Component II: Protection of Agricultural and Horticultural Crops

2g. Sugar Beets (U.S. Value 2006: $1.5 billion)

***Problem Statement*:** Sugar beet production does not produce maximum yields due to the following pests:

- Sugar Beet Root Maggot
- Beet Leafhopper
- Wireworms
- Cutworms and Armyworms
- Collembola
- Sugar Beet Root Aphid
- Weeds (including kochia, pigweed, nightshade spp., nutsedge, foxtail spp., wild millet and oats, sowthistle and Canada thistle, common lambsquarter, common mallow, cocklebur, dodder spp., and barnyardgrass)

***Research Needs*:**

1. **Sugar Beet Root Maggot**

   Importance: This insect is considered the most serious sugar beet pest in the western United States, including the states of North Dakota, Minnesota, Montana and Idaho, as well as Colorado and Oregon. Heavy infestations cause severe stand loss, particularly with small plants, because the maggots feed upon and sever the taproot, resulting in wilted or dead plants, reduced plant vigor, and damaged plants that may be more susceptible to root diseases. Primary control tools are synthetic chemicals, and without treatment sugar production in the most severely infested regions would be reduced by 40 to 80 percent.

   Research Gaps: Efficacious and commercially acceptable biological control agents or conservation/augmentation methods for managing root maggot populations need to be developed. In this regard, rearing methods for the insect need to be developed to facilitate screening of microbial agents and screening of traditional or transgenic hybrids for efficacy. Current models used to predict sugar beet root maggot impact were developed for the Snake River Valley of Idaho, and need to be adapted to the other growing regions. In addition, current economic thresholds need to be refined, particularly for maggot-affected areas outside Idaho, and, for all areas, better adjustments for rapid fly buildup need to be factored into the decision-making process.

Actions: ARS will:

Biology

- Develop an understanding of diapause development and termination in the root maggot.

Control, Biological

- Develop microbial control agents and methods for their use within the framework of integrated pest management of the sugar beet root maggot.

Control, Host Plant Resistance

- Develop traditional or transgenic resistant lines of sugar beets, within the framework of relevant National Program 301 and National Program 302 programs.

2. Beet Leafhopper

Importance: Beet leafhoppers feed upon sugar beet plants, though they seldom reach densities to cause economic damage. Beet leafhoppers, however, are the sole vector of curly top virus, an extremely serious pathogen of sugar beets, and it is the leafhopper's ability to vector the curly top virus that makes it a critical insect pest. The virus overwinters in adult leafhoppers, which become a source of infection the following year. Curly top virus is so devastating to sugar beets that it almost eliminated the sugar beet industry in Idaho and Washington prior to the development of virus-tolerant cultivars.

Research Gaps: The biology of the beet leafhopper and curly top virus epidemiology is poorly understood. There is a need to develop and/or refine cultural practices that can reduce leafhopper densities. There is an additional need to develop area-wide pest management approaches that reduce sources of both vector and pathogen in overwintering sites outside of sugar beet growing acreage.

Actions: ARS will:

Control, Interference with Vector Biology

- Develop integrated management practices to control the beet leafhopper, thereby reducing the incidence of curly top virus in sugar beets, within the framework of projects within National Program 303.

3. Wireworms

Importance: Wireworm larvae are sporadic but serious pests in sugar beets, feeding on the germinating seed and/or the developing root, working below the soil surface, attacking and killing the seedlings, and causing stand reduction. Under a heavy infestation, bare spots may appear in fields making reseeding necessary. Wireworm infestations are more likely to develop where grasses, including grain crops, are growing or were grown in the previous year.

Research Gaps: Integrated approaches for wireworm management utilizing trap crops, microbial control agents, and natural attractants (like pheromones) need to be developed. A better understanding of the mechanisms that confer wireworm resistance in unique potato germplasm derived from wild potato species might be useful in developing resistant cultivars of sugar beets.

Actions: ARS will:

Monitoring

- Develop and improve monitoring tools aimed at wireworms in sugar beets and other crops attacked by wiremworms.

Control, Trapping

- Identify attractants of larval wireworms to facilitate development of a synthetic bait for trapping.

Control, Host Plant Resistance

- Identify and develop genetic traits that could be incorporated into sugar beets and confer resistance to wireworms, within the framework of National Program 301 and National Program 302.

4. Cutworms and Armyworms

Importance: A variety of lepidopterans are problematic in sugar beets. Armyworms are considered a major problem in the western half of Idaho and a sporadic problem in Montana, Wyoming, and parts of North Dakota. Sugar beet plantings adjacent to armyworm-infested alfalfa hay fields or cereals may be completely defoliated by armyworm larvae that migrate and disperse from these crops when hay is cut or the grain crop is harvested. Cutworm infestations, while sporadic, can severely decimate the sugar beet crop. Some cutworm species primarily feed underground, cutting plants off below the soil line, while other cutworm species feed aboveground, cutting plants off at or above the soil line. In either case, sugar beet stands may be significantly reduced. Current control measures rely upon prophylactic use of fast-acting chemical insecticides.

Research Gaps: Economic injury thresholds for both cutworms and armyworms are needed to reduce prophylactic insecticide use. Biological control agents (particularly parasitoids and microbials) need to developed and refined to fit within an integrated pest management framework.

Actions: ARS will:

Control, Attractants

- Extend discoveries about adult moth attract-and-kill strategies developed in potatoes to the lepidopteran complex in sugar beets. (See Vegetable Component)

5. Collembola (springtails)

Importance: Recently, subterranean springtails have become sporadic pests of sugar beets in the central and southern Red River Valley of Minnesota and North Dakota, as well as the sugar beet-growing areas of eastern Montana. Springtails are usually regarded as benign or even beneficial, since they feed on decaying plant material and improve soil structure. However, certain environmental conditions in the early spring can result in high populations of springtails and these infestations can cause major sugar beet stand reductions and yield losses. Springtail populations become most problematic in high organic matter, fine-textured soils like clays, and damaging infestations have often occurred in fields where small grains (barley or wheat) were previously grown. No insecticides are specifically labeled for springtail management in sugar beet.

Research Gaps: Management tactics based upon a better understanding of springtail biology are needed. Biological tools compatible with or even complementary to those for the other sugar beet pests need to be developed. These tools could be either resistant/tolerant lines or microbial agents.

Actions: ARS will:

Control, Biological

- Develop biobased tools for management of Collembola in parallel to main efforts targeting sugar beet root maggot and wireworms, as well as seedling pathogens.

6. Sugar Beet Root Aphid

Importance: Sugar beet root aphids feed upon the small secondary roots of sugar beets. Their feeding interferes with plant growth by inhibiting nutrient and water uptake and transport. Severe infestations cause leaf yellowing and wilting and the damage results in yield and quality losses. Some adult aphids leave sugar beet fields and overwinter on cottonwood trees, while other root aphids remain in the soil in the fall and overwinter. These aphids are capable of beginning new infestations on sugar beets the following spring. Given their cryptic habits but near universal occurrence in every sugar beet field every year, the economic importance of sugar beet root aphids likely has been underestimated across the West. The best current option for managing the sugar beet root aphid is the use of resistant sugar beet cultivars.

Research Gaps: Economic thresholds for the sugar beet root aphid need to be developed. Biologically-based control strategies are lacking as only varietal resistance is currently available.

Actions: ARS will:

- National Program 304 does not have sufficient resources to address this insect pest.

7. **Weeds**

Importance: Troublesome weeds including including kochia, pigweed, nightshade spp., nutsedge, foxtail spp., wild millet and oats, sowthistle and Canada thistle, common lambsquarter, common mallow, cocklebur, dodder spp., and barnyardgrass impact sugar beet production. The widespread adoption of glyphosate-resistant sugar beets in 2008 has radically transformed the weed control situation in the crop. Nevertheless, transgenic beets present new problems in prevention of weed resistance to this important herbicide, given the large number of weed species in sugar beet fields, particularly weeds related to the crop.

Research Gaps: The potential of gene flow from transgenic sugar beets to weeds needs to be evaluated, accompanied by analysis of the ecological effects and the persistence of those genes.

Actions: ARS will:

- ARS currently has no resources to address weed management in sugar beets.

Anticipated Products:

- Increased knowledge of biology, ecology, behavior, and genetics of the key pests.
- More effective and commercially-acceptable sugar beet varieties with resistance to insect pests, esp. root maggot, root aphid, and wireworm.
- Improved pest management systems for insect pests of sugar beets.

Potential Benefits (Outcomes):

- Reduced crop losses and increased profitability for sugar beet growers.
- Significant reduction in the prophylactic use of the synthetic insecticides to control root maggot and wireworms in sugar beets.

***USDA ARS Resources*:**

- Fruit and Vegetable Insect Research, Wapato, Washington
- Insect Genetics and Biochemistry Research Unit, Fargo, North Dakota
- Molecular Plant Pathology Laboratory, Beltsville, Maryland
- Northwest Irrigation and Soils Research Laboratory, Kimberley, Idaho
- Pest Management Research Unit, Sidney, Montana
- Sugar Beet and Potato Research Unit, Fargo, North Dakota
- Sugar Beet Research Unit, Fort Collins, Colorado