Component II: Protection of Agricultural and Horticultural Crops

2c. Nut Crops (U.S. Value 2007: $3.8 billion)

***Problem Statement*:** The principal commercial nut species (almonds, hazelnuts, macadamias, pecans, pistachios, and walnuts) do not produce maximum yields due to the following pests:

- Pecan weevil (in all pecan producing states except in the western United States, though it has been detected in New Mexico)
- Pecan Aphids (all pecan producing states)
- Navel Orangeworm (California but also some other western states, in almonds, pistachios, and walnuts)
- Peach Twig Borer (California, in almonds)
- Oriental Fruit Moth
- Obliquebanded Leafroller
- Filbert Worm and Filbert Weevil (primarily Oregon)
- Phytophagous Mites (all nut crops)
- Stink Bugs (all nut crops)
- Pecan Nut Casebearer (all pecan producing states)
- Weeds (nutsedges, vining weeds such as morningglory spp.) compete for resources in new orchards, interfere with irrigation, harbor insect and rodent pests, increase disease pressure, impede harvest, interfere with low volume irrigation systems, and intercept soil-applied chemicals (all orchards)
- Glyphosate-Resistant and Other Herbicide-Resistant Weed Biotypes (all orchards)

***Research Needs*:**

1. **Pecan Weevil**

   Importance: The pecan weevil is a key pest of pecans in many of the major pecan-producing states including Alabama, Arkansas, Florida, Georgia, Kansas, Louisiana, Mississippi, Oklahoma, South Carolina, and Texas. This economically important insect causes direct damage to the crop by feeding on and ovipositing in the developing nut. The pecan weevil infests more than 60 percent of managed pecan acreage; more than 300,000 acres are treated annually for this pest.

   Research Gaps: Current management practices rely solely on application of chemical insecticides for suppression of adult insects in the canopy during their feeding and oviposition periods. Application of these chemical insecticides can substantially reduce natural enemy populations causing outbreaks of other pests (such as aphids). Thus, due

to potential pest resurgence as well as other environmental and regulatory issues, alternative control methods must be sought. Biological control agents (such as entomopathogenic nematodes and fungi) have shown some efficacy in suppressing pecan weevil larvae and adults, but additional research is required to integrate optimum biological control tactics with other management strategies. Additional innovations in pest suppression (such as using volatiles) should also be explored.

Actions: ARS will:

Control, Biological

- Determine the efficacy of biological and microbial control agents. Investigate the basic biology and ecology of these agents to enhance efficacy.
- Explore for new biological control agents with superior efficacy.
- Investigate improved methods of biological control agent production, formulation, and delivery.
- Integrate optimum biological control tactics with other management strategies.

Control, Other Alternative Approaches

- Additional innovations in pest suppression including the use of volatiles (such as for attract and kill) will be explored.

2. Pecan Aphids

Importance: Pecan foliage is attacked by three aphid species across the southern United States: black pecan aphid, blackmargined aphid, and yellow pecan aphid. Aphids feeding on pecan foliage can cause a reduction of leaf chlorophyll and leaf area, a decrease in leaf photosynthesis, depletion of carbohydrate reserves in stem tissue and even defoliation. Additionally, aphid feeding affects nut yield, nut quality, and return bloom. Aphid feeding also causes an indirect reduction in photosynthesis when black sooty mold grows on foliage covered with honeydew.

Research Gaps: The nature of the interaction between the aphids and the host pecan is poorly understood. More information is required regarding host plant resistance as related to cultivar susceptibility. Seasonal variation in constitutive levels of plant growth regulators appears important to aphid growth and damage to certain cultivars. Additionally, alternative and conventional management techniques are needed to insure continuous protection against aphid feeding.

Actions: ARS will:

Control, Host Plant Resistance and Interference with Aphid Feeding

- Assess seasonal impact of aphids on suspected susceptible and resistant cultivars.
- Assess the efficacy of different classes of plant growth regulators that disrupt normal development and feeding of aphids.

Control, Alternative and Conventional

- Assay natural enemy attractants under field conditions.
- Compare conventional and alternative aphid management plans.

3. Navel Orangeworm

Importance: In California the navel orangeworm (NOW), is a primary pest of almonds and pistachios and a secondary pest of walnuts (although in some years it causes more damage than any other insect). Direct damage by NOW can exceed 30 percent in almonds and 11 percent in pistachios, and infested nuts face an increased likelihood of mycotoxin (aflatoxins B1, B2, G1, G2) contamination, which is a serious food safety concern.

Research Gaps: Development of integrated control programs are needed on an area-wide level. Tactics that should be researched and integrated include: sanitation, mating disruption, and alternatives to chemical insecticides (such as use of entomopathogenic nematodes).

Actions: ARS will:

- Implement an area-wide IPM program that will reduce navel orangeworm damage,aflatoxin contamination, and broad-spectrum insecticide use.
- Collect baseline data characterizing the experimental plots in terms of NOW population density, historic levels of damage, sanitation efficacy, and the cost of current practices. Compare the efficacy of current and proposed NOW management programs using cost/benefit analysis.
- Identify key variables responsible for both consistent control and program failure and analyze the relative importance of these variables using epidemiological/epizootiological statistics.
- Expand an existing damage prediction model for Nonpareil almond damage that is based on Kern County data, to the other growing regions in the Central Valley; and develop a damage prediction model for pollenizer varieties of almonds and validate the model in the different growing regions.
- Determine the role played by NOW movement among multiple hosts on the efficacy of the new management practices demonstrated.
- Create NOW damage databases using grower-provided data that can identify high-risk areas for each commodity within a county and utilize these databases to develop a better understanding of the distribution of both NOW infestation and aflatoxin contamination within and between counties.

4. **Glyphosate-resistant and Other Weeds**

Importance: Weed control is a significant management issue in nut orchards. In young plantings, weeds compete with nut trees for nutrients, light, water, and space. Weeds can harbor insect and rodent pests, increase disease pressure, and interfere with irrigation systems. Additionally, because most nut crops are mechanically shaken from the tree and swept up from the orchard floor, complete control of weeds prior to harvest is essential for efficient harvest. Chemical weed control in tree nuts is dependant on relatively few herbicides: glyphosate (43-66 percent of acreage), paraquat (11-50 percent of acreage), and in some systems, oxyfluorfen (21-45 percent of acreage). Multiple applications of these herbicides are often needed each year. Recent identification of glyphosate-resistant weeds in some areas may lead to reduced weed control in these systems which, in turn, could lead to use of herbicides with less acceptable environmental impacts, decreased productivity, increased cold damage, or increased insect and pathogen problems.

Research Gaps: A greater understanding of the biology and physiology of weeds and alternative control strategies is needed.

Actions: ARS will:

Research directed toward controlling these resistant weeds is being addressed primarily in other ARS National Programs; no actions are proposed within National Program 304.

***Anticipated Products*:**

- Filling key knowledge gaps in basic insect pest and natural enemy biology and ecology such that our ability to develop effective methods of pest management will be enhanced.
- Novel alternative pest management tactics involving biological or microbial control agents, targeted volatiles, natural products or other innovative strategies.
- Improved methods for production, formulation, and delivery of biological control agents.
- Development of integrated orchard management systems.

***Potential Benefits (Outcomes)*:**

- New effective pest management strategies for nut crops that are ecologically and economically sound.
- Increased productivity and competitiveness in U.S. nut crops.
- Model systems of biological control agent production and application, and integrated pest management programs that are broadly applicable to other commodities.

***USDA ARS Resources*:**

- Commodity Protection and Quality Research, Parlier, California
- Fruit and Nut Research Unit, Byron, Georgia