left in the plots decreased. The most effective sequential treatment left only 2 weeds per 100 feet of row. With today's weed technology in sugarbeets, the grower has several management strategies he can follow. He can maximize the use of herbicides and leave a few weeds in his crop, or he can optimize the use of herbicides and then remove the weed escapes with hand labor.

Acifluorfen and cultivation control a broad weed spectrum in soybeans - Tifton, Georgia. A timely early postemergence application of acifluorfen (10 to 14 days after soybean planting) followed by one cultivation about 25 days after soybean planting controlled a broad spectrum of weeds in soybeans that included Texas panicum, tall morningglory, small-flower morningglory, Florida beggerweed, and

sicklepod. This effective postemergence weed control systems approach in soybeans minimizes the need for preplant soil-incorporated or preemergence herbicides that usually require ideal environmental conditions for acceptable weed control.

Glyphosate applied with rope wick controls weeds in peanuts - Tifton, Georgia. Sicklepod, a very troublesome weed in peanuts, was controlled by the nonselective herbicide glyphosate delivered through the nonmechanical, capillary-action rope wick applicator to sicklepod growing taller than peanuts. Further development of this treatment will lead to economical control of sicklepod, increased profits for peanut farmers, and reduce excessive use of herbicides.

Selected tillage tratments for weed control reduce soil compaction and increase crop yields - Tifton, Georgia. Tillage practices for weed control such as deep-turning or subsoiling reduce soil compaction and permit increased crop yields by better utilization of water and fertilizer. Soil compaction data also show that certain seedbed tillage practices such as disc-harrow increased soil compaction with a resultant decrease in crop growth and yield. Irrigation alone cannot overcome the effect of soil compaction. Proper seedbed preparation techniques to eliminate soil compaction as well as efficient control of weeds that reduce cultivation and management of center pivot irrigation can result in high-quality, high-yielding crops.

Guidelines developed for use of herbicides to control weeds and to accelerate soybean harvest - Urbana, Illinois. Research has demonstrated that ametryn, paraquat, and glyphosate can be used to desiccate soybeans and speed up harvest, without reducing yields, if applications are made no earlier than 2 weeks before soybean maturity. These treatments can be helpful in reducing harvest delays and losses due to weed growth and adverse weather.

Research on the incorporation of herbicides in soils provides guidelines for use of tillage equipment to incorporate herbicides. Urbana, Illinois. Research data for several years at several locations provides definite guidelines to producers about the mixing characteristics for several soil-applied herbicides with several tillage tools. Comparative data were made available to growers regarding large and small disks, field cultivators, and rotary incorporating devices. These guidelines help the producer to soil-incorporate herbicides more effectively, efficiently, and safely.

Weed competition research determines the extent to which yellow nutsedge reduces corn yield. Urbana, Illinois. Yellow nutsedge reduces yield of corn an average of 17 percent in a moderate infestation of 300 tubers per square meter in the soil and 41 percent in a heavy infestation of 1200 tubers per square meter where no control measures were practiced. A relationship between yellow nutsedge density and percentage yield reduction in corn reveals that an 8 percent reduction in corn yield can be expected for each 100 yellow nutsedge shoots per square meter in the field.

Johnsongrass reduces sugarcane yields - Houma, Louisiana. Johnsongrass that germinated during March in fall-planted sugarcane competed with the plant and following ratoon crop of sugarcane cultivar CP 65-357. When weeds were removed on May 15, June 15, July 15, or at harvest in plant cane, the yield of sugarcane/ha in the plant crop was 100 percent, 91 percent, 81 percent, and 77 percent of the weed-free check, respectively. However, the effects of weed

competition in plant sugarcane, regardless of duration, did not persist to reduce yields in the first-ratoon crop. But, when the johnsongrass infestation in plant sugarcane was allowed to continue into the first-ratoon crop before removal on May 1, June 1, July 1, or at harvest, the yield of sugarcane/ha in the ratoon crop was 90 percent, 76 percent, 75 percent, and 45 percent of the weed-free check, respectively. The main effect of johnsongrass competition was to reduce the population of millable stalks of sugarcane.

Increased seeding rates increase soybean tolerance to herbicides - St. Paul, Minnesota. Residues of the herbicide atrazine, used to control weeds in corn, may adversely affect the yield of soybeans planted after corn. The herbicide metribuzin may injure soybeans if applied at an excessive rate. Soybeans planted at twice normal seeding rates have yielded much better than those planted at normal seeding rates in plots treated with either metribuzin or atrazine at high rates purposely selected to cause considerable damage to the soybeans.

Time-of-day affects the efficacy of postemergence herbicides for control of the weed sicklepod - St. Paul, Minnesota. The weed sicklepod folds its leaflets at night with the result that only about 14 percent as much leaf area is exposed to an over-the-top spray at night as during the day. Control of sicklepod by postemergence applications of the herbicide linuron was much better from applications made during the day than from applications made from evenings to early mornings. Control was highly correlated with the amount of leaf surface exposed to the spray.

Rope wick applicator offers greater precision, selectivity, and lower costs in weed control - Stoneville, Mississippi. A rope wick applicator was developed to apply glyphosate and nonselective systemic herbicides in crops and pastures by selective placement of the herbicide on weeds growing above the crop plant canopy. Precise application of herbicides by the nylon rope wick reduces drift and crop damage, conserves herbicide solution, lowers costs, and provides effective control of such perennial weeds as johnsongrass in soybeans and cotton, and horsenettle and late eupatorium in grass pastures. Herbicide on the wick is replenished by capillary movement of herbicide solution from the reservoir. More than 20 manufacturers are making the device and have requested licenses to sell herbicide applicators based on disclosures of the U.S. Patent Application Serial No. 969,036 entitled "Rope Wick Applicator." More than 10 million acres of crops were treated with this method in 1979.

Release of mass-reared native insect moths gives localized control of purple nutsedge in farmers' fields - Stoneville, Mississippi. The value of releasing insect moths weekly at the same site was determined by making releases of adult Bactra verutana at 6 sites in farmers' fields infested with purple nutsedge. Each release contained about 2,500 moths (50:50 sex ratio) and the number of releases varied from 2 to 4 over a 3-4 week period. Counts of injured and dead nutsedge made one week after each final release revealed 50-100 percent damaged or dead shoots. Thus, releases of 5-10,000 moths had considerable effect in giving localized control of nutsedge.

A plant pathogen shows potential as a preemergence soil-applied biological control agent for weed control in cotton - Stoneville, Mississippi. Alternaria macrospora, a plant pathogen, was evaluated in greenhouse and field studies to determine the feasibility of utilizing this fungus as a biological herbicide to

control spurred anoda, an important weed in cotton. For the first time for a biological herbicide, the feasibility was demonstrated for utilizing preemergence soil and postemergence applications of granular formulations of the pathogen. The pathogen was also applied as a foliar spray of spores. The foliar application of a spore suspension reduced the number of spurred anoda plants in the field by 75 percent after six weeks and the remaining plants were severely stunted. However, granular formulations applied preemergence to the soil or postemergence to foliage in small field plots resulted in essentially 100 percent infection of spurred anoda seedlings.

*Wild oat diversity is an important factor in effective control practices - Fargo, North Dakota. Wild oat infestations have been reported in many different geographical locations. Specific regional problems in wild oat control may be anticipated. Recent studies have shown that the dormancy of wild oat seed is influenced by the geographic origin of the selection. Seed from southern latitude selections tend to be more dormant than those from northern latitudes. Wild oat selections also differed markedly in their response to individual herbicides. However, no selection was tolerant to multiple herbicide treatment. Continued effectiveness of wild oat control practices depends on a basic understanding of the diverse nature and behavior of wild oat selections from various parts of the United States. Principal Investigator: J. D. Nalewaja, North Dakota State University, Fargo, ND.

A postemergence herbicide application for selective control of established annual ryegrass in perennial grass seed fields - Corvallis, Oregon. Diclofop applied postemergence selectively controlled established annual ryegrass, the most difficult weed problem in perennial grass seed fields in western Oregon in established creeping red and Chewings fescue, orchardgrass, and Kentucky bluegrass. A postemergence diclofop application was not inactivated by crop residues on the soil suface. Such residues destroy the effectiveness of the soil-applied herbicide treatment now used. Thus, diclofop offers a significant breakthrough in the search for an effective, safe, and economical herbicide for grass weed control in unburned grass seed fields.

Integrated weed management system (IWMS) improves new seedings of alfalfa for seed production - Prosser, Washington. AN IWMS based on interrow tillage, EPTC injected as subsurface lines currently with seeding, postemergence application of 2,4-DB, trifluralin incorporated with a power-driven, tine-tooth harrow when the alfalfa plants were 6 to 8 inches tall, and minimum hand labor kept alfalfa weed-free from seeding in April until harvest in September. The hand labor input was 3 to 6 hours per acre as compared with 337 hours per acre where weeds were controlled by interrow tillage and labor without the aid of herbicides. There were no significant differences in seed yield among treatments, and yields were excellent (avg. 600 lb/A). Since the labor required for weeding new seedings of alfalfa unaided by herbicides is more than the resulting crop could justify, alfalfa seed growers traditionally clipped the alfalfa and weeds to suppress the weeds and harvested no seed during the seeding year. With the IWMS, profitable production of alfalfa seed of excellent quality is possible during the year of seeding.

Technological Objective 3: New and improved weed control technology for use in horticultural crops that will increase production efficiency, reduce losses in yield and quality, and the cost of control.

Research Locations:

Tifton, Georgia	Charleston, South Carolina
Beltsville, Maryland	Weslaco, Texas
Frederick, Maryland	Prosser, Washington
New Brunswick, New Jersey	Kearneysville, West Virginia

Examples of Recent Progress:

Charcoal reduces crop injury by herbicides - Tifton, GA. Charcoal slurries were sprayed in spots immediately over the watermelon seed. It was determined that 60 g/l of charcoal was necessary to protect watermelon from terbacil injury. This treatment provided essentially perfect weed control. This type of protection should be applicable to many crops and herbicides where marginal crop tolerance exists.

Alternate method of applying herbicides to container-grown ornamentals - Tifton, Georgia. Comparisons between granular formulations of herbicides and the application of liquid emulsifiable concentrates (EC) injected through the irrigation system were made in trials with 6 herbicides on 14 ornamental species. Both applications gave equally excellent weed control. Injection of EC formulations through the irrigation system would drastically reduce costs to the grower. Most growers are already equipped to inject other compounds such as fertilizers into their irrigation system. Likewise the cost of the chemical would be reduced as EC formulations generally are less costly than granular formulations.

Selective herbicides give effective weed control without tillage on small farms - Beltsville, Maryland. Data on herbicide efficacy and persistence was collected which will be useful for establishing new labels in horticultural crops. One year of field research indicated that herbicides without cultivation will provide good weed control in narrow row snap beans and allow greater yields than conventional snap beans grown in wide rows with herbicides plus cultivation for weed control. Weed-crop competition studies provided data toward a multi-year competition study.

New herbicide registrations developed for use on small farms - Beltsville, Maryland. Data on herbicide efficacy was developed which will be useful for establishing new herbicide registrations in crops suitable for small farming. A double cropping experiment also identified the potential of selected herbicides in a first crop to persist into a second crop and produce residual weed control and/or crop injury. A plastic mulch experiment indicated the need for supplemental weed control in the hole in the plastic where the crop emerges and between rows for all plastics as well as under the mulch for clear plastic.

New chemical weed control practices developed for horticultural crops on small farms - Frederick, Maryland. Efficacy and safety data were developed to support the registration of glyphosate and alachlor for use as herbicides in field grown woody stock and alachlor, napropamide, oryzalin, and oxadiazon for weed control

use in container-grown ornamentals. This represents significant progress in registering herbicides for weed control on small farms and in the multibillion dollar nursery-crop industry nationwide.

Herbicides developed for weed control in selected speciality crops - Frederick, Maryland. Preplant, postplant, and directed spray applications of glyphosate provided effective weed control in strawberries without decreasing yields or quality. Residue analyses were conducted. Efficacy and residue data have been submitted to support registration of glyphosate for this use.

Detection of weed populations in food crops - Weslaco, Texas. Aerial photography with color infrared film has more clearly identified weed populations in vegetable crops. The photographic films can also be passed through isodensitracers which read the quantities of weeds present in a food production area. This method of weed detection is important in weed interference and competition studies in row crops and can improve the surveying of weeds by determining the movement of weed populations from one production area to another.

Characerization of black nightshade and related species in North America - Prosser, Washington. Nightshades are common agricultural weeds in North America and in recent years have increased dramatically in irrigated crops in the western and mid-western United States. Information from taxonomic treatments and comparison of 93 accessions from numerous locations grown in the field and greenhouse were combined and summarized to produce a key and descriptions of the four most common agricultural nightshades in North America. This research clarified the taxonomic status of these nightshades, provided a key and species descriptions whereby they might be easily characterized in the field, and suggested appropriate common names for them.

Technological Objective 4: New and improved weed control technology for use in forage crops, pastures, rangelands, and turf that will increase efficiency of food and feed production, improve aesthetic values, reduce losses in yield and quality, and reduce the cost of control.

Research Locations:

Flagstaff, Arizona	Reno, Nevada
Tucson, Arizona	Ithaca, New York
Tifton, Georgia	Corallis, Oregon
Beltsville, Maryland	College Station, Texas
Columbia, Missouri	Temple, Texas
Lincoln, Nebraska	Logan, Utah

Examples of Recent Progress:

Sunlight at higher altitudes is more effective in the photodecomposition of picloram - Tucson, Arizona. Aqueous solutions of picloram exposed to direct sunlight at altitudes ranging from 2,363 to 9,157 feet near Tucson, Arizona,

showed that increased altitude resulted in an increased rate of photodecomposition. At all altitudes, from 70 to 80 percent of the picloram broke down during the first day of exposure. When dry picloram crystals were exposed to direct sunlight, 30 percent broke down during the first day. This is important in determining potential length of picloram residue life in aqueous environments and helps explain some of the past failures in the use of this herbicide to control brush species in arid, high-altitude environments of the Western United States.

Tebuthiuron selectively controls creosotebush, whitethorn acacia, desert zinnia, and tarbush - Tucson, Arizona. Selective control of whitethorn acacia, tarbush, desert zinnia, and creosotebush on coarse textured soils can be achieved with pelleted tebuthiuron at rates as low as 0.17 lb active ingredient per acre. Higher rates will be necessary for control of these shrubs on finer textured soils. Control of these undesirable woody plants results in increased growth of herbaceous plants which protect the soil from wind and water erosion and permit forage production on southwestern rangelands. This herbicide significantly broadens the spectrum of weeds and woody plants that can be controlled and makes it possible to improve forage production on millions of acres of rangelands.

Pelleted picloram controls cactus when applied in winter, spring, or summer - Tucson, Arizona. Pelleted picloram applied during the winter, spring, or summer was equally effective for control of pricklypear cactus and burroweed in southern Arizona. This information indicates that timing application of picloram for control of these two species is not critical. Thus applicators have a relatively long period in which to make treatments.

The effectiveness of indigenous insects in the suppression of populations of native thistles - Lincoln, Nebraska. The biology and infestation patterns of three native, seed-feeding insects were studied in Platte thistle (Cirsium canescens Nult.) populations. The insects were two fruit files and a pyralid moth, Paracantha culta (Weideman), Orellia occidentalis (Snow), and Homeosoma stypticellum (Grote) respectively. Various factors influence the relative abundance of each insect in any particular plant or small group of plants but seed production was markedly reduced in all plants sampled in 1979. The insects reduced the populations of Platte thistle to such an extent that they are of no consequence as a hazard to forage production in the millions of acres comprising the Sandhills of Nebraska and sandy areas of neighboring states.

Microenvironmental monitoring and remote sensing determines optimum herbicide application date for maximum mortality of brush species - Reno, Nevada. Total water potential was determined in relation to salt rabbitbrush and greasewood phenology and control with herbicides. Time of available moisture and favorable temperatures for rapid growth of brush and maximum susceptibility to herbicides was much shorter in saline compared to nonsaline soils. Water potential below 20 cm remained in the available range through August where brush was controlled while moisture potentials decreased below the available range in June in an adjacent unsprayed area. Water potential in the upper 10 cm of soil associated with shrub mounds was generally much higher than that between the mounds where infiltration is limited by poor soil physical characteristics.

Benefits of brush control are enhanced by establishment of forage grasses - Reno, Nevada. A dramatic increase in the density of big sagebrush was the dominant factor in successional changes on improved and native ranges. On a plowed

and seeded area with a good productive stand of crested wheatgrass, the number of sagebrush plants/acre was 690 in 1976 and 660 in 1979. On a chained and seeded area with a poor stand of crested wheatgrass, the number of sagebrush plants/acre increased from 3,000 in 1976 to 50,000 in 1979. On a sprayed area with about 95 percent overall control of big sagebrush, the frequency of 70 percent in 1979 indicates that most of the brush seedlings present in 1978 survived and were established by 1979. Results of these two studies show that benefits of brush control by either plowing or chemical control potentially can be lost unless a good stand of introduced or native grasses can be established before environmental conditions are favorable for the establishment of a competitive shrub stand.

Pastures and run-out legume hay fields can be renovated by no-tillage weed control means - Ithaca, New York. USDA-SEA-AR researchers have developed systems for site programs involving integrated combinations of herbicides, fertilizers, and planting equipment to establish birdsfoot trefoil and clovers in pastures and sods with very high success probabilities over the last 5 years. Because of technology developed by Federal researchers at Cornell, the percentage of establishment successes in sod have nearly doubled in the last 5 years. The farmers now have economically feasible options for no-tillage planting of these legumes and will benefit considerably from reduced energy requirements.

New direct planting methods developed for establishing legumes in stubbles of silage corn and small grain - Ithaca, New York. USDA-SEA-AR scientists at Cornell University have developed methods for planting legumes by direct planting or no-tillage means that result in establishment successes and yields equal to or greater than those obtained by conventional tillage. By use of appropriate herbicides and proper time of application after silage, corn, or small grain harvest, or after killing of cover crops and planting with newly developed drills, their success probabilities exceed 90 percent. The methods allow planting later into spring and early in mid- and late-summer. These findings will greatly facilitate establishing legumes, weed control, conservation of energy on the farm as well as the soil resource, and at less overall cost to the farmer.

Herbicide tolerance of kleingrass and buffelgrass - College Station, Texas. Kleingrass, buffelgrass, and weeping lovegrass (Morpa and Renner) were tolerant to preemergence and early postemergence treatments of butylate under greenhouse conditions. This herbicide will be further evaluated to determine if it can be used to control weeds and brush in these forage grass cultivars under field conditions.

New herbicide controls live oak and mixed brush in East Texas - College Station, Texas. Tebuthiuron applied as pellets is giving excellent control of live oak at 2.24 kg/ha. Lower rates (1.12kg/ha) are being studied. Tebuthiuron pellets at 2.24 kg/ha also controls post oak, blackjack oak, winged elm, and other brush regardless of time of application (January, April, July, or October). These research results provide ranchers with greater flexibility for controlling brush on rangelands.

New herbicides supplement 2,4,5-T for mesquite control - College Station, Texas. Triclopyr and 3,6-dichloropicolinic acid are showing equal or superior control to 2,4,5-T for honey mesquite in greenhouse and preliminary field

experiments on Texas grazing lands. Greenhouse and laboratory experiments showed accumulation of triclopyr in mesquite was similar to 2,4,5-T but more 3,6-dichloropicolinic acid accumulated in honey mesquite stems and roots than 2,4,5-T, triclopyr, or picloram.

Prescribed burning improves buffelgrass pastures - Temple, Texas. Despite strong interest among ranchers and service agency personnel, controlled fire has not been used in management of seeded grasslands in South Texas because of concern about possible damage to the principal seeded species, buffelgrass. Research has demonstrated that buffelgrass vigor and production are benefited by prescribed burning and that the treatment suppresses competition by undesirable shrubs. Prescribed burning is now recognized by area ranchers as a relatively inexpensive alternative to herbicide sprays and mechanical treatments and is easily integrated into overall range management schemes.

Some forage grasses as well as weeds may be poisonous to livestock - Logan, Utah. Kleingrass (Panicum coloratum) hay was harvested from an irrigated pasture in Texas and was fed to a Hereford calf for 2 months. The animal did not develop swellhead or any signs of photosensitization. No liver damage was detected. No drought stressed kleingrass hay was available for feed during 1979. Stressed kleingrass hay had previously produced photosensitization in a Hereford calf. Common purslane, Portulaca oleracea, was collected in Logan, Utah, and examined for soluble oxalates and toxicity to 1-week-old chicks. Soluble oxalate content ranged from 7 to 9 percent. A water extract of 4 grams of plant killed chicks within 4 hours. Losses of cattle from common purslane have been reported in Mexico.

Use of selective herbicides to control poisonous weeds reduces livestock losses - Logan, Utah. Estimates of losses that would have occurred on the North Fork Grazing Unit of Manti Canyon Cattle Allotment had the large and dense patches of larkspur (Delphinium barbeyi) not been treated and controlled with applications of 2,4,5-T would have been 117 cows for the period 1970 through 1979. Actual losses have been only 5 cows. Therefore, the control program which cost $2,050 has resulted in saving 112 animals in 9 years. Replacement of these 112 animals would have cost the ranchers in excess of $28,000. This research demonstrates the cost effectiveness and benefits from the use of 2,4,5-T to control poisonous weeds.

Technological Objective 5: New and improved weed control technology for controlling, managing, or using weed populations to improve water quality, fish and wildlife habitats, and recreational areas in aquatic and noncropland sites.

Research Locations:

Albany, California
Davis, California
Denver, Colorado
Fort Lauderdale, Florida
Stoneville, Mississippi
Prosser, Washington

Examples of Recent Progress:

Phytotoxic plant growth inhibitors found in spikerush - Albany, California. Spikerush (Eleocharis coloradoensis) was subjected to several methods of chemical analysis. Pure compounds isolated were tricin, luteolin, "gamma-sitosterol," ferulic acid, p-coumaric acid, and dihydroactinidiolide (DAD). DAD was synthesized. The above compounds were evaluated for allelopathic activity or inhibition of root elongation of watercress seedlings and/or of germination of radish seeds. Ferulic acid and DAD were very active, luteolin and p-coumaric acid slightly active, and tricin and "gamma-sitosterol" inactive. Analogs of DAD were synthesized and shown to be inactive. The antibiotic Bostrycin has been isolated and identified from the fungus Alternaria eichhornia and shown to be phytotoxic to waterhyacinth.

Combinations of copper and endothall show potential for control of the aquatic weed hydrilla - Davis, California. Combinations of the aquatic herbicide endothall and an organically complex copper gave better control of Hydrilla verticillata than either compound alone. Although these results are from small-scale greenhouse experiments, they suggest that field applications which produce 0.25-0.5 ppmw endothall and 0.5-1.0 copper may effectively reduce vegetative top-growth of hydrilla. This finding is of particular importance since hydrilla has invaded large portions of the Imperial Irrigation District in El Centro, California.

Insects control waterhyacinth - Fort Lauderdale, Florida. Sameodes albiguttalis, a South American pyralid insect species, was released at 20 sites in Florida for the biological control of waterhyacinth, (Eichhornia crassipes). The insect has become established at or near 16 of these sites and has begun to disperse throughout Florida. The rate of population expansion from south Florida to the north is estimated at 35 km/mo. In south Florida, population establishment was best obtained by releasing neonates during October-March. Populations established more readily on plants displaying characteristics of luxuriant growth as opposed to those displaying characteristics of poor growth. Detailed descriptions and illustrations of all instars of S. albiguttalis have been prepared. Host tests of Parapoynx rugosalis (Pyralidae) were conducted in Panama by exposing the larvae to 16 aquatic plant species. Only Najas minor and Hydrilla verticillata appeared to be preferred hosts. A total of 62 collections of Myriophyllum spicatum from 11 states and 377 collections of hydrilla from 11 states and their associated fauna have been made. Chironomid and pyralid larvae are the most frequently encountered herbivores on these species in the U.S.

Selective herbicides control the aquatic weed hydrilla - Fort Lauderdale, Florida. Hydrilla was controlled for approximately 24 months in a 8 ha lake by a single application of fenac. Hydrilla regrowth originating from sprouted tubers was retreated with fenac in an attempt to eradicate the weed. A combination of fenac and copper complex controlled hydrilla in a 0.23 ha Tampa pond within 4 weeks and had maintained control after 12 months. Hexazinone controlled hydrilla in a 0.57 ha Tampa pond after 3 months. A 2 percent regrowth was occurring after 12 months. Both ponds were subjected to water exchange due to heavy rains and flooding after 5 months. Bioassay of water and bottom hydrosoils after 12 months indicated that chemical residues were absent. Procedures were developed for inducing tuber formation by hydrilla under controlled growth conditions in the laboratory. The results of preliminary

evaluations indicate that several growth regulators and herbicides interfere with tuber production under experimental conditions. After 26 months growth in hydrosoils of decreasing fertility, hydrilla declined and all but disappeared from outdoor aquaria with sand or marl substrates.

Hydrogen peroxide controls the aquatic weed hydrilla and appears safe to fish - Stoneville, Mississippi. Hydrogen peroxide was shown to selectively control submerged aquatic weeds such as hydrilla and coontail and did not affect emersed or floating plants exposed to the atmosphere. The major advantage is the short-term exposure period (30 minutes to 1 hour) required for control and rapid degradation to nontoxic substances. After four days of continuous plant exposure, more than 98 percent of the peroxide had degraded into oxygen and water. Partial treatments appeared to be relatively safe for fish as they sensed the peroxide and moved away from it.

Mass-rearing of a native insect moth for biological control of waterhyacinth - Stoneville, Mississippi. Waterhyacith, a freshwater aquatic weed, has spread over 1 million acres of water bodies in the Southeastern United States causing major agricultural, navigational, and health related problems. The larvae of the native insect moth (Arzama densa) collected in the field on waterhyacinth completed their development on an artificial diet partially composed of freeze-dried waterhyacinth. Three subsequent laboratory generations have been reared, and presently the colony is estimated at 30,000 individuals. Future research plans for this insect include manipulative augmentation with natural populations. Also, the native moth could serve as a classical biological control agent against waterhyacinth in other countries.

Intraspecific variation offers promise of developing suitable herbicide-tolerant grass for ditchbanks - Prosser, Washington. The tolerance of 66 accessions and varieties of creeping red fescue varied widely when treated with glyphosate at the early heading stage of development. Combination of the mechanism responsible for the exhibited tolerance with other desirable characteristics displayed by less tolerant accessions would provide a glyphosate-tolerant, low-statured perennial, rhizomatous hydrophytic grass to protect ditchbanks and other moist areas from weeds and erosion. Such cover would also provide wildlife habitat and reduce the use of herbicides and costly mechanical cleaning operations now used on ditchbanks to control weeds and prevent reductions in water flow and seepage.

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AGRICULTURAL CHEMICALS TECHNOLOGY FOR
CROP PROTECTION AND MODIFICATION

This basic, multidisciplinary national research program emphasizes the development of new knowledge, new concepts, and new principles on the relationship of chemical structure to biological activity; including the nature, behavior, and fate of chemicals in soils; their mechanisms of entry, movement, activity, selectivity, metabolism, and fate in plants; their performance efficiency; and safety to crops, soils, and nontarget organisms in the environment. This research is essential to the efficient and safe use of pesticides and plant growth modifiers in the development of high-yielding food, feed, and fiber agroecosystems that will maintain the nation's food supply and improve the quality of the environment. This program supports the missions and goals of SEA and the Department. It is organized into 29 projects at 15 locations and is conducted by 28 SEA scientists in cooperation with several Federal agencies, State agricultural experiment stations (SAES), private universities and research institutes, and industrial research organizations. Progress in 1979 was reported in 67 scientific publications.

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Technological Objective 1: New concepts and knowledge for improving the primary evaluation and structure-activity assessments for enhanced development of improved herbicides, fungicides, nematicides, insecticides, and growth regulators that are compatible with a quality environment.

Research Locations:

Berkeley, California	Frederick, Maryland
Peoria, Illinois	Raleigh, North Carolina
New Orleans, Louisiana	Fargo, North Dakota
Beltsville, Maryland	Philadelphia, Pennsylvania

Examples of Recent Progress:

Screwworm fly sterilant developed - WRRC, Albany, California. The screwworm fly is a most serious cattle pest in southwestern areas of the U.S. and Mexico. In cooperation with the Screwworm Laboratory in Texas, it has been shown in extensive laboratory research that an easily synthesized compound, 4-methoxybenzyl-= 2,4-di-t-butylphenol [J2644], is nontoxic but effectively sterilizes the female fly in one feeding. It is less effective upon the male. Feeding tests are planned this year to determine its potential efficiency in the field.

Basic research on structure/biological activity aids in the discovery of new herbicides - Beltsville, Maryland. Biological activity followed computer predictions in studies of chemical structures versus biological activities of 49 substituted pyridazinones. BASF scientists applied computerized pattern-recognition techniques in the analysis. Based on these results, four new pyridazinones were synthesized and their biological activities were evaluated. One of the four new compounds had activity equal to or greater than the previously known pyridazinones.

Two new classes of high-efficacy nematicides discovered with greater environmental safety - Beltsville, Maryland. Very high levels of nematicidal activity, discovered in two new classes of chemicals last year (in cooperation with Insect Physiology Laboratory, at Beltsville, Maryland), are now known to be active against a root-knot nematode, one of a group of important and widespread plant parasites. Laboratory and greenhouse direct-contact tests showed that they are from 5- to 20-fold more active than several commercial standard nematicides. These high activity levels, accompanied by lower mammalian toxicity (no effect at 300 mg/kg, AO rabbit) hold promise for urgently needed safer and environmentally compatible chemical control measures against plant-parasitic nematodes.

Growth regulator pretreatment enhances herbicide effect - Frederick, Maryland. Pretreatment with gibberellin sprays three days before injecting bean plants with the herbicide bentazon significantly increased the effectiveness of the herbicide in a test system. This dual treatment technique provides a method for evaluating other growth regulating compounds as enhancers or modifiers of herbicide toxicity which could lead to more efficient and selective weed control.

Technological Objective 2: New and improved knowledge of the nature, behavior, and fate of agricultural chemicals in soils that influence the performance of pesticides and growth modifying chemicals and their safety to crops, soils, and nontarget organisms in the environment.

Research Locations:

Beltsville, Maryland

Examples of Recent Progress:

New synthetic pyrethroid insecticides are biodegradable in soil - Beltsville, Maryland. The soil persistence and biodegradability of a new generation of insecticides, the synthetic pyrethroids (cypermethrin, decamethrin, and permethrin) were determined in soil. Although the rate of degradation varies with the compound, the application rate, soil type, temperature and aeration, and the chemicals isomeric form, at normal application rates (0.02-0.2 lb/A), their degradation occurs rapidly and extensively in nearly all of the soils examined. The major degradation pathway involves a simple hydrolysis to yield products which are also rapidly metabolized by soil microorganisms to CO_2 and other ecologically acceptable products.

Longterm arsenic uses for weed control show no harmful effects - Beltsville, Maryland. Experiments were conducted to examine the longterm effects of arsenical herbicide use on plant and soil systems. Results after seven years indicate that no adverse effects can be anticipated from their continued use on soil and plant contents, nor on crops grown at normal application rates. Slight increases in phytotoxicity and crop residues are observed at twice the recommended rates of application for weed control.

Methods of analysis developed to separate arsenic species and determine their fate in the environment - Beltsville, Maryland. The development of a rapid method for separating, detecting, and quantitating different arsenic species will allow many studies of arsenic in environmental substrates to be conducted. This will enhance our knowledge and understanding of basic behavior and characteristics of the various arsenic compounds. Many government agencies, as well as other researchers, are greatly concerned about developing a better understanding of these transformations and their effects in the environment.

Microecosystem developed to simulate rice fields - Beltsville, Maryland. Microecosystems were developed that simulate rice field environments. These microecosystems can be used to evaluate the fate of pesticides and related compounds that are used in growing rice. The fate of 3,4-dichloroaniline (DCA), a metabolite of the herbicide propanil that is used for weed control in rice, was determined in these microecosystems with the following results: DCA was heavily adsorbed in the soil, taken up by rice to a limited extent, rapidly degraded in water, and weakly accumulated by aquatic organisms. These results indicate that DCA will not create an environmental problem.

Technological Objective 3: New and improved knowledge on the mechanisms of entry, movement, activity, selectivity, metabolism, and fate of applied pesticides and growth regulators in relation to their effective action in plants and their safety to subsequent crops and nontarget organisms.

Research Locations:

Beltsville, Maryland
Raleigh, North Carolina
Fargo, North Dakota

Examples of Recent Progress:

Basic research on how herbicides interact with plant membranes will aid in discovery of new herbicides - Raleigh, North Carolina. Many important herbicides, including chlorpropham, perfluidone, propanil, and trifluralin, are known to interfere with the oxidative and photoproduction of ATP energy by isolated mitochondria and chloroplast, respectively. The same herbicides have been shown recently to perturb an artificial membrane system that lacked proteins, but was composed entirely of lipids. These results indicate that the interference with energy production may result from disturbances imposed on the lipid components

of membranes. This observation provides a clearer understanding of how herbicides kill plants and should be useful in developing new and more selective herbicides.

Surfactant-controlled photodegradation of herbicides - Fargo, North Dakota. Nonionic surfactants can either enhance or suppress herbicidal photodegradation. By selection of formulation surfactants, herbicidal residual action (lifetimes) with respect to photodecomposition in aqueous media can be controlled. Since pesticides are photolyzed as vapors and aerosols after aerial application, an extremely photolabile pesticide might be protected against photodecomposition with appropriate additives. In order to select surfactants more carefully, an important factor is knowledge of the triplet energies of the surfactants and pesticides in question. Thus, for enhanced degradation, the surfactant triplet energy must exceed that of the pesticide; and for protection, the surfactant triplet energy must be lower than that of the pesticide in the formulation.

New concepts of pesticide additive behavior and fate in plants - Fargo, North Dakota. Nonionic surfactants are used extensively in pesticide formulations. Unfortunately, little is known about their effects on vital plant processes. Recent studies with selected nonionic surfactants have shown that these formulating agents readily penetrate plant tissues and cells. Although they are not cleaved or degraded extensively over short time periods, they are partially hydroxylated and rapidly conjugated in the plant. The resultant changes in the hydrophile-lipophile balance and membrane affinity of these metabolites suggests that any biochemical or physiological effects due to applied surfactants may be short-lived.

Diagnostic test developed for major pesticide degradation pathway in plants - Fargo, North Dakota. Recent research has established the enzymatic mechanism by which plants convert the fungicide, pentachlorobenzene, to pentachlorothioanisole. This knowledge is important to pesticide chemists because it is the first case in which a pesticide has been shown to be converted first to a highly polar glutathione conjugate and then to a simple non-polar methyl thioether in a plant. If this process is found to be common for other pesticides metabolized by glutathione conjugation, methyl thioethers could be used as diagnostic compounds for the existance of the glutathione conjugation pathway. This would be helpful because methyl thioethers are much easier to isolate and identify than glutathione conjugates.

Plant growth regulator interactions as a basis for wild oat herbicide action in plants - Fargo, North Dakota. Wild oat is a major weed problem in U.S. small grain production. Losses from wild oat are estimated in the hundreds-of-millions dollars each year. Studies have shown that a new wild oat herbicide, diclofop-methyl, acts to kill grassy weeds by interfering with the action of the plant hormone, IAA. Such an interference can lead to serious disruption of normal biochemical functions involved in plant growth and maintenance. Some grasses such as wheat and broad-leaved plants such as soybean are able to resist the toxic action of a herbicide because they possess an enzyme system that is capable of changing the herbicide to a nontoxic form. Basic information on the molecular structure that is required to interfere with the functions of the plant hormone and the structure that is vulnerable to attack by the enzymic detoxication system will be valuable in the development of improved herbicides for selective grassy weed control in small grains.

Technological Objective 4: Develop new information on natural bioconstituents and related synthetic compounds that control physiological and biochemical processes for the development of chemicals to modify plant structure and processes.

Research Locations:

Peoria, Illinois	New Orleans, Louisiana
Beltsville, Maryland	Philadelphia, Pennsylvania

Examples of Recent Progress:

Brassinosteroids show an ability to promote the growth of plants - Beltsville, Maryland. Several synthetic analogs of brassinolide were prepared. Brassinolide is a tetrahydroxy steroid isolated from rape pollen and is 2 a, 3 a, 22 a, 23 a-tetrahydroxy-24 a-methyl-B-homo-7-oxa-5 a-cholestan-6-one. Five of the analogs (brassinosteroids) were active in enhancing the growth of bean tissue in a bioassay system. The biologically active brassinosteroids are tetrahydroxysteroid lactones or ketones. The activity is to a large extent dependent upon the orientation of the two hydroxyls in the A ring of the steroid structure. Both hydroxyls must be free (esters are inactive) and be alpha-oriented. The orientation of the two hydroxyls at C-22 and C-23 only slightly affects activity. Yields of lettuce and radishes were significantly increased by repeated applications to young seedlings of a low concentration (0.01 ppm) of the brassinosteroids under field conditions. Field experiments also indicate that brassinosteroid treatment of seed potatoes can increase yields of marketable potatoes.

Camptothecin effective as plant growth inhibitor - Beltsville, Maryland. Camptothecin, an alkaloid found in the tree from China, Camptotheca acuminata, inhibited the growth of newly-developed tissue in several crop plants. The compound increased the storage life of potatoes and radishes by inhibition of sprouting and root growth. Axillary bud growth of tobacco and ornamentals was inhibited by camptothecin. At a concentration that retarded growth of lawn grass ($5x10^{-5}M$), a toxic effect was observed in crabgrass. This newly-discovered type of plant growth regulator provides a basis for further studies of natural products that may be environmentally safe and effective agricultural chemicals.

Controlled-release (CR) formulation permits pre-plant application of molinate on rice - New Orleans, Louisiana. Pre-plant incorporation of conventional molinate formulations in rice is not feasible because of phytotoxicity to rice. However, greenhouse research on rice infested with barnyardgrass indicated that an alginate/molinate CR formulation may be suitable. A pre-plant application at 3 lb/A of the conventional molinate granules caused 65 percent injury to the rice and give 98 percent weed control; the alginate/molinate beads caused 0 percent rice injury and gave 81 percent weed control. A slightly higher rate of application for the CR formulation is indicated for further research evaluation.

Two isomers of a 3-ring strigol analogue were isolated and analyzed - SRRC, New Orleans, Louisiana. In the synthesis of a 3-ring analogue of strigol, 3-([(2,5-dihydro-4-methyl-5-oxo-2-furanyl)oxyl]-methylene)3,3a,6,6a-tetrahydro-2H-cyclopenta[b]furan-2-one, careful recrystallization of the product led to the isolation of two isomers, one melting at 174-175°C (HMI) and another at 143-145°C (LMI). Procedures for identification and separation of the two isomers have been developed using high pressure liquid chromatography (HPLC). Initial in-vitro tests for witchweed seed germination activity indicated that the LMI was ten times more active than the HMI.

Two-step oxidation greatly improves yield of critical step in strigol synthesis - SRRC, New Orleans, Louisiana. The conversion of 3-hydroxy-2,6,6-trimethyl-=cyclohex-1-ene-1-carboxaldehyde to 3-oxo-2,6,6-trimethylcyclohex-1-ene-1-=carboxylic by oxidation was considerably improved by use of a two-step oxidation procedure. The first step utilizes the Jones reagent to oxidize the allylic alcohol and simultaneously oxidizes some of the aldehyde group (about 5-25 percent). The non-acidic organic material is primarily a keto-aldehyde. The aldehyde group is oxidized by silver oxide to produce the keto-acid in yields of about 70 percent. These improved yields of strigol signal a potential breakthrough in the synthesis of strigol (a naturally occurring chemical in plants that is required to stimulate witchweed to germinate). Larger quantities of strigol are critically needed for evaluation under field conditions for control of witchweed.

Plant growth regulating compounds isolated from a modified fatty acid mixture - ERRC, Philadelphia, Pennsylvania. Some of the active plant growth inhibiting constituents previously detected in the hydration product of diepoxystearic acid have been isolated and their gross chemical structure elucidated. The active materials isolated have one common structural feature, namely, a cyclic five-membered ring containing an oxygen atom with two pendant hydroxy groups. Two types of growth regulating activity were observed for these materials in laboratory tests. Some of the compounds controlled plant growth without destroying plant tissue whereas others were herbicidal in action at the point of contact.

Technological Objective 5: Improved automated search, storage, and retrieval systems for relating chemical structure and biological activity of pesticides and growth regulators, including their nature, behavior, and fate in all aspects of the environment.

Research Locations:

Beltsville, Maryland
Frederick, Maryland

Examples of Recent Progress:

Computer programs developed for storage and retrieval of pesticide data - Beltsville, Maryland. Computer storage will allow anyone to quickly obtain information on the dissipation rate of a chemical in soil, plant, water, and air. The availability of a computer program to ascertain the nature, magnitude, and significance of a pesticide interaction is a major step toward aiding the scientist to determine and evaluate the interaction.

Advanced chemical notation improves chemical information management - Frederick, Maryland. It is now possible to use both upper and lower case letters and an accompanying expanded set of punctuation marks in computer systems that store and retrieve information on many chemicals evaluated for biological activity. This has permitted the development and preliminary testing of an advanced linear chemical structure notation (AWLN) that is more powerful and compact than the previous line notation (WLN), and will facilitate chemical structure description for use in computer systems.

Frederick Chemical Data base consolidated in the SEA computerized system - Frederick, Maryland. The 31,000 chemical data base has been placed on tape, transferred to the Science and Education Administration (SEA), and is available for retrieval by the Data System Application Division. A publication on this data base is being developed.

Manage chemical information on the Mitchell file of plant growth regulators - Frederick, Maryland. The chemical structure diagrams from the file have been translated into Wiswesser Linear Notation (WLN), validated, and errors corrected. Biological response information for all 8,000 of the chemicals has been put in form suitable for computer use.

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Special Research Program

INTEGRATED PEST MANAGEMENT SYSTEMS

Technological Objective 1: Combine two or more pest suppression methods into practical integrated pest management systems to reduce pest problems in crop production, animal production, marketing and human health and safety.

NPS Contact: Waldemar Klassen

Research Locations:

Note: Scientists at various locations submit systems research proposals in order to compete for funding from the Administrator's IPM Systems Fund of $1.1 million per year. Projects at the following locations are currently funded:

Fort Collins, Colorado
Gainesville, Florida
Tifton, Georgia
W. Lafayette, Indiana
Orono, Maine
Stoneville, Mississippi
Ithaca, New York
Weslaco, Texas

Examples of Recent Progress:

Since this Program was initiated in FY1980 no progress can be reported. However, each systems project is briefly described below.

IPMS-NER-80-1. Intergrated systems for managing potato pests. Orono, Maine FY 1980-1984. Coorinator S. S. Leach, SEA/AR, Orono, ME; Co-principal investigators: W. E. Fry, Plant Pathology Department and R. D. Sweet, Vegetable Crops Department, Cornell University, Ithaca N. Y.

ABSTRACT: The proposed research will identifiy systems which will further refine integrated management of potato pests in the Northeast and which will enhance the efficiency of pesticide use. Application of these systems should benefit growers economically and environment ecologically because less pesticide will be inappropriately applied. The approaches include: management of the crop canopy to suppress pests, integration of host resistance to several pests into the potato management system, and identification of non-target effects of pesticides. The systems research requires the cooperation of state and federal weed scientisis, entomologists, plant pathologists and horticulturalists.

OBJECTIVE 1. Management of plant canopies to minimize pest problems.

APPROACH: Interaction of various methods to manage crop canopies will be evaluated for their effects on microclimate and for their influence on target and non-target pest populations. Interactions of cultivar, date of planting, in-row spacing, fertility level, and irrigation on weed suppression and on microclimate alteraction will be evaluated in large factorial experiments. The influence of selected canopy management programs on selected

important pests will be evaluated in smaller pest-specific experiments.

OBJECTIVE 2. Integration of host resistance into the potato management system.

APPROACH: Various techniques of adjusting pesticide dosage to complement cultivar resitance will be evaluated. Field experiments and computer simulation will be used. Forecasts of need for pesticides will be modified to incorporate the effects of host resistance. Evaluations will include the effects on non-target as well as on target pests.

OBJECTIVE 3. Determine methods of pesticide management to maximze beneficial effects on target and non-target organisms with minimal use of insecticide, fungicide and herbicides.

APPROACH: Foliar and systemic insecticides will be evaluated for maximum effectiveness on target insects, natural predators of target insects and nontarget organisns. Special emphasis will be made to evaluate the effects of systemic insecticides on soil-borne potato pathogens and resulting disease incidence as well as their effects on benefical soil orgainisms e.g. nitrifying bacteria.

Foliar and the new systemic fungicides used to control late blight of potato will be evaluated for effectiveness on target and non-target organisms. Comparisons will be made of each material as to their control when applied in a 7-day schedule, following blight-cast, and when blight appears. The systemic materials will be carefully monitored as to their effects on soil-borne organisms, both pathogenic and non-pathogenic.

Herbicides will be evaluated for their effects on target weeds and non-target organisms. They will be applied broadcast, banded over and between rows as determined by weed appearance. Cultural practices and timing of herbicide application will be studied to determine methods by which chemical use can be reduced and improve soil conditions for optimum plant growth. Special emphasis will be placed on the effects of disease and meribuzin on Colorado Potato Beetle and Rhizoctonia solani respectively.

IPMS-NER-80-3. IPM in no-tillage systems for forages and rotations involving forages. Ithaca, New York. fy 1980-84. Coorinator: D. L. Linscott (agromony-weeds); R. D. Hagin, SEA/AR (Weed and crop chemistry); H. M. Schaaf, SEA/AR (plant breeding-statistics); R. R. Seaney Cornell University (forage crops); W. S. Reid, Cornell University (soil fertility and management); R. R. Hahn, Cornell University (extension-weeds);TBD (economics); R. Vaughan, SEA/AR (general biology); L. Hatch, Cornell University (experimentalist); TBD (animal scientist).

ABSTRACT: The 5 year project incorporates additional integrated pest management aspects into an existing program (a pilot test of weed control alternatives for forage and pasture production with limited- or no-tillage systems) and as well develops new programs for crop rotations of the region involving both no-tillage and conventional systems in long-term experiments. The proposed research is a

joint effort of scientists of the USDA-SEA and Cornell University and involves the disciplines of Agronomy, Weed Science, Entomolgy, Plant Pathology. The multi-disciplinary apporach greatly enhances the probability of developing successful IPM systems for forage crops.

Need for Expanded IPM systems Experiments in Forages and Other Crops

Limited-tillage and no-tillage cropping systems are bound to increase in importance in the future in view of the increasing costs for energy and the uncertainty of supply. To be successful these systems will require significant management inputs for pest control. The major pest impediments to development of limited-tillage systems include weeds, insects and disease organisms. While there have been significant accomplishments in the individual pest control disciplines in conventional tillage systems, pest management in no-tillage systems, especially systems integrating weed, insect and pathogen control have received insufficient attention. A particular informational void exists in forage crop establishment and production by limited-tillage means and fully integrated pest control.

Forage crops are a mainstay in the agricultural economy of the Northeast. It is vital that we develop the pest management technology for the tillage and cropping systems likely to be adopted in the next 10 to 20 years for forage crop production.

The technology developed must be consistent with our need to protect the environment while maintaining overall production economics. This process is not at all simple and require the collective thinking and efforts of several reseach disciplines. We feel that a significant expansion of the present pilot program on alternate means of weed control in forages, to include inputs of entomologists and pathologists as well, will go a long way toward solving the forage production problems in an economical way while preserving the environment.

Overall Objectives

(a) Determine the impact of no-tillage systems versus conventional systems in long-term crop rotations of the region on crop yields and on the development of weeds, insect pests and disease populations.

(b) Determine the influence of weeds, insect pests, and plant diseases on (1) probabilities of establising forages by direct-planting in corn and small grain stubbles and in grass-hay and pasture sods and (2) on the yields of forages establised thereby.

(c) Identify, and quantify effects of specific breakdown products of killed plant residues that affect seedling germination and early growth and development in no-tillage systems, particularly of those involving perennial weeds and/or grass sods.

(d) Investigate the interactions of pesticides and tillage systems on non-target as well as target species.

(e) Determine practical means for overall management of weeds, insects, and pathogens in limited or no-tillage systems.

(1) Sub-objectives:

(a) Agronomic

i. To determine the relative establishment and yields of crops in a ccorn-corn, -oat, -wheat, alfalfa-alfalfa rotation as influenced by tillage systems and weed control.

ii. To determine the effects of state-of-the-art weed control measures in a cropping-tillage rotation on weed populations in the growing season and on long term shifts in populations.

iii. To determine the impact of other pesticides on effectiveness of herbicides.

iv. To determine the status and changes in soil physical prperties in conventional use no-tillage systems and their influence on total crop production and pest management.

(b) Entomologic

i. To conduct a general faunal survey of the arthropods occuring in the rotational system as affected by tillage practices.

ii. To determine the effect of tillage history and current tillage practices on known soil insect pests in a fixed rotation sequence. Further, to identify new insect pest problems that may arise from the use of no-till, rather than conventional, crop establishment.

iii. To examine the impact of tillage practices on the spatial and temporal variability of resources critical to the population process of beneficial organisms in the rotation system. Emphasis will be placed on the interactions between tillage and rotational sequence.

(b) Pathologic.

i. To determine the incidence and severity of diseases in crop and tillage rotational situations and their effect on crop yield.

ii. To determine the potenital of specific fungicides for diagnosing new problems.

iii. To attempt to determination of specific interactions that may exist between insect and disease pests with and without control measures, and to determine their effects on crop yields.

iv. To attempt to determination of the role of weed pests and rotational cropping shedules on the incidence and survival of plant pathogens.

(c) Toxicologic

i. To identify specifically the compounds from decay of killed quackgrass (Agropyron repens) which negatively affect germination and early growth of alfalfa in no-tillage plantings. Quantify the differences in effects on alfalfa and other major legumes of the region, red clover and birdsfoot trefiol.

ii. Determine if other produced toxins are primary or secondary products of decay.

iii. As in objective 1, except compounds resulting form decay of the most important perennial broadleaf and grass species killed or stunted in no-tillage plantings.

iv. Determine possible interactions of herbicides-fungicides on buildup of decay related toxins.

v. Develop practical means of avoiding the problem.

Potential Economic Benefit

The potential for savings in energy costs by adoption of limited-tillage or no-tillage systems is enormous. First we are dealing with legumes, a natural supplier of nitrogen to crops. Any system which reduces the need for fertilizer nitrogen while maintaining competitive levels of crop production improves the economic posture of the farmer. Further, synthesis of nitrogen fertilizers takes copious amounts of energy. Second, the emphasis is on no-tillage or limited-tillage production systems in this project. Reduction or elimination of the fuel consuming plowing-disking-harrowing operations prior to planting results in significant savings in the fuel dollar and in operator time. Third, the skillful integration of pest management practices may well lead to reduced requirements for pesticides, which are in themselves expensive and which take significant imputs of energy to formulate. Fourth, limited tillage systems may well improve the chances for legume establishment success in some cases, and particulary late summer early fall plantings. If so, a very sginficant saving in time, fuel, seed, fertilizer and pesticide expenditures will be realized.

Potential Environmental Benefit

Tillage operations that bury plant residues leave the soil exposed and ultra-susceptible to erosion by rainfall and wind action. Numerous studies indicate that no-tillage systems which leave plant residues on the surface result in greatly reduced soil loss. In our long term national interests, it is critical to minimize losses of agricultral soils from erosion. Secondary benefits resulting are cleaner streams delayed sediment fill of ponds and lakes, cleaner air and the like. uccessful implementation of limited tillage systems requires the judicious use of pesticides. Improper use can result in harm to the environment. However, with proper integrated use of pesticides, combined with proper crop rotations, we anticipate a requirement may be equivalent to or below that for conventional-tillage systems, particularly the non- or near mono-culture systems.

IPMS-NCR-80-1. An IPM system for crop production in the eastern corn belt region. W. Lafayette, IN. FY 1980-1984. Coordinator: M. M. Schreiber, SEA/AR (Weeds). Investigators: J. L. Williams, Purdue Agricultural Experiment Station (Weeds); T. T. Bauman Purdue . E. S. (Weeds); M. A. Ross, Purdue A. E. S. (Weeds); H. L. Warren, SEA/AR (Plant Diseases); T. S. Abney, SEA/AR (plant diseases); G. E. Shaner, Purdue, A. E. S. (nematudes); R. M. Lister, Purdue A. E. S. (insects); E. T. Turpin, RPurdue A. E. S (Insects); J. E. Foster, SEA/AR (insects); C. R. Edwards, Purdue A. E. S. (Insects); W. C. Moldenhauer, SEA/AR (Soils); J. R. Barrett, SEA/AR (Agricultural engineering); W. E. Tyber, Purdue A. E. S. (Economics); J. R. Wilcox, Purdue A. E. S. (Genetics-agronomy).

ABSTRACT: This proposed study will deal with pest management problems in three major crops grown in the Eastern Corn Belt Region: corn, soybeans, and wheat. The main experiment and satellite studies have been designed to assess the

management on the overall management of diseases, nematodes, viruses, insects, and weeds on crop production. Crop yield will be the primary criterion.

a) Selection of Crop Rotation Systems. Corn, soybeans, and wheat are the crops of major concern, based on acreage and value in this region. Four rotation systems appear to be most likey employed and thus worthy of intensive long-term study. These include: continous corn (R1), continous soybeans (R2), a two year rotation between corn and soybeans (R3), and a three year rotation consisting of corn, soybeans and wheat (R4).

b) Selection of Tillage Systems. Reduced tillage has gained a strong following in the Corn Belt. Some studies indicate increases, decreases, or no changes in pests depending upon the particular pest or tillage system used. Three tillage systems have been selected. These include: conventional moldboard plowing in the fall with spring disking for final seedbed preparation with the option of at least one cultivation in the row crops (T1), a conservation tillage which will remove all crop residue and call for fall chisel followed by spring disking for final seedbed preparation (T3). The latter system has been included not only for a direct comparison with crop residue remaining (T2) but in relation to the possible use of crop residues in relation to the possible use of crop residues in energy research.

c) Selection of Pest Management Systems. In this proposal, weeds have been given primary emphasis because: they are ubiquitous, require herbicidal control every year in each crop, they can annually contribute significantly to crop losses, can and do serve as primary or alternate hosts for other pests, and can and do serve as suitable sites for larval and/or adult development of insects. Farmers could make more knowledgeable decisions if they knew what their weed probelms were going to be before they had to decide on the weed control program. This is particularly important since over 75% of the herbicides are applied before the crop emerges, preplant incorporated or preemergence.

Three levels of chemical weed management will be employed: A minimum level of herbicides at lower concentrations (W1), a moderate level and contrations generally approach the average farmer use for crops in this study (W2), and a maximum level of herbicides use and concentration (W3).

In time or as needed, when diseases, nematodes, and/or insect pests reach significant economic threshold limits that threaten crop production, chemical treatment for the pest will be used within the subplot treatment for all replications. The selection of these materials will be compatible with the other systems to the degree possible.

d) Plot Design and Statistical Approach. A split-plot design will be used with four replications. The whole-plot units will be randomized by combination of crop rotation (7) and tillage (3). Sub-plot units will be randomized weed management systems (3). Proposed cropping sequences were selected for the whole-plot units for a 7 year period. In the 4th and 7th year we will have been through 1 or 2 cycles of the three-crop rotation, 2 or 4 cycles of the soybeans. The true value of this project is the interactions of the systems used with time.

OBJECTIVES-OVERALL:

The proposed research goal is to investigate the interactions of crop rotations and tillage systems common to the Eastern Corn Belt region in relation to the most practical, economically feasible, and environmentally compatible integrated pest management systems on yield and quality of different crops. The interdisciplinary, long term approach will: a) study the population dynamics of the most common pests (diseases, nematodes, viruses, insects, and weeds) and to quantify their influence on the quality and quantity of the crops studied, b) develop and assess new tactics for the management of populations of these pests in the systems studied, c) make economic analysis of the emerging integrated pests management systems, d) determine the energy efficiency of the integrated pest management systems, e) determine the merits of the systems studied in relationship to the maintenance of soil productivity and conservation, and f) evaluate soil fertility management in multiple cropping and tillage systems and soil-borne pathogenic organisms on the mineral nutrition of crops studied.

SPECIFIC OBJECTIVES

A. Weed Science

1. Evaluate the weed flora as influenced by weed management, crop rotation and tillage systems.
2. Determine the weed seed populations in soil as influenced by weed management, crop rotation, and tillage systems.
3. Determine the feasibility of predicting the dynamics of weed populations and their direct impact on crop yield under the crop rotation, tillage, and weed management systems studied.
4. Determine and quantify the effects and interactions of specific weed management systems on the incidence of insect, disease, nematode, and virus problems as related to crop rotation adn tillage systems studied.
5. Determine and quantify the interaction of herbicides and their residues on disease severity in crops used in this study.
6. Determine the extent and suitabliity of weed species for larval and/or adult development that are vectors for plant diseases particularly viruses.

B. Plant Pathology

1. Monitor the incidence and severity of diseases, nematodes, and viruses in crops as influenced by weed management, crop rotation, and tillage systems.
2. Quantify the effects and interactions of specific weed management systems on the incidence of potential diseases, nematodes, adn viruses as related to crop rotaion and tillage systems used (A4 above).
3. Determine the interaction of herbicides and their residues on disease, nematode, and virus severity. (A5 above).
4. Determine the suitability of weed species for larval and/or adult development for insects that are vectors for plant diseases and viruses. (A6 above and C3 below).
5. Evaluate the soil fertility management in multiple cropping and tillage systems and their influence on soil-borne plant pathogenic organisms.

6. Determine the feasibility of predicting the dynamics of key disease, nematode, and virus severity under the crop rotation, tillage, and weed management systems studied.

C. Insects

1. Monitor insect populations on crops and weed as influenced by weed management, crop rotation, and tillage systems studied.
2. Determine egg deposition of key insects as influenced by weed management, crop rotation, and tillage systems.
3. Determine the suitability of weed species for larval and/or adult development of key insects in systems studied. (A6 and B4 above).
4. Develop and determine the feasibility of predicting the dynamics of key insect populations and their direct impact on crop yield under the crop rotation, tillage, and weed management systems studied.

D. Soil Management

1. Evaluate the systems studied as they influence soil productivity factors namely soil structure, erosion, and pesticide residue.

E. Economics

1. Evaluate by economic analysis the crop rotation, tillage, and pest management systems studied.
2. Incorporate economic strategies into predictive dynamic models of all systems studied.

F. Energy

1. Develop and test by mathematical models and simulations production practices in relation to energy use as affected by crop rotation, tillage, and pest management systems studied.

VII. EXPERIMENTAL PROCEDURES FOR SPECIFIC OBJECTIVES

A. Weed Science

1. Weed Flora. The weed flora in each plot will be evaluated at the beginning and at mid season by counting the number of weeds by species in thirty 1 x 1 meter quadrants at random. The number of counts made will be adjusted depending on the homogeneity of the weed populations in the main experimental area. These data will be used to determine the effectiveness of control imposed and control desired for remainder of the season. Along with seed populations (determined below), this information will be used to select appropriate weed control treatments for the crop in the succeeding year.

E. C. Ruppel, SEA/AR (Plant diseases); G. D. Griffin, SEA/AR (Nematodes); R. H. Mickelson, SEA/AR (Agricultural Engineering); J. L. Capinera, Colorado State Univ. (Insects); R. P. King, Colorado State Univ. (Economics); D. W. Lybecker, Colorado State Univ. (Economics); R. L. Zimdahl, Colorado State Univ. (Weeds).

ABSTRACT: Ongoing pilot test research at Fort Collins, Colorado, indicates that intensive weed control methods, predominantly chemical, can reduce weed seed population by 65% with 3 years. However, when herbicides were discontinued after 3 years, the number of weeds increased in the fourth year from 1013/ha. in the treated plots to 30,146/ha. in the untreated plots; in the fifth year these numbers were 222 and 261,926/ha. respectively. These and other results from the ongoing project lead us to believe that while weed control is required each year, intensive herbicide usage is not. Therefore, the IPM systems level research proposed herein integrates this knowledge with other pest problems into a study which assesses the impact of weed control systems on the management of pests (insects, nematodes, pathogens, and weeds) in a surface-irrigated barley-bean-corn-sugarbeet rotation in central Colorado, and the impact of weed control systems and tillage methods on the management of pests in continous corn under center pivot irrigation in eastern Colorado. The major thrust of the research is to develop new and improved management systems for controlling weeds in a typical furrow-irrigated crop rotation, and in continous corn grown under center pivot irrigation. Concurrently, we plant to quantify the effects of specific weed management systems on the incidence of diseases, insects, adn nematodes in the designated cropping systems. We estimate that the potential benefits of this IPM systems research will be $48 million annually for Colorado, Idaho, Montana, Utah, and Wyoming--$36.5 million attributed to reducing crop losses from weeds and $11.5 million savings in cost in herbicides.

A. Overall Objectives

The goal of the proposed research is to : (a) expand and refine integrated systems for management of pests (insects, nematodes, pathogens, and weeds) that are practical, economically feasible, and environmental compatible; (b) study aspects of the population dynamics of the most troublesome pests (insects, nematodes, pathogens, and weeds); (c) devise improved tactics for regulation and control of populations of these pests; and (d) make economic analyses of the emerging integrated pest management systems and compare them to conventional systems so that the cost/benefit/risk analyses of all components can be demonstrated.

B. Specific objectives for crop rotation and continous corn studies.

1. To quantify the effects of specific weed management systems on the incidence of insect, disease, and nematode problems in a barley-bean-corn-sugarbeet rotation and in continuous corn.
2. To study the interaction between weed control techniques and tillage practices on pest control in continous corn grown under center pivot irrigation.

(a) Subobjectives- Weeds:

1. Evaluate the weed flora in the crop rotation and continuous corn studies.
2. Determine the effects of crop rotation, tillage practices, and IWMS on the total weed seed population in soil.
3. Determine the feasibility of predicting which weeds will dominate with different crops, cultural practices, and weed control techniques.

(b) Subobjectives- Insects:

1. Monitor insect populations on crops and weeds in the crop rotation and continuous corn studies.
2. Determine egg deposition of key pests, i.e. western corn rootworm, western bean cutworm, Mexican bean beetle, and sugarbeet root maggot in the crop rotation and continuous corn studies.
3. Determine the suitability of weeds for larval and/or adult development of key pests.

(c) Subobjectives- Nematodes:

1. Monitor nematode population dynamics in the crop rotation and continuous corn studies.
2. Survey geographical areas in northeastern Colorado and south-central and west central Idaho to identify and establish nematode population dynamics.

(d) Subobjectives- Plant Pathogens:

1. Monitor the incidence and severity of diseases in the crop rotation and continuous corn studies.
2. To quantify the effects of specific weed management systems on the incidence of potential pathogens in the genera Fusarium, Rhizoctonia, Pythium, and Phytophthora in the designated cropping systems.

(e) Subobjectives- Economics:

1. Build simulation models which will predict the dynamics of weed populations and their impact on crop yields under the two cropping systems being studied. These models will integrate information from other components of the study into a single analytical framework.

2. Design and evaluate alternative weed managment strategies and identify those which, under specified price conditions, result in highest net return per acre.

IPMS-SR-80-1. IPM systems for horticultural crops. Weslaco, Texas. FY 1980-83. Coordinator: C. M. Heald, SEA/AR (nematodes); R. M. Menges, SEA/AR (weeds); W. W. Carter, SEA/AR (nematodes); C. E. Thomas, SEA/AR (plant diseases); J. R. Thomas, SEA/AR (soils); Del Var Petersen, SEA/AR (biometrics); L. N. Namken, SEA/AR (soils); E. Stein,SEA/AR (chemistry); J. Cook, Texas A&M Univ. (insects); TBD, Texas D&M Univ. (insects); TBD, Texas A&M Univ. (horticulture).

ABSTRACT: Pests (weeds, diseases, nematodes, and insects) are common to most vegetable growing areas of the world. Subtropical areas are especially plagued because of continuous growing season therefore providing a constant host supply for economically important pests. Production of cantaloup, onions, pepper and cabbage is a multi-billion dollar production scheme in Texas as it is in other vegetable producing areas of the nation. Average lossess due to pests are in excess of 25% ranging into the millions of dollars taken from the grower by the major pests. An Integrated Pests Management System could provide a stronger food supply, reduce energy consumption, reduce environmental pollution and increase farm income. The objective of this research is to obtain maximum economic returns to the producer without due environmental damage by developing a pest management system that makes judicious use of pesticides while optimizing

the effects of biological control, climatic variables, beneficial insects, resistant varieties, and cultural practices. Conservation of energy is an integral part of the system. A nutritous product free of pesticide residue, is the end product to be made available to the consumer as fresh or processed food. An Integrated Pest Management System is proposed to manage weeds, diseases, nematodes, and insects on cantaloup, cabbage, onions and peppers. Phases of the production system included will be field preparation, planting requirements, variety selections, crop rotations, pest management, cultivation, harvesting practices, and marketing and processing procedures. Product quality and nutritional levels will be evaluated to insure that the product marketed will give consumers the most for their money as well as the maximum dollar returns to the producer. The broad scope of the multi-discipline research team and the extensive research background projects a probability of 95% success in this IPM Systems Project.

OBJECTIVES: Develop a systems approach for control of insects, weeds, nematodes, and diseases to decrease cost of production and increase net return to growers.

1. Determine interaction amoung major pests (weeds, diseases, nematodes, and insects) on host crops.
2. Select pesticides for minimum useage.
3. Determine interactions between weather factors and initiation and spread of pests.
4. Determine the effect of field preparation on the viability of pests.
5. Determine interaction of fertilizer balance and level on pest development.
6. Determine the effect of production, harvesting, and pest management practices on postharvest quality.
7. Determine the impact on the Nation's agricultural economy.
8. Develop a program for disemminating IPM recommendations to growers.
9. Identify new pests affecting plant health.

PROPOSED SYSTEMS EXPERIMENT

Develop IPM system for the control of weeds, diseases, nematodes, and insects in a multi-cropping system with emphasis on vegetables and melons. An intensive cropping system will be used with cantaloup, cabbage, onion, and pepper grown in the cooler season and field crops in the hotter season.

The experimental design is a randomized complete block evaluating for control of weeds, insects, diseases, and nematodes along and is combinations for each crop. Each experiment will be replicated 4 times and mean pest evaluations and yields will be arrayed according to Duncan's multiple range test. Data will be transformed before analysis to log, square root, etc. Regression analyses will be conducted between pest evaluation and yield.

Proposed 4 Year Rotation Program

Year 1 Cantaloup (Jan-Jun) Peppers (Jul-Nov)
2 Cotton (Feb-Sep) Onion (Oct-)
3 Onion (-Mar) Beans (Apr-Jun) Cabbage (Jul-Dec)
4 Cantaloup (Jan-Jun) Peppers (Jul-Nov)

IPM-SR-80-2. Maximizing pest management in soybeans through manipulation of management techniques. FY 1980-82. Tifton, Georgia, Auburn, Alabama, and Stoneville, Mississippi. Coordinator: E. W. Hauser, SEA/AR (agronomy-weeds); G. A. Buchanan, Auburn University (weeds); J. W. Todd, Georgia Coastal Plains Experiment Station (insects); G. L. Sciumbato, Mississippi Agricultural and Forestry Experimental Station (plant diseases); H. R. Hurst, Miss. Ag. and For.

Exp. Sta. (weeds).

ABSTRACT: The objective is to develop more efficient production systems for soybeans by maximizing management of insects, diseases, and weeds primarily using biocontrol or nonchemical techniques. The plan will develop an integrated pest management system for insects, diseases, and weeds. Biocontrol will be emphasized for insects and diseases by utilizing natural control factors plus employing economic thresholds to determine insecticide and fungicide input; and for weeds by utilizing production techniques to maximize crop-weed competition thereby reducing herbicde imputs. Benefits for farmers include a 2% reduction in losses from weeds and up to 1% reduction of pesticides entering the environment from croplands exceeding 50 million acres. The duration will be 3-5 years.

Category: IPM Systems Research, Level 2

Objectives:

1. To develop more efficient production systems for soybeans by maximizing pest control through manipulation of management techniques.
2. To identify biolobical, cultural and chemical weed control systems which are compatible with management systems on soybean insects and disease plants.
3. To clarify principles of biocontrol for weeds in soybeans by the use of different row spacings and different period of weed-free maintenance.
4. To reduce the cost of production by decreasing pesticide inputs and the number of cultivations required to produce optimum yields.
5. To identify biological, cultural and chemical insect and disease control systems which are compatible with management systems for weed infestations in soybeans.
6. Determine the impact of insect and disease control practices on weed populations and the effect of weed control practices on insect and disease infestations.
7. To reduce risks to the environment through a reduction in the amount of pesticides needed to grow soybeans.

POTENTIAL ECONOMIC AND ENVIRONMENTAL BENEFITS:

Total losses due to weeds amount to 17% of the total production of soybeans. Based on a projected harvested acreage of 50,000 acres (28 bushels per acre at $5 per bushel) the gross returns from the crop exceed seven billion dollars. If the results from these proposed studies are fully implemented, the losses due to weeds should be reduced from 17% to either 12% or 15%. Assuming just a 2% reduction in total losses due to weeds, the potential value of this research to U. S. soybean farmers exceeds $14,000,000 annually.

Actual losses due to insects and diseases are difficult to assess because of variation from year to year and also due to inherent differences among geographical areas. Nationally, insects and diseases damage soybeans less that do weeds. In Georiga, however, reliable data show that for a typical year the average yield reduction from insects is a minimum of 12%. The states of Alabama, Louisiana, and Mississippi suffer similar losses. Approximately 15,000,000 acres of soybeans are grown in these four states. Results of the proposed studies should

reduce this loss by 1% (from 12 to 11%) for a potential gain of over $2,000,000 annually in these four states alone. Expected benefits for other areas would be dependent on the intensity of the insect and disease problems.

It is obvious that interactions occur between these pest species, and the management level selected by the grower must take these interactions into account. Economic thresholds of infestation for insect pests are advanced far enough so that they can be utilized by the grower in making decisions relative to control tactics. Progress has also been made in disease thresholds. We feel that the detrimental effects of infestation by insects plus weeds and diseases plus weeds will be at least additive in nature and thus the grower must consider the effects of both upon the condition of the crop. In all likelihood, as weed management systems are refined, the subsequent effects of insect damage or disease damage will become more identifiable to the grower; whereas, now the effects of insects or of diseases may be masked by the overriding effects of weed competition for moisture and nutrients. If we can demonstrate optimum levls of weed and insect control or weed and disease management for the maximization of economic return to the grower, then we will indeed not only have made a significant step toward keeping him in the farming business, but also will have increased his economic well-being.

Benefits for the general public include a potential reduction of pesticides entering the environment on croplands exceeding 50 million acres.

IPMS-SR-80-3. An IPM System for dogfly and other filth breeding flies. Gainesville, Florida. FY 1980-84. Coordinators: D. E. Weidhaas, SEA/AR (insects) and J. A. Mulrennan Health and Rehabilitative Services, State of Florida; R. S. Patterson, SEA/AR (insects); P. B. Morgan, SEA/AR (insects); D. G. Haile, SEA/AR (agricultural engineering); B. W. Clements, State of Florida (insects); J. Brown, State of Florida (control specialist); P. Kochler, University of Florida(extension-insects); Ray Lanier, Economics, Statistics, and Cooperative Service (economics).

ABSTRACT: Stable flies (Stomoxys calcitrans (Linn.)) are a serious pest of both man and animals. Both adult sexes bite and suck blood; requiring at least one blood meal each day. In North Florida they cost the tourist industry millions of dollars of loss by preventing use of extensive areas of beach. They also reduce weight gain and milk production in livestock and transmit livestock diseases. They are a nuisance pest to recreationists, including fishermen and boating enthusiasts. Currently the only known method of control is the application of insecticides to problem areas after the problem has reached intolerable levels. The objective is simply to evaluate whether the integration of 2 to 5 independent (including 3 recently developed) control methods applied at the proper locations and times (when the density is low and the fly not a problem) where the problem originates will provide a usable integrated pest management scheme. Since the management schemes include methods which will control other species of filth-breeding flies, we anticipate the management scheme could provide control for various species of house flies as well as stable flies.

We currently have available to us, through recent research at our laboratory, 3 new methods of control for these flies: (1) attractant toxicant devices (ATD);

(2) the release of pupal parasites; and (3) the release of sterile males. All methods have been demonstrated to bring about control. In addition, waste management and insecticides are available for special limited problem areas, if needed. The use of ATD's and parasites should be sufficient for population control. However, if necessary, other control components can be added. Such systems need to be evaluated, adapted to, and demonstrated in a large area with the practical problem as an integrated scheme of population management. Benefits, in terms of millions of dollars, will acrue to the tourist industry, recreation opportunities, and livestock production. Since stable flies are a problem in other parts of the U.S.A. and in developing countries, the results could be of world-wide significance.

Objectives:

1. To map all areas where stable flies are produced in a large portion of the problem area in Northwest Florida.
2. To develop seasonal abundance curves for stable flies in the area.
3. To use 2 or more control technologies at the source of the problem to provide population management to keep flies below economic threshold and nuisance levels.
4. To provide an integrated pest management scheme applicable to Northwest Florida and transferable to other locations and countries.

Workplan:

Our first and second years would involve mapping major stable fly breeding areas throughout the area and accumulation entomological survey data on the seasonal abundance of stable flies in relation to their sources of production and migration. Considerable background data are available, but the complete data for a large area have not been assimilated. At the same time, preliminary trials of ATD's and the release of parasites would be undertaken. Parasite rearing and ATD's would be planned and developed as surveys are completed, indicating the total needs for them in terms of the total population and breeding sites. Starting in the 2nd or 3rd year, control operations would begin in a core area and continually expanded into the total area. Years 4 and 5 would be used to evaluate the value of control through entomological survey data.

Location and Facilities:

The site would involve a large portion of Northwest Florida both to the east, west, and north of Panama City all the way and into the state of Georgia. Facilities are available at the West Florida Arthropod Research Center in Panama City, Florida, and at Gainesville.

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Special Research Program

MINOR USE PESTICIDES

This Special Research Program involves availability of pesticides for minor and special uses by the agricultural community and assures continuation of crop and livestock production technology for production, storage, distribution, and marketing of food, feed, seed, and fiber. These technologies will result in lowering the cost of fruits, vegetables, and other agricultural commodities and increase the efficiency of production of these crops to growers, small farmers, and homeowners. Entomologists, plant pathologists, weed scientists, chemists, and nematologists work in a team approach to develop the data required to register minor use pesticides.

NPS Contact: P. H. Schwartz

Technological Objective: Develop data for use in registration of pesticides for minor crops, minor uses on major crops, and speciality uses.

Research Locations:

Salinas, CA
Denver, CO
Byron, GA
Savannah, GA
Urbana, IL
Vincennes, IN
Beltsville, MD
Frederick, MD
Delaware, OH
Wooster, OH
Corvallis, OR
Charleston, SC
Weslaco, TX
Logan, UT
Prosser, WA
Yakima, WA
Kearneysville, WV

Examples of Recent Progress:

Significant progress made in developing data to support registrations of minor uses of pesticides - Nationwide. Scientists in Agricultural Research cooperated with state scientists on 101 food requests in IR-4 during 1979 and 499 ornamental requests. These projects were conducted at 17 locations in AR. Of these projects 60 food projects and 354 ornamental projects were completed in 1979. The IR-4 program currently has a backlog of about 600 food requests and they are receiving 200 new researchable projects a year.

About 973 ornamental requests have been assembled into data packages leaving 1634 priority 1 and 2 projects to be researched. About 3500 priority 3 and 4 ornamental projects will need research data eventually.

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See appropriate NRP Listings.

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SPECIAL RESEARCH PROGRAM

PILOT TESTING OF ALTERNATIVE METHODS FOR PESTS CONTROL

The purpose of this Special Research Program is to secure the development and commercial use of methods of pest management that tend not to produce adverse environmental impacts and which are essentially safe for people. For example, the new technology must be free of the problems which attended many of the broad spectrum insecticides such as hazard to man, biomangification, toxicity to nontarget species, etc. To a limited extent, this Program includes systems research which includes optimization of the use of environmentally hazardous pesticides.

Technological Objective:

To rapidly advance newly emerging technology toward implementation in order to (1) reduce net losses from pests, (2) to reduce the impacts of pest control technology on the environment either by improving current technology or by developing new technology, and (3) to reduce the hazard to man of pest control technology.

NPS Contact: Waldemar Klassen

Research Locations:

Note: Scientists at various locations submit pilot research proposals for alternative methods in order to compete for funding from the Administrator's Pilot Testing Fund of $1.67 million per year. Projects at the following locations currently are funded:

Stuttgart, Arizona
Davis, California
Shafter, California
Fort Collins, Colorado
Gainesville, Florida
Tifton, Georgia
Manhattan, Kansas
Beltsville, Maryland
Starkville, Mississippi
Stoneville, Mississippi
Columbia, Missouri
Oxford, North Carolina
Reno, Nevada
Los Cruces, New Mexico
Ithaca, New York
University Park, Pennsylvania
Florence, South Carolina
College Station, Texas
Lubbock, Texas
Weslaco, Texas
Prosser, Washington
Yakima, Washington
Madison, Wisconsin
St. Croix Island, Virgin Islands

WR-77-1 - Intergrated weed control, seeding technology, and grazing management of sagebrush grasslands- Reno, Nevada. Western rangelands are for the most part abused and today consist of unstable and low producing communities. It is of paramount importance to improve these rangelands and to graze them so they will be productive in terms of red meat and wildlife and will have soil-surface characteristics that will resist erosion.

Brush and weed control technologies coupled with seeding methodologies (including seedbed preparation, and planting of adapted species) have been developed for improvement of Intermountain rangelands. Evaluation of various grazing manage-

ment systems has been initiated but research on these comparisons is in its infancy on western rangelands.

The objective of this program is to evaluate and compare various range improvement technologies (brush and weed control and seeding) and to integrate these with grazing management systems. The combinations of improved and unimproved rangelands managed under different grazing systems will then be evaluated in terms of forage production, stability of plant communities, cattle production, wildlife habitat, and watershed characteristics.

The evaluation of range improvement/grazing management systems is being conducted on the Gund Ranch, a working cattle ranch owned by the University of Nevada. The property includes 2,818 acres of deeded land, 8,000 acres of transferred land from the Bureau of Land Management (BLM) and 60,000 acres in the surrounding BLM grazing allotment. At the Gund Ranch, there are two distinct series of rangeland communities. One is located on saline/alkaline areas which support Great Basin Wildrye and other salt tolerant grasses. These communites are found on the deeded land of cattle ranches in the intermountain area. These rangeland are typically degraded and dominated by the brush species, greasewood, rabbitbrush and sagebrush.

At the Gund Research and Demonstration Ranch twelve treatments for the rehabilitation of degraded sagebrush ranges have been completed or initiated. These 40 acre treatments include: (1) season long grazing under current grazing management; (2) rest-rotation grazing management without range improvement treatments; (3) spraying sagebrush with 3 lb/ac of a lve of 2,4-D and seeding 'Nordan' crested wheatgrass into the standing, dead brush; (d) rangeland plowing followed by seeding 'Nordan' crested wheatgrass; (5) rangeland plowing followed by seeding a mixture of 'Nordan' crested wheatgrass, alfalfa and fourwing saltbush; (6) spraying brush with 2,4-D followed by application of 1 lb/ac of atrazine for herbaceous weed control, to be followed by seeding crested wheatgrass in October 1980; (7) application of atrazine to be followed by brush control in 1980 with 2,4-D and seeding in October 1980; (8) complete exclusion of domestic livestock; (9) prescribed burning followed by season long grazing; (10) prescribed burning followed by rest-rotation grazing management; (11) prescribed burning followed by exclusion of grazing by domestic livestock; and (12) prescribed burning followed by seeding of 'Nordan' crested wheatgrass. The prescribed burn was postponed to allow more fuel to accumulate. Each treatment has been enclosed with an experimental high tension, high voltage electric fence.

A dramatic increase in the density of bit sagebrush was the dominant factor in successional changes on improved and native ranges. Many seedlings of big sagebrush were observed after the wet winter and spring of 1977-78. Many of these seedlings were well established by 1979. On a plowed and seeded area with a good productive stand of crested wheatgrass the number of sagebrush plant/acre was 690 in 1976 and 660 in 1979. On a chained and seeded area with a poor stand of crested wheatgrass the number of sagebrush plants/acre increased from 3,000 in 1976 to 50,000 in 1979. On a sprayed area with about 95% overall control of big sagebrush, the frequency of this species increased from 1% in 1976 to 77% in 1978. A frequency of 70% in 1979 indicates that most of the brush seedlings present in 1978 survived and were established by 1979. Results of these two studies show that benefits of brush control by either plowing or spraying poten-

tially can be lost unless a good stand of introduced or native grasses can be extablished before environmental conditions are favorable for the establishment of a competitive shrub stand.

Soil psychrometers were used to determine total water potential in relation to salt rabbitbrush and greasewood phenology and control with herbicides. Total moisture potential of saline soils was low in the spring due to a low osmotic potential even though matric potential was high. Time of available moisture and favorable temperatures for rapid growth of brush and maximum susceptibility to herbicides was much shorter in saline compared to nonsaline soils. Water potential below 20 cm remained in the available range through August where brush was controlled while moisture potentials decreased below the available range in June in an adjacent unsprayed area. Water potential in the upper 10 cm of soil associated with shrub mounds was generally much higher than that between the mounds where infiltration is limited by poor soil physical characteristics.

Contact: Ray Evans

WR-77-2 - A comprehensive study of rehabilitated range econsystems in the Southwest- Los Cruces, New Mexico. Mesquite and creosotebush have invaded and drastically reduced the productiveity on 139 million acres of arid rangeland in the Southwest. Even though local economies have been adversely affected by the reduction in livestock numbers resulting from this brush invasion, there has been little application of available technologies for brush control.

The objectives of this study of a large-scale application of chemical mesquite control and creosotebuch control by rootplowing and reseeding are (1) obtain accurate estimates of range improvement costs; (2) determine the production of livestock on improved range; (3) determine the environmental impact of range restoration measures; (4) determine the mobility of herbicides within natural systems and determine whether toxic primary or derivative compounds may concentrate at some point in ecosystem food chains; and (5) to provide quantitative data to permit the formulation of models which can test grazing and management strategies which will maximize livestock production while maintaining the stability of altered ecosystems.

Determination of plant production on sprayed and non-sprayed mesquite dunelands. Plant production was measured for the fourth consecutive season on a 3,634 ha study site that received the first of two applications of 2,4,5-T in 1975. Three harvests of above ground grass and forb biomass were made at three temporary exclosures on the sprayed area and three temporary exclosures on the 3,318 ha control area. Crop year precipitation (12 months preceeding end of season) averaged 326 mm on the sprayed and 371 mm on the control area. The control area received 33 mm more precipitation during the critical growing months of July, August, and September than did the sprayed area. This small rainfall differential was enough to cause a marked difference in the growth of perennial grasses.

Production on dunes areas differed from that on interdune areas. Using the end-of-season harvests as an estimate of production, the sprayed area had a total production of 985,665, and 576 kg/ha in 1976, 1977, and 1978, respectively. On the non-sprayed area total production was 343, 156, and 259 kg/ha in 1976, 1977, and 1978, respectively. Perennial grass production was 7-, 8-, and 3-fold greater on the sprayed area than on the control in 1976, 1977, 1978, respectively.

Mesa dropseed, whihc contributed 88 to 92% of total production on the sprayed area, suffered considerable mortality in 1977 and 1978 due to poor rainfall distribution. Evaluation of mesquite kill on a dune basis revealed that 18% of the dunes had complete stem kill, 35% of the dunes had 51 to 99% stem kill, 44% of the dunes had 1 to 50% stem kill, and 3% of the dunes were essentially unaffected except for temporary stem die-back. Analysis of soil and plant samples collected at intervals following spray application in 1977 showed that 2,4,5-T residuals in both dune and interdune soils had decreased to zero by the 28th day after spray application. Less than one part per million of 2,4,5-t residual was present in green grass and shrub matterial at the end of the season, 112 days following spray application.

Comparison of rodent, bird, insect, and oil microorganism populations on sprayed and non-sprayed mesquite dunelands. Collaborating scientists from New Mexico State University have reported preliminary results of their studies. During 1979, over 18,000 trap nights yielded over 700 small mammals representing 10 rodent species. Autopsies are underway and analysis of species richness, species diversity, and commumity structure is in progress.

Bird numbers were counted on both walking and vehicle census lines on the sprayed and non-sprayed areas throughout the season. Preliminary analyses suggests that fewer species and few individuals of birds were present in the sprayed area than in the non-sprayed area.

A pitfall trap study of tenebrionid beetles on sprayed and non-sprayed areas resulted in the capture of several thousand beetles of nine different species. There was little difference in tenebrionid beetle populations on the treatment areas. A survey did not show any significant differences in populations of root insects on broom snakeweed in sprayed and non-sprayed areas. Preliminary analysis of sweepnet samples made at three dates during 1979 indicate little differences in insect populations on the sprayed and non-sprayed areas.

Field measurements of soil CO2 evolution were made on dune and interdune areas of the sprayed and non-sprayed sites. Laboratory determinations of microbial dehydrogenase activity and microflora counts were made. Preliminary results do not indicate any qualitative or quantitative differences in microbial numbers or activity between sprayed and non-sprayed sites. Bacteria, actinomycetes, and fungi were present with bacteria being greatest in number. Average CO2 evolution was 1750 mg/m2/24 hr during the period, March to November.

Contact: C. Herbel

WR-78-1 - Aphid control in orchards and drainage ditches- A pilot study on area wide control- Yakima, Washington. In the Northwest, the green peach aphid is responsible for being the major vector of yellows viruses on sugarbeets and potato leafroll virus of potatoes. The primary objective of this project is to suppress, without the use of insecticides, the aphids in their spring habitat where large populations of viruliferous aphids are generated on weed hosts. The major effort is by permanent replacement of weed hosts of aphids with grass cover or by cultivation.

During the first two years of the pilot test, the phenology of the key weed species of the green peach aphid (GPA) were studies in the orchard and drainage

sites. Overwintering GPA were found to be potential vectors of yellows viruses of sugarbeets. In the drainage ditch area, several miles of ditch banks were sprayed with different herbicides to determine the best method to kill the weeds so that grass could be planted to replace the noxious weeds. On the floor of two peach orchards, large plots were established to compare plots with grass, clean cultivaton, and with weeds for the primary purpose of evaluating the advantages of grass cover. Because of this research two peach growers have accepted the grass cover as a cultural practice for peaches. Grass cover appears to be superior to the more popular practice of clean cultivation which encourages broadleaf weed establishment between cultivations.

WR-80-2- Impact of Managing Cover Crops, Weeds, and Pesticides on the Ecology and Regulation of Citrus Thrips. The citurs thrips, Scirtothrips citri (Moulton) is the most injurious insect of citriculture in Arizona and California. Characteristically, the thrips scars the friut sufficiently to reduce the grade, cause young growth to take on a thickened leathery and often distorted growth affecting tree vigor and reduce yields following severe thrip infestations. Traditionally, the recommended practice for controlling this thrips is spraying toxic chemicals to the foliage during prebloom, immediately following petal fall and early summer periods. These sprays though aimed at citrus thrips, generally kill natural enemies of the California red scale, Aonidiella aurantii (Maskell) and citrus red mite, Panonychus citri (McGregor), thus causing an upset in the pest complex of citrus orchards.

Objective and Approach

An alternative to controlling thrips on the foliage would be to manage populations in the soil as the thrips must drop to the soil before completing metamorphosis. This approach represents an attack on a weak link of the citrus development as there is no protection for the thrips in the soil. In addition, the approach would reduce the environmental pollution and costs.

Specific objectives are as follows: (1) Regulate citrus thrips population in the soil. (2) Survey composition of microarthropods in the soil. (3) Determine seasonal abundance of native predators. (4) Determine effect of relative humidity and temperature on the developmental rate and survival of thrips in metamorphosis. (5) Quantitatively evaluate the effect of covercrops, bare-ground and non-tillage on thrips and soil inhabiting microarthropods. (6) Determine the intratree spatial distribution and migration of citrus thrips nymphs. (7) Minimize pollution of orchard soils and vegetation by selective placement of toxicant and timing this treatment to take advantage of the weak links in the developmental stage of the thrips. (8) Define realistic and meaningful economic thresholds.

WR-81-1- Short Season Culture and Pest Management in Cotton- Shafter, California. The pink bollworm and other late season pest problems have been of considerable economic importance in Arizona and Southern California since 1965. In 1977 this pest caused an estimated 135 million dollar damage to the cotton crop in Arizona and the Imperial Valley of California in spite of mulitple applications of insecticides and recommended planting adn plow-down dates. Since 1977 the pink bollworm has assumed a threat to the 1.5 million acre cotton crop of the San

Joaquin Valley of California. This pest caused an estimated annual 500 million dollar loss across the Cotton Belt. Applications of insecticides for control of pink bollworms have reduced predator populations resulting in devastating populations of other pests including tobacco budworm, corn earworm, and cotton leaf-perforators. Insecticide application and mandated planting and plowdown dates for cotton have been ineffective in pest control or in themselves have reduced production too severely. The problem is Beltwide.

Objectives and Approach:

The objective of this research proposal is an alternative system for producing cotton that would produce a cotton crop with satisfactory fiber and seed yield and quality before economic population levels of pests are present in the environment. In addition to alleviating crop losses to pests, benefits should accrue from reduced insecticide applications into the bio-system and reduced energy imputs of water, fertilizer, and harvest costs.

The approach is a system of cotton production that increases the rates of interception and total utilization of solar energy by the crop and utilizes primary responses of the cotton plant to the environment in which it is grown. The basic approach is the redistribution of a plant population that results in an increased photosynthetic efficiency per unit area of up to 100% over conventional row plantings, and that permits the expression of a fruiting form at the first, genetically controlled fruiting site. The term "narrow-row" is generally applied to the proposed experimental system.

The narrow row system should have growth dynamics that achieve economic levels of cotton production before economic populations of pests are present. The system should also allow for harvest and total crop termination before the appearance of diapausing generations of pests and reduce pest-sustaining environments. The narrow row system offers the most viable approach to pest management without reducing yields.

Among the benefits that should accrue to a short production season with a narrow row system are: reduced applications of insecticides into the environment; better utilization of insect predators; maintained or improved inherent fiber and seed yield and quality characteristics; preservation of fiber and seed yield and quality by earlier harvest; reduced consumptive use of water and applied fertilizers; increased time for management of agricultural systems that include cotton production in the system; escape from or reduction of pathological pests that prevail in the conventional production system such as boll rot, Verticillium wilt and aflatoxin; preservation of soil structure; and reduced harvest machinery costs.

Contact: V. T. Walhood

WR-78-2- Use of resistant alfalfa in rotations to suppress root-knot nematode-Reno, Nevada. Root-knot nematodes cause extensive damage to many crops including sugarbeet, potato, tomato, carrot, bean, etc., often requiring costly control measures such as fumigation or fallowing. Recently developed alfalfa germplasm (Nevada Synthetic XX) has near immunity to Meloidogyne hapla, and preliminary studies show that one year rotation with Syn XX reduces M. hapla populations in

heavily infested field soil to nearly undetectable levels. The pilot test is a 4-year study to evaluate the use of root-knot nematode resistant alfalfa as a nematode control measure in rotations with nematode susceptible crops including potatoes, tomatoes, and sugarbeet.

Objectives:

1. Determine if alfalfa with high resistance to Northern root knot nematode can be used to reduce nematode populations to noneconomic or low infection levels on heavily infested soil in large field situations.
2. Determine the effectiveness of such control on yield and quality of the susceptible crop.
3. Determine the threshold infestation levels for crop damage and its influence on length of rotation. Alfalfa resistant and susceptible to northern root knot nematode has been seeded in nematode infested blocks of 1 acre or more. These plots will be rotated with susceptible host crops on a 1-,2-, and 3-year rotation. Studies are being conducted with cooperators in Washington, Oregon, Utah, California, and Nevada.

Progress:

Experiments utilizing Nevada Syn XX (resistant to M. hapla) and Washoe (susceptible) were established at Prosser, Washington; Longan, Utah; Reno, Nevada; and Fremont, Michigan; and will be rotated annually and biennially with such M. hapla-susceptible crops as potatoes, carrots, tomatoes, beans, and sugarbeets. Nevada Syn YY was established at Klamath Falls, Oregon, where M. incognita is the principle nematode species. Sampling studies, a part of W-134 regional research, were initiated; and first year data at Prosser and Logan show a decline in nematode populations where Syn XX was seeded. Nematode populations in checks were not sufficiently high to cause damage to the rotation crops. Bioassay samples at Teno and Klamath Falls failed to reveal any nematodes, although galls were observed on susceptible crops at both locations.

Rotation schemes with alternate crops will continue as planned with concurrent sampling to evaluate nematode populations, and crop yield and quality loss.

Contact: B. D. Thyr

NCR-80-1- Development of a new concept in Grain and Food Product Insect Control Utilizing combined physical, chemical, and biological agents-Madison, Wisconsin. Little effort has been put forth within the stored-product research sector to develop a combined system of physical, chemical, and biological control methods for a pest complex of an ecosystem such as stored grain.

Objectives and Approach:

Insect control in grain and other food products is especially important during the early stages of infestation. The objectives of this study are to develop an inexpensive yet highly effective method for detection and/or control of storage insects that combines physical, chemical, and biological controls. The approach concentrates on combining available knowledge of traps and other physical factors with chemicals such as insecticides, food attractants, pheromones,

hormones, and their analogs, and biological agents such as pathogens into an integrated system of control. Insects which are attracted and killed can be removed along with the trapping device. Although the approach emphazies control of low levels of infestation, the possiblility of controlling high infestation levels in order to avoid costly fumigation will be explored. In the latter case the use of many small and disposable paper devices containing an attractant and insecticide will be incorporated directly in the product, such as in grain, and then removed in a cleaning or handling procedure to remove the dead insects with the majority of the insecticide residues. The benefits include all advantages of grain protectants but with greater efficiency and possibly at a lower cost. In existing infestations it will be possible to treat in the many situations that fumigants are impossible or undesirable to use because of safety factors.

Progress: Pheromone studies with 3 species of grain weevil Sitophilus sp. have demonstrated the presence of pheromones that are effective in attracting both sexes. This research is currently being prepared for publication.

The population aggregating pheromone of the lesser grain borer has been synthesized in the natural enantiomeric configuration and evaluated for activity. Two papers, one on biology, and one on the chemistry of the pheromone, will be published this year.

There is evidence for the existence of a male-produced aggregation pheromone in Tribolium castaneum. The pheromone, which attracts both males and females, has been isolated and identifaction studies are in progress.

Vegetable oils (cottonseed, soybean, maize, and peanuts) were used to suppress the granary weevil, Sitophilus granarius, in wheat grain. Insect progeny production decreased significantly at five ml/kg dosage. At 10mk/kg level complete control was achieved which lasted at least 60 days. These oils also significantly repelled the granary weevil adults.

Field trapping studies on the effectiveness of Trogoderma pheromones for trapping khapra beetles andother species of Trogoderma were conducted. These studies were conducted in California as well as in the major port facilities of the U.S. The pheromone traps were highly successful in trapping Trogoderma (primarily T. variabile). Floor traps were generally more effective than aerial traps. More insects were usually caught near openings to the outside of the warehouses. In field trapping studies with the Rhyzopertha dominica population aggregating pheromone, floor traps were effective for a longer time than aerial traps. Field studies with the Trogoderma pheromone are continuing with emphasis on trap placement with in a cereal grain storage.

Contact: W. E. Burkholder

NCR-81-1- Develop Practical Mehtods for Applying Bacillus thuringiensis to stored grain and oilseeds for Moth Control- Manhattan, Kansas. Bacillus Thuringiensis will control Indian meal moths and almond moths in stored grains and oil seeds, it is stable enough on stored seeds to provide long term protection, and it is compatible with chemical insecticides and fumigants that are used for controlling

other pest species. Preliminary tests indicate that B.t. can be applied to the surface layer of grain and mixed in by hand after the bins are filled, or added to the last few bushels of grain as it is augered into the bin. This pilot study is undertaken to develop practical techniques for applying dust and wettable powder formulations of B.t. to stored grains, peanuts, and soybeans stored and managed under the prevailing farm and commercial methods. Uniformity of deposition and initial toxicity will be used to evaluate the application techniques. Subjective determination of effectiveness throughout the normal storage periods for the commodities will be used to evaluate overall performance, stability under differing climatic and storage conditions, and compatibility with other commodity management and pest control practices. The methods developed will be immediately applicable in much of the 9.95 billion bushels of farm and 6.6 billion bushels of commercial storage copacity in the U.S.

Objectives:

a. Determine the practicality of alternative methods of applying wettable powder and dust formulations of B. t. to the surface layer of bulk grains, peanuts, and soybeans stored in the prevailing kinds of storage facilities.
b. Determine uniformity of deposition and accuracy of dosage that are possible with each application method under actual use conditions.
c. Determine the effectiveness of B.t. on different commodities whem applied using each mehtod under actual use conditions and in conjunction with other pest control measures.

Contact: W. H. McGaughey

NCR-77-2- Reduction of frost damage by suppressing ice-nucleation-active bacteria-Madison, Wisconsin. Economic losses of crops due to frost damage are an important part of the production costs for many crops. Sweet corn, beans, tomato, potato, squash, and citurs are particularly vulnerable to damage from frost. We have learned that frost damage is associated with the presence of specific bacteria on the foliage of polants witch serve as nuclei for ice formation. Protection of crops to temperatures 3 to 6 degrees below freezing has been achieved by removing or rendering inactive this tacterial component. Use of bactericides, nucleation inhibitors, and competing bacteria have all been shown to produce measurable decreases in foliar injury in both growth chamber and limited field experiments.

Objective:

To evaluate the feasibility of decreasing frost damage to high value crops by altering the numbers of bacteria on plant surfaces that can act as ice-nucleation centers. We will determine if this type of protection against frost can be economic value to growers.

Progress:

Significant changes in populations of ice-nucleation-active bacteria within a single 24-hour period were observed. Populations of these bacteria increased substantially on frozen but not on non-frozen leaves for 2-3 days immediately after a frost. Methods for quantitative determineation of epiphytic bacterial populations and for estimation the variability of populations in crop canopies

were substantially improved. A new method for quantitating ice nuclei on leaves was developed and used for evaluation of effectiveness of bactericidal treatments for protection of crops from frost injury. The effective growing season for snapbeans was extended by about two weeks, a difference that could make the difference between a profitable crop adn a total loss.

Contact: R. D. Durbin

NER-77-3 - Development of dwarf apple orchards for enhanced pest management- Beltsville, Maryland. The lower portions of the canopies of large trees become overloaded with pesticides in the process of supplying the tops of the canopies with sufficient pesticides for protection. Small trees do not have this disadvantage; therefore, the amount of spray used in small orchards can be decreased considerably. The acceptance and economy of small trees must be tested and systems of pest management must be developed before their use can be recommended.

Objectives:

Develop a pest management system and assess grower acceptance of a new orchard system for production of apples; determine optimal use of pesticides; and develop production and economic data of this new compact orchard concept in various apple growing areas of the eastern U.S.

Progress:

Four tests orchards have been planted. Orchard locations are as follows: Beltsville, MD; Biglerville, PA; Geneva, NY; and Belchertown, MA. The Beltsville orchard was large enough to start spray studies during the spring of 1979. Three treatments have been used - 75%, 50%, and 25% of the dose recommended per acre for protection of large trees. It appeared that even 25% of the normal dose provided sufficient protection against various pests. Detailed evaluation will be made after harvest. Economic data on planting costs have been collected at all locations. Planting are made in such a way that conclusions will be drown concerning the effect of climate on rootstock-scion combinations.

Contact: M. Faust

NER-77-4 - Feasibility of using N substituted alkyl amides and amines to manage plant parasitic nematodes- Beltsville, Maryland. Commercial nematicides are relatively few in number, and because of relative inefficiency, must be used in hihghdosages to reduce nematode damages in crops (estim. at $4.0 billion yearly in U.S.). Many of them adversely affect environmental quality, and several may be lost for general use by deregistration actions. There are urgent needs for new, safer, more energy-efficient nematicides, and for new technologies that have potential for making all nematicide use safer and more effective at reduced total dosages, by controlling emmission rates and improving stability in target areas in the soil. New amide and amine discoveries promise safer and relative target-specific activity (little or no toxicity to man and other vertebrates). At present, these new compounds are unstable in soil and require adaptive research to fit them for soil use.

Objectives:

Discover and develop new and improved principles and practices of nematode control by determining best use of these compounds to reduce nematode damage to

crops; use of soil drenches, soil mixes, foliar sprays; development and use of new technologies to provide formulations with controlled emission rates and improved stability in soil; and, fitting these new nematicides and formulations technologies for practical field use.

Progress:

Development of formulations capable of stabilizing these compounds (amines and amides) is first priority because they are easily bound or degraded in soil when used in technical or in standard formulations. One of the most active juvenile hormone compounds, N,N-dimethyl dodecanamine (NNDD) was formulated in cellulose acetate, and poly(caprolactone) and made available as flakes. Flakes were shown by bioassay, aeration as related to weight loss, and recycling tests (multi-use), to have NNDD release rates that were slower than those observed from technical solutions and standard solvent formulations. Cellulose acetate formulations were most efficient but all were within narrow ranges (10-20 mesh) in two dimensions but were of uneven thickness, leading to inconsistencies in ratios between surface area and volume. Additional formulation technology is required to develop formulations in ± spherical or equidimensional particles such as granules to provide consistent surface: volume rations. Several starch xanthate-juvenile hormone formulations were ineffective because of inactivation of active ingredient during formulation process. Elastomer-based formulations also inactivated the active ingredient.

Contact: Julius Feldmesser

NER-78-1 - The feasibility of managing golden nematode population densities by integrating control tactics- Ithaca, New York. Discovery of the golden nematode on Long Island, NY, in the 1940's was recognized by state and federal agencies as portending a major threat to the potato industry, and a quarantine was immediately invoked to reduce spread and contain the nematode on Long Island. After over thirty years of a regulatory program estimated now to cost $2 million annually, infestation still occurs on Long Island and the nematode has spread to Western New York where infestations have been discovered in at least 3 counties. The quarantine failed to prevent spread of the golden nematode because of regulatory action is not taken until nematode densities reach discovery levels. Research has shown that the nematode reaches a density at which spread occurs long before it can be detected. Thus, the present approach of survey and soil fumigation has little or no chance of preventing further spread. Management systems are urgently needed that will keep nematode densities below levels where spread occurs. Such management systems involving resistant cultivars, non-host crops, and non-volatile nematicides have proven effective in small plot research. They need to be tested on a field scale basis under grower conditions, and if effective they will provide for more efficient utilization of land, reduce pesticide usage, reduce the cost of the golden nematode regulatory program, and prevent further spread of the nematode.

Objective:

To determine the effects of selected nematode management systems (combinations of nematode control tactics) on populations dynamics of the golden nematode and on potato yield.

Progress:

Studies are continuing on alternative management systems suited for both table-stock and seed potato growers that will keep golden nematode densities below spread level. Thus far golden nematode levels have not developed to detectable levels, and none of the management systems has adversely affected yield. The theory is that use of proper management systems will prevent additional spread of the nematode. Some additional grower trials are planned based on the trial management schemes.

Contact: B. B. Brodie

NER-78-2 - Suppression of weeds by enhancing the competitiveness of forages in minimum-tillage systems- Ithaca, New York. This pilot test emphasizes alternative methods for weed control and management during the establishment of forage crops for hay and pasture by minimum and no-till means. Much of the farmland in the 12 Northeastern states which is used for producing perennial forage crops is difficult to plow because of slopes, stoniness, or drainage. Erosion is also a significant hazard. Research has demonstrated that minimum-tillage systems can be used to establish perennial forage species. Recent developments of effective herbicides and minimum-tillage drills have greatly increased this potential. The pilot test has two primary objectives: (1) to test systems for establishing and managing productive forage mixtures which strongly resist encroachment by weeds in no-tillage farming; and (2) to develop probabilities for successful weed control, forage and pasture establishment and longevity of production in no-tillage "package for site" systems, and to provide the basis for economic assessment.

During 1978 and 1979, the direct planting of alfalfa, birdsfoot trefoil, and red clover into annual grain stubbles, silage corn stubble, and rye winter cover, were outstaning successes. Where comparisons were made with conventional systems involving planting disking-harrowing-packing prior to planting, the direct-planted legumes plant numbers and yields were equal or superior to the conventionally planted. Part of the reason for better establishment was reduced annual weed populations in the direct-planting system. Weed seeds were not brought to the surface by direct-planting in contrast to the conventional. Most other weeds were handled readily by the herbicides available. The exception was annual grasses on some sites. Annual grass weeds can pose a problem since there are no labeled herbicides for controlling them following planting. In some cases, annual grass control can be achieved by delaying planting until emergence of weed seedlings, spraying with paraquat or glyphosate, and planting afterwards. Control of annual grasses by clipping has proven variable since success by this method will depend on the timing and height of clipping and the species to be controlled.

Successful no-tillage sod establishment of birdsfoot trefoil and red clover is correlated with the degree of vegetation control. Legume number and berbage yield increases as weed control increases. In the pilot tests, several herbicides killed or suppressed the grass-weed swards sufficiently to allow birdsfoot trefoil or red clover to establish with a high fequency. Where the sods

were pre-grazed prior to herbicide application, legume establishments and yields were generally enhanced. Direct,sod plantings of red-clover or birdsfoot trefoil are highly feasible based on current test results. Such is not the case with alfalfa at the present time. Failures were experienced in a significant number of alfalfa plantings in sod, apparently the result of allelopaths, pathogens, insects or the combination. Solutions to the problems are being researched. It is evident direct planting of alfalfa in sod, in contrast to planting in grain stubble, will require some different techniques.

A package has been put together for site programs involving integrated combinations of herbicides, fertilizers and planting equipment to establish birdsfoot trefoil and clovers in pastures and sods with very high success probabilities. Because of technology developed, the percentage of establishment successes in sod have nearly doubled in the last five years. The farmers now have economically feasible options for no-tillage planting of these legumes and will benefit considerable from reduced energy requirements.

NER-78-3 - Avoidance of White Rot in onions- Beltsville, Maryland. White rot of Allium species is a severe problem on onions, bunching onions, garlic, leeks, etc., that are grown under cool climatic conditions. At present, there are no resistant varieties nor adequate chemical control measures. White rot is a severe problem in California, New Jersey, Oregon, and Washington.

Objective:

This project is to develop a workable system to detect fields with the potential for severe losses due to this disease. This is begin attempted by sampling soil from fields in New Jersey at the time of planting. The soil is assayed immediately for the inoculum density of Sclerotium cepivorum, the white rot pathogen. At harvest, the white rot severity is determined in each of these fields and correlated with the inoculum density of the pathogen at the time of planting.

Progress:

Forecasting the severity of white rot of onions is now a reality. Two years of research data in New Jersey production fields showed that white rot severity on onions is correlated with the soil populations of the pathogen that causes the rot, at the time of planting. These findings show that a disease forecasting system can be set up to predict losses before planting. When such a forecasting system is put into effect, may fields normally planted to onions, leeks, garlic, and bunching onions could be avoided to present losses or, if needed for planting, could be treated by chemical means.

Contact: P. B. Adams

NER-78-4 - Suppression of face flies with traps - Beltsville, Maryland. The face fly is found primarily on the faces of cattle and horses where it feeds on secretions of the eyes and nostrils. Besides annoying animals, therby interferring with normal grazing activities, the face fly is a mechanical vector of Moraxell bovis, the organism responsible for bovine pinkeye and a true vector for several species of eye worms. Although the face fly has been in the United States

since 1953, there is, at the present time , no satisfactory control measures for it. This is true even though this species is quite susceptible to many approved insecticides. Reasons for this include the difficulty of applying insecticides to the faces of animals and the migratory habits of the fly. Two habits of the face fly, however, offer control possibilities. One, they oviposit in fresh cow manure where the larvae develop and two, adult face flies are attracted to white painted plywood traps.

Objectives:

1. Determine whether the traps provide control of the flies in pastures where no insecticide is used.
2. Determine whether the traps can eliminate adult face flies which immigrate into pastures containing cattle under insecticide treatment or which survive exposure to the insecticide.
3. Demonstrate the efficacy of a feed-through insecticide when used on all farms in a wide area.

In 1978 sticky survey traps were used to monitor the face fly populations in four areas of Howard Co., MD. In 1979, the following treatments were imposed: In one of the areas all cattle were fed Rabon Oral Larvicide either in their concentrate mixture or in a molasses-mineral block. In a second area, 4-12 white-painted, pyramid-shaped traps were placed at each farm in pastures containing cattle. The traps were covered with a sheet of plastic and painted with a sticky substance (Tack-Trap) to physically capture the flies. In a third area, a combination of these treatments were used. A fourth area served as a check. Efficacy of treatments were evaluated by survey pyramid traps and by counts of flies on the faces of cattle. These counts were adjusted by covdriance analysis to early season counts before treatments were fully implemented. Mean trap and face counts were: 68.4, 5.6; 61.2, 7.4; 84.4, 8.3; and 93.6, 7.8 for the Rabon, trapped, combination, and check areas respectively. Trap counts were different ($P < .05$) for the Rabon and trapped areas compared to the check one; however, with face counts only the Rabon area was lower ($P < .05$) than the check.

It is noted there was no significant control of face flies in the combination area. This was probably due, in part, to lack of isolation in this area. Because of this, in 1980 the combination area and a portion of the control area were switched and additional farms were added to the new combination area. Also, the total number of traps in the trapped areas have been approximately doubled. A majority of the traps were in place by the middle of March before face flies started to appear. Rabon blocks were in place by the second week in April.

Counts on survey traps and cows' faces are being taken, but as of this date data has not been summarized sufficiently to tell the degree of control being obtained.

Contact: R. W. Miller

NCR-81-1 - Evaluation of integrated pest management systems for winter wheat production in actual farm situations in the Northeastern Region- University Park, Pennsylvania. The farmers in the Northeastern Region are in a favorable location to play an increasing fole in helping to meet the growing world demand

for wheat. The Region has favorable soil and climatic conditions and is near seaports so as to allow energy efficient export. Wheat for export could provide an alternative cash grain crop for the relatively small farm units typical of the region. The average wheat yield in the Region, however, is only about 36 bu/A and has increased only slightly during the past 30 years. Based on yields from small plot, variety testing trials in the Region, this average yield is only about 40% of the genetic potential of current varieties. There has been no significant crop or pest management research with wheat in the Region during modern times and wheat is not systematically or intensively managed by farmers.

Objectives and Approach

The objective is to evaluate various integrated pest management systems for wheat in actual farm situations, and to demonstrate the potential economic value of near optimum pest and crop management systems. A three-year pilot testing program is proposed to accomplish the research and demonstration. The primary re- Pennsylvania, but the results should have important implications for the entire eastern soft wheat region. Farmer cooperators will be enlisted through county extension agents. Weeds, disease, insect, and lodging problems will be assessed relative to yield following various crops and using various row widths, seeding rates, and fertilizer practices. Emphasis will be placed on timely planting, careful land preparation, and precision planting. Test strips will be grown in the farm fields and surrounded by wheat planted by the farmer with his drill. The test strips will be sown with a suctom drill that facilitates precise control epidemiology will be monitored under the various management systems and following various crops. Tiller number, seeds per head, and other yield components will be determined for the various systems. Total plot straw and grain yields will be precisely determined following harvesting by combine. The county agent will use the test site for farmer demonstration. Yield results and cost return analyses will be used to establish recommendations for farmers, and the Cooperative Extention Service will cooperate in implementing improved practices on the farm.

The major benefit will be increased wheat production near the export market place and associated economic return to the farmer. With the adoption of improved cultural practices and pest management systems, wheat should become competitive with corn as a cash crop. This should slow down or, hopefully, reverse a dangerous trend toward dependence on corn as the grain crop in the Region. Compared to corn, wheat requires less energy for production, little or no herbicide treatment, and protects the soil from erosion.

Contact: H. G. Marshall

NCR-77-3 - Development of a mixture and rate controlled sprayer- Columbia, Missouri. The safe and efficient use of pesticides requires that they be applied in a precise manner. Research is progressing on the development of a special sprayer that automatically controls the pesticide rate while mixing the pesticide with the diluent. This research was divided into three main thrusts. The first thrust was the design and development of metering, mixing, and handling components. The second part of the research was involved with the construction of metering devices. The third portion of this study involves the evaluation testing of the complete sprayer system.

Progress:

All major components of the prototype sprayer have been constructed. The sprayer is designed for mounting on the rear of a tractor using the three-point hitch assembly. The diluent (water) container is a polyethylene tank that is connected to a power-take-off driven centrifugal pump using conventional sprayer plumbing components. Modifications of the sprayer system include the addition of a small mixing chamber at the nozzle. The concentrated pesticide is injected into the spray steam in this mixing chamber at the nozzle. The concentrated pesticide sprayer uses the fast-latch assemblies to secure the pesticide concentrate container to the sprayer. A special probe assembly for removing concentrated pesticide from the container was designed and tested which can be inserted quickly and safely into the pesticide container without contamination of the sprayer and contact with the operator. A small electric-driven pump assembly is used to move the pesticide from the container through a by-pass regulator to an automatic, direct-current, servo operated sprayer system. Injection pressure is controlled by the forward velocity of the sprayer vehicle. Laboratory tests show that the system is stable, that a single injection point is necessary, and that boom pressure of the diluent can be maintained at 20 lbs/in2 provided special low pressure type nozzles are used on the boom.

Contact: M. R. Gebhardt.

SR-77-4 - Citrus Mealybug pest management program for citrus in the Rio Grande Valley of Texas- Weslaco, Texas. The citrus mealybug has caused signficant economic losses in the quality and quantity of citrus produced in the subtropical area of Texas. Over 5000 acres are known to be infested. Pesticides have proven ineffective in controlling established populations.

Objective:

A pest management pilot study was developed utilizing the natural enemies of the mealybug and the use of selective pesticides for the control of other citrus pests.

Progress:

The toxic residual activity of 5 pesticides were tested aginst 6 species of beneficial insects known to attack the citrus mealybug. Carbaryl and phosmet were the most toxic while oil combined with chlorobenzilate was the lease toxic to natural enemies. Only supracide and oil combined with chlorobenzilate provided good control of 1st instar mealybugs. None of the pesticides tested resulted in control of 2nd instars or older mealybug stages. A total of 4 newly introduced parasites: Leptomastix dactylopii, Anagyrus pseudococci, Leptomastidea abnormis and Chrysoplatycerus splendus; plus a coccinelled predator, Scymnus sp., from South Australia were mass produced and released in South Texas totaling 525,000 individuals. Traces of Leptomastidea abnormis were recovered indicating colonization of a new species. Pauridia peregrina continues to be the dominant parasite. Augmentive releases of beneficial insects are presently being evaluated. The natural enemy complex of the citrus mealybug appears to be capable of controlling the mealybug within an integrated pest management program utilizing a combination of oil and an acaracide. The identity of 3 kairomones is still under investigation. Ants have been successfully controlled in citrus with dia-

zinon 14 Granular at a rate of 0.6 lb/tree. The impact of ant interference with natural enemies is presently being evaluated.

As a result of this pilot test the citrus mealybug currently is not a problem in the Rio Grande Valley.

Contact: W. G. Hart and D. E. Meyerdirk

SR-78-1 - Management of tobacco budworm with hybrid sterility- Stoneville, Mississippi. The tobacco budworm, Heliothis virescens, is considered to be a $100 million pest of cotton and causes extensive losses in other crops including soybeans. Resistance to pesticides has intensified the control problem and has increased cost. Populations suppression with release of irradiated sterile insects has been disappointing.

A hybrid produced by crossing the tobacco budworm with a related species, H. sublfexa, which feeds on ground cherry, Physalis spp. produces fertile females and sterile males. Progeny from backcrossing the hybrid female with wild males likewise produced fertile females and sterile males.

Results of laboratory and limited field tests indicate that the behaviour of BC insects and the native population is well synchronized and that BC females are equally competitive with native females for native males. Theoretical calculations indicate that when releases of 30:1 (BC:native) are made, the native population will regress to 1 in 5 generations.

A 4-year pilot test program was initiated in fy 1978 on St. Groix, Virgin Islands, with the following objectives: (1) Year 1 - Determine host plants and populations dynamics (seasonal history and numbers) of the tobacco budworm on the island, refine rearing procedures and develop methods of harvesting, packaging and shipping pupae, and releasing adults. (2) Year 2 - Make limited releases to determine whether the sterile character infuses into the native population and extent of dispersal. (3) Year 3 - Continue to evaluate infusion and dispersal of the sterile character in the native population; establish methods of determining the ratio of native to BC insects. (4) Year 4 - Full release program over entire island to evaluate the BC as a suppression technique.

Progress:

During the periods January 19-February 16 and April 13-17, 1979, adults from about 7,000 and 15,000 pupae/day, respectively, were released on St. Croix V. I., to evaluate infusion and spread of the sterility factor in the natural population. Males from the first release were recaptured in traps located 5 miles west to 7.5 miles east to 4 miles north of the release point. Overall, 86% were captured within 2 miles of the release point with 4, 3, 1.4, 2.2, 0.4, and 3.1% captured 2, 3, 4, 5, 6, or more miles, respectively, from the release point. About one month following the first release, ca. 10% of the native males collected in traps were BC males. At some locations, one-third of the males were BC males. The frequency stabilized at ca. 3% ca., 4 generations after the release. This persisted through the low population period of July and August. In September and October ca. 10-11% of the males trapped and mated with virgin females in the laboratory were BC males. Released insects interacted well with native insects, and mating pairs collected at host sites indicated random mating between released and native insects.

From November 1-December 12, 1979, adults from a total of about 10,000 pupae/day were emerged at 10 release sites selected in western St. Croix. The released insects interacted well with the relased insects and infusion of sterility into the native population was greater following this release than earlier releases. Released insects were collected in traps located throughout the island indicating good dispersal of released insects. Collection data on infusion, spread and persistence of the sterility factor in the natural population from this release continues.

Spring captures of BC males in April and May 1979 near the site of release the previous year at Stoneville, Mississippi, indicated successful infusion of the sterility factor into the native population and that BC insects diapaused and survived the winter. BC males (average 3.6%) were captured 2 to 4 mile from the release site the next spring.

Sterile Heliothis BC insects used in all the experimnets were produced at Stoneville, Mississippi, packaged and shipped via postal service to St. Croix. Regular weekly shipments of 10,000/day were made during the 1979 field releases on St. Croix. Quality of the insects has been good. Insects for research at Stoneville are also produced in facility.

Contacts: D. E. Martin (Stoneville, MS) and F. I. Proshold (St. Croix, V.I.)

SR-78-2 - Protection of sweet corn with semiochemicals- Gainesville, Florida. Recent research has shown that if an appropriate quanitity of synthetic pheromone mimic is evaporated into the atmosphere over a crop such as cotton, male moths are unable to respond to calling females. Thus, mating is disrupted, resulting in a concomitant reduction in the larval population. A 4-year pilot test was initiated in 1978 to asses the feasibility of using the air permeation technique to control mating of the corn earworm (CEW) and fall armyworm (FAW) in sweet corn. Mating disruptants are being used in combination with conventional insecticides in an attempt to reduce the number of insecticide sprays (18-24/season) currently required for control of these pests by 40-50%. The effects of mating control of the CEW and FAW will be evaluated on the basis of larval damage in immature corn and the quantity and quality of corn ears produced relative to corn treated solely with insecticides.

Two aerial application methods and several pheromone mimic ((Z)-9-tetradecen-1-ol formate) formulaions were tested for efficacy in disrupting sex pheromone communication of Heliothis zea in sweet corn. A plastic-laminate formulation (Hercon) was very effective for pheromone and Z9TDF, but the application equiptment was unreliable. The hollow fiber formulation (Conrel) was effective only with Z9TDF, and the application equipment was very reliable. The fiber formulation and application system proved siutable for major field tests required to establish the feasibility of mating disruption for control for Heliothis in sweet corn.

Replicated field plot tests (0.4-0.8 ha. plots in sweet corn) with aerially applied Hercon flake and hollow fiber (Conrel) formulations of Z9TDF (H. zea mating disruptant) and Z-9-dodecen-1-ol acetate (fall army-worm disruptant) established that 148-222g/ha. of fiber or 1483-1977 g/ha. of flake (ca. 7-10 g/AL) are re-

quired to achieve complete mating disruption for 9 to 14 days. Efficacy was directly related to moth density.

(Z)-9-Tetradecen-1-ol formate was evaporated in sweet corn in August-September from dispensers prepared by Bend Research, Inc., Bend, OR, to determine the effectiveness of the forumlation ofr disrupting pheromone communication in H. zea. Dispensers were releasing Z9TDF at ca. 5.16 ug/h when placed in the field on August 17; by August 29, the release rate had dropped to 1.74 ug/h. The Bend dispensers were highly effective (98%) in disrupting the response of male H. zea to female-baited traps for at least 38 days.

Gelatin-based microcapsules containing (Z)-9-dodecen-1-ol acetate, (Z) -9-tetradecen-1-ol acetate, or Z9TDF (Z9DDA and Z9TDA for Spodoptera frugiperda and Z9TDF for H. zea) supplied by Food Industries Ltd., were field tested in 3 different plots of sweet corn. The formulated materials (ca. 6.0 g AI/plot were applied with a Hudson ULV back-sprayer to the foliage of the corn plants on August 14. The Z9DDA and Z9TDA formulations were totally ineffective. The Z9TDF formulation was effective in disrupting pheromone communication of H. zea males to female-baited traps for only 3 days.

The release rates of Z9TDF from 4 sizes of polyethylene tubing were measured periodically for 50 days by collecting the Z9TDF vapors on a polymeric adsorbent. The resulting release rate curves had shapes that were determined by the tubing's diameter and wall thickness. One tubing size that combined good longevity with adequately high release rates was tested in the field to determine whether it could disrupt sex pheromone communication in H. zea. When a larger quantity of Z9TDF was released, 87% disruption was obtained for 66 days.

The 4 compounds of the H. zea sex pheromone were tested alone and in combinations as disruptants. The most effective chemical when used alone was the major compound, (Z)-9tetradecen-1-ol formate was as effective as the major component when dispersed from aerially applied Hercon flakes.

Contacts: E. R. Mitchell and A. N. Sparks

SR-78-3 - Protection of tobacco by augmentation and conservation of natural enemies of tobacco budworm, tobacco hornworm, and aphids- Oxford, North Carolina. Up to 8 application of insecticides are made on tobacco each year primarily to control budworms and hornworms. Most of the materials are not only highly toxic to beneficial arthropods but also to other non-target organisms including man, and the frequency of application represents a considerable use of energy.

Objectives:

The objectives are to develop ecologically acceptable methods of tobacco insect control that will (1) minimize losses to insects; (2) minimize the use of toxic and persistent chemicals; (3) increase the use of specific insecticides harmless to non-target organisms; and (4) assess the feasibility of mass rearing and release of natural enemies.

Progress:

Approximately 240,000 stilt bugs were released in 40 fields totaling 152 acres

for an average of 1600 per acre. Progeny from stilt bugs over wintered successfully. However, as in 1978, stilt bugs did not build up early enough to reduce early-season budworm thresholds. Hornworm thresholds were too low for valid comparisons; however, total larvae were 2.2 times more numerous where stilt bugs were not active. Tomato hornworms continued to increase in importance, totaling 20.6% of the hornworms observed. Corn earworms also increased totaling 23.5% of the Heliothis observed (based on pupal indentification).

Total budworm thresholds declined from 1.3/field in 1978 to 0.7/field in 1979. Hornworm thresholds dropped from 0.5/field to only 0.07/field.

Percent parasitism of budworms increased in pest management fields in 1979 to an average 53.5% with only 10.1% pupating compared with 20.8% in 1978. However, parasitism in fields where insecticides were used averaged only 14.7%. Parasitism of hornworms also increased in pest management fields to 58.1% with only 18.4% pupating compared to 33.8% in 1978.

The green peach aphid continued to be a problem with over 0.6 thresholds/field in 2 groups of fields. Pirimicarb (Pirimor), a specific aphicide, gave excellent control with minimal damage to beneficial insects.

The stilt bugs became established and survived in areas in which broad spectrum insecticides were not used. Hopefully, budworm parasites will continue to increase in these areas, particularly Campoletis sonorensis, along with other parasites and predators to supplement stilt bug activity. Even at the present rates of parasitism and predation, however, the current budworm threshold of 10% of the plants infested could be increased to 30% or more which would essentially eliminate treatments during most years.

Contact: A. H. Baumhover

SR-78-5 - Evaluation of early maturing, nectariless, frego bract, and other resistant cottons in various combinations on cotton production in the mid-south- Mississippi State, Mississippi, and Stoneville, Mississippi. The nectariless trait suppresses early season insects. Early maturing cotton strains require appoximately 14 days less to produce yield equal to presently grown varieties, thus escaping late season Heliothis buildup. Frego-bract gives excellent boll weevil resistance and when coupled with fall diapause control, can give almost season long control of weevils.

The objective is to determine if a better method of producing cotton is feasible in the rain-grown cotton belt. The test involves integrated pest management with varieties resistant to insects as a base component. The test is being conducted in two different ecological areas in Mississippi: (1) An area where boll weevil is not normally considered in insect control, and (2) An area where boll weevil must normally be considered in formulation insect control plans. These two areas will be typical of much of the cotton producing areas in the mid-south and perhaps over the Southeast.

Progress:

nine nectaried and 9 nectariless paired strains (DES-24, Stoneville glandless,

Stoneville High gossypol, Stoneville okra leaf, DPL-61, Coker 420 smooth, Stoneville 213, Stoneville 817 frego) were grown at 6 locations in Mississippi. Two types of insect control programs were used: a) no early season control (NESC), and b) early season control (ESC). The ESC was 2 lb ai aldicarb/acre. The objective was to cause a Heliothis buildup and thus test the 18 lines at 2 levels of Heliothis with stand insecticides on the high Heliothis level and biological methods on the low Heliothis level. Heliothis were minimal until August at most locations. Thus, the aldicarb was actually early season lygus control at all locations and some early season boll weevil control. At one location only lygus was present as a pest insect until late August. At another location boll weevil was an early persistent pest. Azinphosmethyl was applied for boll weevils when needed and Pydrin or Dipel plus Coax was used in some plots.

Three of the tests were conducted near Mississippi State University and in Panola County. In Panola County ESC significantly reduced lygus and increased yields and earlines. At MSU ESC reduced boll weevils significantly and increased total yields. In Panola County where lygus were a pest, nectariless increased yield and earlines in the absence of ESC but not with ESC. Nectariless had no effect on yield at MSU. Signficantly, more Chrysopa were in nectariless plots at MSU. Geocoris were lower, but not significantly lower in nectariless plots. A few worms were encountered at MSU. Both Coker smooth strains and both Stoneville okra leaf strains received signficantly fewer eggs than all other strains. This tended to be translated into slight reductions in larvae and damaged squares in these lines.

Yields ranged from 552 lb (glandless-nectariless) to 757 lb (Stoneville okra leaf-nectariless) lint per acre at MSU. Yields ranged from 620 lb (frego-nectariless to 950 lb (DES-24N) at the Sullivant location in Panola County. Yields ranged from 342 lb (frego-nectariless) to 635 lb (Stoneville okra leaf-nectariless) at the Austin location in Panola County. Frego bracht yielded 708 lb at MSU which was near the top, but was the lowest yielding at the 2 Panola County locations where lygus were a pest. Nectariless did not alleviate the lygus sensitivity in these lines.

The other 3 tests were conducted in the Mississippi Delta. In these tests, nectariless cottons continue to have less yield losses due to early season insects than nectaried cottons. In a 2-year study at 3 locations/year, the average lint yield of nectariless and nectaried cottons was 958 and 955 kg/ha, respectively, when early season insecticide applications were made. When no early season insecticides were applied, the average yield was 838 and 721, respectively, for nectariless and nectaried cottons. Development of nectariless, smooth leaf (sm3) early maturing, high fiber quality, and high yield cottons is continuing.

Eight of the most promising lines, tested for the past 2 years, have been selected. These are: nectariless and nectaried versions of DPL; Stoneville 213; Coker smooth; and DES-56. In the third and last year of this pilot test (1980), replications will be increased and experimentation will be restricted to these 8 lines.

Contacts: J. N. Jenkins (Mississippi State, MS) and W. W. Meredith (Stoneville, Mississippi)

SR-78-7 - Crop rotations for managing nematodes, diseases, and weeds in multiple cropping and minimum tillage systems- Tifton, Georgia. Growers are showing increased interest in growing sequences of agronomic-horticultural crops on the same land unit to more fully utilize their land, equipment, and labor and increasing their net profits under irrigation. Intensive sequential cropping could exceed 1,000,000 acres in the Southeastern Coastal Plain Area in the next 10 years. Information is urgently needed on how intensive cropping and reduced tillage or modified seedbed systems will affect the management of plant pests. Of specific interest is the probability that multiple cropping and certain tillage practices will gradually increase the intensity of chemical input needed for control of nematodes, weeds, diseases, and insects.

Objectives:

(1) To utilize intensive cropping rotations with new and improved integrated pest management systems for weeds, nematodes, insects, and diseases with emphasis on applying selected pesticides through center pivot irrigation systems, and (2) To study the effect of various tillage or seedbed preparation methods on pest control and crop production under irrigation.

Progress:

At this stage of the research program, sufficient information has been obtained to recommend complete production system packages for several crops on the general soil types used in the program. These crops include sweet corn, turnip greens, southern peas, cucumbers, snapbeans, field corn, soybeans, peanuts, lima beans, and squash. Significant portions of production system packages are available for many other crops on both soil types, and research is progressing to determine the information required to complete the systems. Also, sufficient information is available to make suggestions as to adjustments required in production systems when these crops are introduced into a multiple-cropping sequence on either soil type at various times of the year. Research on specific aspects of production systems packages is underway for many other crops on the two soil types, and substantial progress is being made to determine the information required to complete these systems.

A wealth of information has been obstained for controling weeds, nematodes, plant diseases, and insects. Specific information is available concerning practices used to control the different classes of pests. Results indicate that successful pest control can be achieved by applying desired pesticides through a center-pivot irrigation system. This is an efficient method of pesticide application, and nutrient application can also be combined with this system. Efficacy of most pesticides was as good or better whenapplied by conventional methods. With the abundant supply of underground as when applied by conventional methods. With the abundant supply of underground water for irrigation coupled with the 240 or more frost-free days characteristic of most of the Coastal Plain region, this area provides an excellent potential for successful multi-cropping. The information obtained on these pesticides can enhance the production possibilities of this entire region.

Contact: C. C. Dowler

SR-78-12 - Augmentative biocontrol of silverleaf nightshade with a foliar nematode parasite- Lubbock, Texas. Silverleaf nightshade (Solanum elaeagnifolium)

is a persistant perennial weed of increasing importance in agricultural land in the Southwestern U.S. The weed infests more than 2 million acres of agriculture land of the Texas Southern High Plains alone. It is reported to be among the most economically important and difficult to control weed species of the area. In addition to its importance in crop land, it also causes some losses by poison to livestock.

Objectives:

(1) To determine the efficacy of the nematode as a biocontrol alone and with certain cultural practices; (2) To document the biology of the nematode and its host range; and (3) To find an economically feasible method for mass rearing of nematodes (artificial culture or by natural means).

Progress:

The silverleaf nightshade nematode, Nothanguina phyllobia, is spread by wind, water, and its movement in soil. Infected leaves and infective larvae in soil can be moved great distances by wind. Irrigation water is used by producers to disseminate nematodes throught a field and surface run off water is effective in establishing new nematode infestations. Our research has shown that infestations spreadabout 3m/year from point of infestation from natural movement.

A 1 ha field test was established. It was determined that an inoculum rate of 3.6 kg/ha of the nematode infested weeds over a 40 ha field. In a naturally infested area the nightshade population was reduced 25% from May to September.

Additional details of the biology of the nematode have been determined. The morphology of the nematode has been described, and we have learned that it is most active at a temperature of 24 degrees. Additional studies of the effect of pH, oxygen, and various salt solutions have been completed.

Contact: C. C. Orr.

SR-78-15 - Control of purple nutsedge by periodic relseases of a weed-feeding insect, Bactra verutana Zeller- Stoneville, Mississippi. Purple nutsedge is a very difficult weed to control, either with herbicides or cultural practices. Thus, when the moth Bactra verutana was found to attack this weed across the southern U.S. and to be sufficiently host-plant specific, a program was initiated to improve its effectiveness. Purple nutsedge appears early in the growing season and grows rapidly so that it competes directly with newly-planted crops. The moth does not become numerous until very late July or early August.

Objectives:

(1) To rapidly increase the moth population, beginning 2 or 3 weeks after planting, by releasing either moths or larvae on a weekly basis for 4 weeks; (2) To determine the most efficient method of release for both adults and larvae; and (3) To compare the effectiveness of releases of moths with those of larvae.

Progress:

All early-season releases in 1979 were of moths, usually early in the afternoon.

Except for dark, overcast days with high humidity and threatening rain, the moths flew hardly at all in daylight beyond making short, quick flights in order to orient themselves on their host plants. On the humid days, many moths flew with the wind, often to 15 or so feet above the ground, as far as the eye could see. A few releases were made at dusk and flight was similar to that of sunny days untill darkness decended when the moths took wing in sustained flights.

Releases of 5,000 to 10,000 moths each were made periodically at six sites in farmers' fields. The number of releases varied from 2 (5,000 moths each) to 4 or 5 (8,000-10,000 moths each). These were spaced one week apart except when heavy rains prevented access to the sites. Counts of infested plants were made an average 1 week after the final release. The natural infestation in the area of the releases averaged 3 (0.5-4)% damaged shoots. The intensity of infestation of 50-100% damaged shoots were confined to circles about 5 meters in radius. Infestations of 20-50% damaged shoots extended out from there to circles about 10 meters in radius. Beyond that to about 30 meters from each release point, infestations averaged 5 (3-8)%. In summary, repeated releases of 5-10,000 moths each over 2-5 weeks had considerable effect on infestations at the release site, but this was localized to a circle about 20 meters in diameter.

Preliminary releases of larvae, distributed in corn-cob grits by a fertilizer applicator, look promising with almost 80% infestation from one application, but these were done in late season. In 1980, plans are to concentrate on releases of larvae in the early season with this technique.

Contact: K. E. Frick

SR-80-1 - Management of insect pests of in-shell peanuts with pheromones and insect growth regulators- Gainesville, Florida. The pilot test encompasses a three-year program to develop a pest management system that will permit management of insect pests of stored in-shell peanuts without resorting to classical insecticides. The pilot test will determine how IGRs and sex pheromones can be employed to manage the Indian meal moth and almond moth. The basis of the proposal is that IGRs and sex pheromones can be used to complement each other. IGRs prevent metamorphosis of larvae, while sex pheromones inhibit mating of mating of adults. The combined effect of application of IGR and pheromone is expected to prevent the build-up of the moth population that would otherwise occur in the warehouse. Relevant toxicological data and available field test data for IGRs and pheromones are favorable. The results of the pilot test should not only pertain to the protection of stored peanuts, but should also provide insight into the suitability of using IGRs and pheromones for the protection of other stored commodities.

Over 1.7 million tons of peanuts were produced in the United States last year with a total value of over half a billon dollars. Virtually all peanuts are stored in-shell after leaving the farm for periods ranging from a few months to a year or longer. Estimated losses amounted to 32.6 million dollars representing a 5.7% loss rate, one of the highest loss rates of any stored commodity in the U.S. Virtually all insect damage to in-shell stored peanuts in this country is caused by the almond moth and Indian meal moth. Both of htese species damage many stored commodities. In fact, the Indian meal moth is considered the most important general-feeding moth species. For many years in-shell peanuts were

protected with a residual spray of malathion applied as the nuts were put in the warehouse. These insect species have become resistant to malathion over the years, thus sharply reducing its effectiveness. Thus, warehouse operators have turned to fumigants as the only available control for these insects. Fumigation has 2 drawbacks aside from problems associated with its toxicity: (1) It is expensive (because of this warehouses are not fumigated often enough to keep losses at a low level), and (2) Fumigants do not kill all of the larvae inside the peanut shells. The openness of the buildings prevents the maintenance of sufficient levels of fumigant; and difficulty and cost preclude the proper sealing of such large buildings. Therefore, there is no satisfactory method for controlling these 2 pests.

Objectives:

The primary objective of this pilot test is to demonstrate how to control insect pests of stored peanuts without utilizing classical insecticides. We will determine how IGRs and sex pheromones, separately and in combination, can be employed to control the Indian meal moth and almond moth. The results of the pilot test will provide the necessary information to exploit IGR and pheromone on a practical basis for the protection of in-shell peanuts. Furthermore, the results should provide insight into the suitability of using IGRs and pheromones for the protection of other stored commodites from insect pests.

Progress:

Sixteen 1,200-pound samples of in-shell peanuts were treated with 4, 10 or 25 ppm of Altosid, an insect growth regulator (IGR), with and without sex pheromone and infested with known numbers of almond moth pupae. To date, ca. 6,000 adults have emerged from the untreated control samples compared to 1,600, 350, and 182 for samples treated with IGR at a rate of 4, 10, and 25 ppm, respectively. Ca. 4,200 adults have emerged from the pheromone-treated samples compared to 290, 370, and 100 for samples treated with pheromone plus 4, 10, and 25 ppm IGR, respectively.

Damage level data are incomplete at the present time but preliminary assessment indicates significant damage reductions for the treatments compared to controls; damage levels being inversely proportional to the quantity of IGR treatment. Damage levels are also significantly lower in samples treated with pheromone. Mating assessment in the treatment rooms indicates a mating reduction of ca. 46% in rooms treated with sex pheromone (significant at .0001 level).

Contact: K. W. Vick

SR-80-5 - Evaluation of cotton cultivars that possess resistance to bollworms, Heliothis zea (Boddie), tobacco budworms, H. Virescens (F.), and boll weevils, Anthonomus grandis (Boheman) under several insecticides regimes in the Southeast. We propose to develop and evaluate an improved method for the production of cotton in the Southeast. The method involves integrated pest management under three insecticide regimes with insect resistant cultivars. Data show that these insect-resistant cultivars probably will require less insecticide or fewer applications than present commercial varieties. The test will be conducted in several

locations in Alabama, North Carolina, and South Carolina. These three states typify much of the cotton producing areas in the Southeast and include many of the major insect problems.

The source of resistance to Heliothis spp. in the Pee Dee germplasm pool that generally reduces square damage and live larvae by 1/2 has not been identified. Identification of the causal agent(s) would be helpful in the development of resistant cultivars and the management of insect pests. High gossypol, frego bract, and earliness are plant characters that contribute to resistance to Heliothis spp. and boll weevils. The nectariless and glabrous traits, singularly or in combination, will aid Heliothis spp. resistance under low infestation levels, but will not be considered in this study.

Objectives:

To determine if satisfacory yields of quality cotton can be produced with less insecticide or few applications for a more profitable crop and an cleaner environment, and to indentify the causal agent(s) responsible for resistance to Heliothis spp. in PD cottons.

Approach:

The reaction of eight cultivars under three insecticide regimes will be determined. The cultivars are as follows: (a) Pee Dee 695 (Heliothis resistant, frego, early line); (b) Pee Dee 875 (Heliothis-resistant, normal bract, compact, early line); (c) Pee Dee 8619 (Heliothis-resistant, normal bract, full season line); (d) Pee Dee 6520 (very early line); (e) HG-BR-8-N (high-gossypol, nectariless line); (f) McNair 220 (early cultivar); (g) Coker 304 (early cultivar); and (h) Coker 310 (full season check cultivar). Data on insects (beneficial and harmful), insect damage and yield will be obtained.

Cultivars will be compared under three insecticide regimes as follows: (a) a high and (b) low rate of synthetic pyrethroid applied every 3 to 7 days throughout the season, and (c) a high rate of synthetic pyrethroid will be applied as needed to control insects; applications will be based on economic thresholds for Pee Dee 695 and HG-BR-8-N. Preliminary results in our small test plots indicate adequate control of Heliothis spp. with low rates or fewer applications on Pee Dee 695 and HG-BR-8N, suggesting a reduction in production cost and reduced insecticide load in the environment.

This test will be conducted by scientists from the Alabama-North Mississippi, Georgia-South Carolina, and Mid-Atlantic Areas. This study should give definitive data for a new and improved mthod of cotton production and pest management applicable over much of the Southeast.

Treatments:

A. Insecticides (3) - whole plots

A1 Complete season isect control with the recommended rate of synthetic pyrethroid (0.10 to 0.20 lb AI/acre) at 5- to 5-day intervals for control of Heliothis spp. and other insects.

A2 Full season insect control with a low rate (1/2) of synthetic pyretroid (0.05 lb AI/acre) applied as above.

A3 Minimum insect control with a high rate of synthetic pyrethroid (0.10 to 0.20 lb AI/acre) applied as needed to control Heliothis spp. and other insects on Pee Dee 695 and the high-gossypol check.

B. No. cultivars - subplots:

B1 Coker 310 - Full season, check cultivars.

B2 Hg-BR-8-N - High gossypol, nectariless, full season breeding line.

B3 Pee Dee 6520 - Very early check breeding line.

B4 Pee Dee 8619 - Full season, normal bract, resistant breeding line.

B5 Pee Dee 875 - Early, resistant, frego, compact breeding line.

B6 Pee Dee 695 - Early, resistant, frego breeding line.

B7 Coker 304 - Early cultivar

B8 McNair 220 - Early cultivar

SR-80-7 - Control of container breeding mosquitoes in New Orleans by integrated use of predaceous Toxorhynchites larvae and standard insecticidal control methods-Gainesville, Florida. The peridomestic mosquito Aedes aegypti which breeds in artificial containers such as discarded tires and cans is a major pest problem and a potential vector of dengue in the Southeastern U.S. Although dengue does not occur in the U.S. it is now present in Mexico, South America and the Caribbean area. Control of this species is difficult because of the prohibitively high and recuring costs of source reduction, and the ineffectiveness of all but aerial adulticide applications.

Objective:

The purpose of this test is to determine the practicality of using Toxorhynchites as a biological control agent of AE. aegypti when integrated with conventional control techniques.

Progress:

Since the pilot project was activated in October 1979, a 12' x 50' trailer has been set up at the Southern Region Research Center containing an insectary and laboratory and office space. Successful rearing of the predator has been accomplished since January 1980 using local employees which include a supervisor (BS and MS degrees in biology), a full-time technician, and one summer employee. A field survey conducted during September and October 1979, has provided information on the numbers, types, location, and importance of the various artificial containers breeding AE. aegypti.

Field releases of the predator adult which began in May have indicated that it is possible to obtain oviposition in some of the most common and important con-

tainers and that by releasing predators on the perimeter rather than at the center of the residential blocks, a wider distribution of oviposition is obtained. The daily survival of predator adults in New Orleans appears to be somewhat less than in Florida where preliminary work was conducted. A third series of tests designed to identify those factors which determine the attractiveness of various containers to ovipositing females such as proximity to vegetation, height, shape, and color has just begun.

Contact: Dana A. Focks

SR-81-1- The potential of an integrated pest management scheme to control house flies and other filth breeding flies at poultry farms with special emphasis on use of parasitic wasp Spalangia endius. House flies and related flies breed in tremendous numbers in poultry manure, they are an annoyance and potential health hazard to man and animals. Farmers are continually begin urged by the local health authorities to control the flies. Unfortunately, current control practices are not efficient and many times are not effective. One reason for this is the ability of flies, house flies in particular, to rapidly develop resistance if subjected to severe selective pressure by chemicals. Likewise, extensive use of pesticides can result in environmental contamination. Therefore, alternative methods of control must be explored using the best attributes of existing and new fly control techniques in an integrated pest management scheme.

Personnel at the USDA-SEA-AR Insects Affecting Man and Animals Research Labortory have developed several new control techniques which have good potential in an IPM program. The use of the parasitic wasp, Spalangia endius, is just one of these. New fly baits with the pheromone muscalure, attractant-toxicant devices (ATD), and treated resting stations are just a few of the techniques which could be incorporated together in an IPM scheme at poultry farms. Cultural control such as rotatilling the sides of the manure, manure management and cleaning can also be easily incorpprated into an IPM program.

The area under consideration for this study is a 24 square mile area along the St. Mary's River in Charlton County, Georgia. This area is bounded by swamp and forests and consists of 6 poultry farms housing ea. a quarter million birds. These farms are located in 3 areas, each isolated so that various control techniques could be carried out at each. Combinations of cultural control, baits, ATD and parasites wil be used at noe. Conventional sprays at another with the third group acting as a check. As the system becomes more efficient then all three areas will be placed in the IPM scheme adn outside poultry farms will be selected as check sites. A comparison of costs factors, both actual and the long range effect on the environment, will be considered in this study.

Objectives:

To develop a safe and economically practical integrated pest management scheme for the control of filth breeding muscoid flies at caged layer installations in southeastern United States. The pupal parasite Spalangia endius Walker will be used as the biocontrol agent along with chemical baits, toxic resting stations. etc. plus cultural control methods.

Contact: D. E. Weidhaas

SR-81-2- Management of Heliothis spp. in Cotton Augentative Releases of Trichogramma- Stoneville, Mississippi. The potential of using Trichogramma to control lepidopteran pests has been recognized for several decades and there has been a substantial federal effort in this area of research during the last 10 years. While many results of studies with these parasites have shown considerable promise, certain limitations have consistently prevented their implementation as an effective pest management tool. However, recent advances in mass production and release technology, quality control, and behavioral manipulation (AR/SEA, College Station, Stoneville, and Tifton locations) have greatly improved the prospects of overcomingthese limitations. Presently, large-scale field tests are needed to determine if Trichogramma can be practically implemented and to obtain sould data on parasite efficacy.

We propose a 3-year program whereby recent technological advances are tested and evaluated in large-scale field trials to control the bollworm (Heliothis zea (Boddie)) and the tobacco budworm (H. virescens (F.)) in cotton. the first 2 years (FY 81-82) of the program would be devoted to season-long assessment of the use of Trichogramma, with and without behavioral materiasl, in replicated large fields of cotton. The 3rd year (FY 83) would involve the release of Trichgramma over 1000 to 1300 acres of cotton assess effects of an area-wide program.

The Pilot Test will be conducted within a state-organized community-wide cotton insect management program (Portland, Arkansas) where pest control practices deleterious to Trichogramma usage can be rigidly controlled and grower cooperation guaranteed. Thus, comparisons may be made between alternative Heliothis spp. management practices and areas receiving no Heliothis spp. control.

Successful completion of the proposed pilot test will result in the consolidation of available technology into a scheme for the use of Trichogamma as an effective adn acceptable pest management alternative.

Objectives:

(1) To evaluate on a large scale, in replicated field experiments, current technology for augmenting and manipulating Trichogramma populations to manage Heliothis spp. in cotton.
(2) To unify Trichogramma technology and demonstration that it can be used effectively within an area-wide program for control of Heliothis spp. in cotton.

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