



**Pest Management Strategic Plan
for Snap Beans in Virginia,
North Carolina, and Delaware**

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**Southern Region IPM Center
Virginia Tech
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EXECUTIVE SUMMARY

With the passage of the Food Quality Protection Act (FQPA), an urgent need has developed to address current pest management issues and embrace alternative or “reduced risk” pest control options for various commodities. The U.S. Department of Agriculture (USDA) Office of Pest Management Policy (OPMP) is funding the production of Pest Management Strategic Plans (PMSPs) that identify pest management needs and priorities for specific crops in particular regions. These documents are developed through the collaboration of growers, commodity associations, specialists, food processors, crop consultants, and the U.S. Environmental Protection Agency. A workshop was held on April 6, 2005, in Exmore, VA, to solicit input from snap bean growers, Extension agents, researchers, and specialists from Virginia, North Carolina, and Delaware. The purpose was to identify critical pest management needs in the snap bean industry. The following PMSP outlines the cultural practices used in snap bean production along with the pests and diseases of greatest concern to growers. Research specialists in the areas of entomology, weed science, and pathology have assembled data tables to demonstrate the efficacy of currently available chemical and nonchemical control methods. The critical needs outlined on the following pages must be addressed in order to ensure the success of future snap bean production in the mid-Atlantic states.

NOTE: Please refer to “Abbreviations” at the end of this report for a list of abbreviations and acronyms used for organizations and other terms discussed below.

PRIORITIES FOR SNAP BEANS IN VA, NC, AND DE

RESEARCH PRIORITIES

- Study the interaction of herbicides, insecticides, and surfactants for snap bean pest management.
- Determine the efficacy of novel seed treatments for control of diseases and insects.
- Study pest management strategies for weeds, particularly lambsquarters, wild mustard, pigweed, eastern black nightshade, morningglory, and other broadleaf weeds.
- Create new pest management tools for insects, particularly thrips, bean leaf beetle, soybean aphid, and lesser cornstalk borer.
- Study diseases, particularly pod rot, root rot complex, white mold, and soybean cyst nematodes.
- Study cultural management practices (e.g., rotation, varieties, plant spacing, planting methods, and soil compaction) and their effects on insects, nematodes, weeds, and diseases.
- Conduct research on growth enhancement and biological control products to study their efficacy, yield, and costs with respect to pest management.
- Investigate the potential impact of soybean rust on snap beans.

REGULATORY PRIORITIES

- Obtain labels for new chemistry. Many are out there, but few are labeled for snap beans.
- Develop viable, effective, low-risk pesticides that are more acceptable to the community.
- Maintain the registration of older, broad-spectrum pesticides that are both practical and safe as a rotational tool in resistance management.
- Ensure timely clearance of Section 3s, Section 18s, and Section 24Cs to support grower needs. For example:
 - Reflex (fomesafen) – need a Section 3 label for postemergence weed control.
 - Need fungicides for control of soybean rust.
 - Need label expansions for many miticides to include snap beans.
 - Need a label change on mefenoxam to control pod rot.

EDUCATIONAL PRIORITIES

- Develop topic-specific one-to two-page fact sheets.
- Establish pesticide resistance management education programs for insects, diseases, and weeds.
- Provide growers with the most current pest management information.
- Keep growers and other clientele up to date on management programs including new chemistry, pesticide alternatives, cultural practices, and related technology (including demonstration plots, field tours, on-farm research, and hands-on workshops).
- Maintain up-to-date, grower-friendly field and pest management guides on paper and on the web. Also, produce guides with basic pictures and information that have a long shelf life. Out-of-print guides should be reprinted with the latest information.
- Adopt grower-friendly technology to ensure the efficient flow of current pest management information to farmers.
- Provide better diagnostic tools to identify biotic and abiotic problems in snap beans.

**RESEARCH
PRIORITIES, CONT'D:**

- Establish monitoring protocols and refine threshold levels for insects, disease organisms, and weeds.
- Petition IR-4 for efficacy studies on controls for weeds, diseases, nematodes, and insects.
- Study the efficacy of insecticides on nematodes.
- Secure funds to test Raptor, which is labeled in some states. Only one year of data has been gathered in VA as of 2005, and an adjuvant needs to be developed.
- Determine the effect of soil compaction on diseases and pests.
- Study the soil nitrogen requirements of beans and determine the proper time to apply side-dressing.
- Conduct variety trials, e.g., darker colored beans.
- Identify optimal plant spacing to control pests and diseases.
- Develop an herbicide equivalent to Reflex.
- Determine the extent of crop burning caused by Reflex.
- Develop a systemic insecticide like Temik for aphid control.

**EDUCATIONAL
PRIORITIES, CONT'D:**

- Help growers identify newly emerging pests and diseases such as soybean rust and soybean aphid.
- Inform growers of the efficacy of novel seed treatments for control of diseases and insects.

PRODUCTION AND CULTURAL PRACTICES

Snap beans, also known as string beans (although strings no longer exist in current commercial varieties), green beans, or yellow wax beans, are actually immature kidney beans. All beans belong to the Fabaceae family. The snap bean, *Phaseolus vulgaris*, is the most important bean grown in the South.

PRODUCTION FACTS AND FIGURES

During the 2005 snap bean season, 5,400 acres of snap beans were planted in Virginia, of which 5,100 acres were harvested. The production rate was 51 cwt./acre for a total of 260,000 cwt. produced worth \$9,620,000. Virginia ranked 7th in the United States and produced 4% of the country's snap beans in 2006 with 5,300 acres planted and 5,000 acres harvested. The production rate was 53 cwt./acre, for a total of 265,000 cwt. worth \$9,540,000.

In North Carolina, 6,800 acres were planted and 5,000 acres were harvested in 2005. The production rate was 50 cwt./acre for a total of 250,000 cwt. worth \$7,500,000. In 2006, North Carolina ranked 6th nationally and produced 6% of the snap beans in the United States. Approximately 7,200 acres of snap beans were planted and 7,000 acres were harvested for a total of 385,000 cwt. worth \$13,590,000.

In Delaware, 2,000 acres of snap beans were planted for processing and 600 acres were planted for fresh market in 2005. The total production for fresh market beans was 24,000 cwt. worth \$744,000.

PRODUCTION REGIONS

The principal snap bean-producing counties in Virginia are Accomack and Northampton. Snap beans are also grown in Chesapeake and Virginia Beach counties as well as the southwest areas of Carroll, Floyd, and Washington counties. Most North Carolina beans are produced in Hyde and Henderson counties. In Delaware, snap beans are grown mainly in Sussex County.

SNAP BEAN VARIETIES

Varieties differ in their pest resistance and yield potentials. For example, *Strike* beans are resistant to the common bean mosaic virus while *Volunteer* beans are rust resistant. All snap beans thrive in warm weather and do not tolerate frost. In Virginia, green snap bean varieties grown for fresh market include *Ambra* (trial), *Bronco*, *Caprice* (trial), *Carlo*, *Charon* (trial), *Dusky*, *Embassy* (trial), *Hialeah*, *Nash* (trial), *Roma II*, *Secretariat*, *Shade*, and *Valentino*. Other bean varieties grown in Virginia include the wax beans *Eureka* and *Rocdor*; the trellised beans *Volunteer*, *Mountaineer*, and *State White Half-Runner*; and the horticultural beans *French Horticultural* and *Supremo*.

In North Carolina, the fresh market snap beans are *Ambra*, *Atlantic*, *Bronco*, *Bush Blue Lake 274*, *Charon*, *Eagle*, *Festina*, *Hialeah*, *Lynx*, *Magnum*, *Roma II*, *Shade*, *Storm*, *Strike*, *Tapia*, *Dade*, *Stringless Blue Lake*, *White Seeded Kentucky Wonder 191*, *Kentucky Blue*, and *Volunteer*.

In Delaware, the fresh market green snap bean variety is *Roma II*. Fresh market wax beans include *Eureka* and *Goldrush*. Processing varieties include *Brio*, *Dandy*, *Hystyle*, *Roma II*, and *Slenderette*. Horticultural snap beans grown in Delaware include *French Horticultural* and *Volcano* varieties.

CULTURAL PRACTICES

As indicated in “Production Regions” above, snap beans are produced throughout Virginia. However, soil types, varieties, and harvesting techniques vary greatly between the eastern and western counties. Given that most snap beans are grown on the Eastern Shore, the cultural practices discussed below apply mainly to that region of Virginia.

Sandy loam soils such as Bojack and Munden are best suited for snap bean production. Soil pH should range from 6.0 to 6.4 with the optimum being 6.2. Phosphorus and potassium are applied as needed before planting. Nitrogen is often applied at a rate of 60 lbs./acre in a band near the seeds at planting. Snap beans are planted in 30- to 36-inch rows following conventional tillage practices to incorporate the fertilizers.

In Delaware, the optimum soil temperature for germination is 70°F - 75°F. Temperatures below 50°F and above 80°F inhibit bean plant growth. The best soil is fertile, has a light or medium texture, and is well drained since root rots can be problematic in heavy, overly damp soil. Soil type and texture must be uniform to ensure maximum production and efficient machine harvesting. The optimal pH is 6.5-7.0, and the best soil nutrient test levels are 150 lbs. available phosphorus and 300 lbs. available potassium. They should be broadcast and plowed under before planting. Nitrogen should be applied at planting at a rate of 40 lbs./acre in 2-inch-wide bands placed 2 inches below the seeds.

In North Carolina, the recommended soil pH is 5.5 - 6.5 with a suggested total of 40 to 80 lbs. nitrogen/acre.

Snap beans typically require 58 to 62 days to reach full maturity. These legumes can be produced in two cropping cycles in eastern Virginia. Spring snap beans are typically planted in Virginia from April 1 to May 15 and are machine harvested from June 10 to July 10. Fall snap beans are planted August 1 to 25 and are harvested from October 1 to 20. Three crop cycles are observed in North Carolina. The first of these occurs in spring when snap beans are planted (March 10 to April 15) and harvested (May 15 to July 20). Summer snaps are planted from April 15 to May 20 and harvested from July 1 to October 1. Fall snaps are planted from August 5 to 25 and harvested from September 25 to November 10. Delaware snap beans are planted between April 10 and August 10 and harvested between June 20 and October 20.

Most of the fields used for snap bean production on the Eastern Shore have irrigation capabilities. Under ideal conditions, snap beans should receive about 1 inch of rain per week

during the growing season. If a drought occurs, bean fields should be irrigated to maintain optimum growth. Producers typically apply an average of 2 inches of irrigated water for spring- and fall-planted snap beans. Most snap beans are harvested mechanically. Fresh market beans are picked when most of the pods have filled out. After harvest, beans are kept cool (40°F - 50°F) by room cooling, forced-air cooling, or hydrocooling. The relative humidity must be maintained at 90% or higher to avoid wilting. It is important to bring snap beans to market immediately because they do not store well, although they can be stored for seven to 10 days under optimal conditions.

ARTHROPOD PESTS

Thrips are a serious pest of spring-planted snap beans. Bean leaf beetles, corn earworms, and European corn borers, however, are more common insect pests in fall snap beans. In addition, the Mexican bean beetle may be a problem in wet years while the two-spotted spider mite is more common during dry years. The seed corn maggot is more likely to occur in early plantings under cool, wet conditions when organic matter is prevalent. Bean aphids, beet armyworms, cutworms, leafminers, stink bugs, tarnished plant bugs, and whiteflies are occasional pests of snap beans but are not usually recurring problems in most fields.

INSECTS

Bean Leaf Beetle, *Cerotoma trifurcata*

Bean leaf beetle (BLB) adults damage snap beans by feeding on young leaves and pod tissue, thus reducing the overall productivity of the plant. Adults are also vectors of bean pod mottle, cowpea mosaic, and southern bean mosaic viruses, which are far more devastating than direct plant feeding. These pests overwinter as adults in leaf litter and become active when temperatures increase in the spring. They later migrate to legumes where they feed and mate. After mating, the female lays her eggs in the soil at the base of the bean plants. Larvae hatch and feed on the roots before pupating in the soil and emerging as adults. There are usually two generations per year in Virginia. The second generation causes greater damage to fall snap beans. These beetles are rarely a problem in Delaware; however, in North Carolina they are the first pests to appear in the spring in bean fields located near woods.

MONITORING: Monitor snap bean plants for defoliation resulting from BLB feeding. Chemical treatment is recommended if defoliation exceeds 20% during prebloom, or 10% during podding with a population potential for further defoliation. Monitor fields for the early appearance of virus symptoms and treat with an insecticide to kill BLB if virus detection has been confirmed.

CHEMICAL CONTROL: Apply insecticides during hatch or adult emergence when both eggs and pupae are present. *Capture* and *Warrior* work better than *Asana* at controlling BLB. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **acephate** (*Acephate* 75WSP) – Organophosphate. PHI = 14 days.
- **acetamiprid** (*Assail* 30SG) – Neonicotinoid. PHI = 7 days.
- **bifenthrin** (*Capture* 2EC) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**

- **carbaryl** (*Sevin 80S*) – Carbamate. PHI = 3 days.
- **cypermethrin** (*Mustang Max 0.8EC*) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**
- **gamma-cyhalothrin** (*ProAxis 0.5EC*) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **lambda-cyhalothrin** (*Warrior 11M*) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **dimethoate** (*Dimethoate 4EC*) – Organophosphate. PHI = 7 days.
- **malathion** (*Malathion 5EC*) – Organophosphate. PHI = 1 day.
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1-3 days. **RESTRICTED-USE PESTICIDE.**
- **pyrethrin** (*Bug Buster-O 1.4EC*) – Botanical.
- **thiamethoxam** (*Cruiser 5FS 48SC*) – Neonicotinoid.

BIOLOGICAL CONTROL: No effective commercial controls are recommended. Natural enemies include parasitic Tiphid wasps.

CULTURAL CONTROL: No effective commercial controls are recommended. Alternative controls include hand picking the beetles and spraying plants with insecticidal soap, neem, or *Bacillus thuringiensis kurstaki*.

TO DO:

- Determine to what degree early defoliation impacts the health of bean crops.
- Study the movement of BLB out of soybeans into snap beans.
- Research the efficacy of new insecticides (e.g., *Cruiser*).
- Educate growers about new chemical control methods.
- Secure labeling for new, effective chemical controls.

Corn Earworm, *Helicoverpa zea*

The corn earworm (CEW), also known as the soybean podworm, cotton bollworm, and tomato fruitworm, is generally a problem in late-planted beans during mid- to late August. Severe infestations can result in significant yield loss but may also cause contamination problems in machine-harvested beans. In a recent survey, 43% of growers in Virginia say CEW is a problem, particularly due to pod scarring. In Delaware, chemicals must be applied to grow snap beans successfully. Approximately 20% of the acreage is treated. CEW is under control in North Carolina and is not a major problem in snap bean crops.

MONITORING: Use blacklight and pheromone traps to monitor moth flight and alert producers to peak moth activity. Treatment is recommended if CEW catches in local blacklight traps average 20 or more per night when most corn in the area is mature.

CHEMICAL CONTROL: Insecticides should be applied every five to seven days following the initial spray at the threshold recommended above. In general, CEW is easy to control with the currently labeled insecticides. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **acephate** (*Acephate 75WSP*) – Organophosphate. PHI = 14 days.
- **bifenthrin** (*Capture 2EC*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **carbaryl** (*Sevin 80S*) – Carbamate. PHI = 3 days.

- **cypermethrin** (*Mustang Max* 0.8EC) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**
- **gamma-cyhalothrin** (*ProAxis* 0.5EC) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **lambda-cyhalothrin** (*Warrior* 11M) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **esfenvalerate** (*Asana XL*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1-3 days. **RESTRICTED-USE PESTICIDE.**
- **methoxyfenozide** (*Intrepid* 2F) – Diacylhydrazine IGR. PHI = 7 days.
- **spinetoram** (*Radiant* 11.7SC) – Spinosad. PHI = 3 days.
- **spinosyn** (*SpinTor*) – Spinosad. PHI = 3 days.

BIOLOGICAL CONTROL: No effective commercial controls are recommended. Natural enemies include flower bugs, lacewings, and wasps belonging to the Ichneumonidae and Pteromalidae families.

CULTURAL CONTROL: No effective commercial controls are recommended. Alternative controls include hand picking the pests and spraying plants with insecticidal soap or neem.

TO DO: None.

Cutworms, *Agrotis ipsilon*, *Peridroma saucia*, and *Feltia subterranea*

Cutworm larvae may be dull gray, brown, or black and may be striped or spotted, depending on the species. Another distinguishing quality is their act of rolling into a tight C-shape if disturbed. The two major species are the variegated cutworm, which feeds on lower leaves and petioles, and the black cutworm, which largely feeds at the soil surface and below on roots and lower stems. The black cutworm will occasionally feed on leaves. Both are nocturnal feeders and take refuge under soil clumps, stones, vegetation, and other places during the day. Cutworms find weedy or minimum-tillage fields especially attractive sites to lay their eggs. Snap beans are not treated for cutworms in Delaware. They are only sporadic pests in Virginia and North Carolina and tend to infest specific fields.

MONITORING: No specific monitoring protocol is recommended for cutworms in snap beans.

CHEMICAL CONTROL: *Cruiser* (thiamethoxam) and *Gaucho* (imidacloprid) will help control cutworms but are very expensive. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **acephate** (*Acephate* 75WSP) – Organophosphate. PHI = 14 days.
- **bifenthrin** (*Capture* 2EC) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **carbaryl** (*Sevin* 80S) – Carbamate. PHI = 3 days.
- **gamma-cyhalothrin** (*ProAxis* 0.5EC) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **lambda-cyhalothrin** (*Warrior* 11M) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **cypermethrin** (*Mustang Max* 0.8EC) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**
- **diazinon** (*Diazinon* 50W) – Organophosphate. **RESTRICTED-USE PESTICIDE.**

- **endosulfan** (*Thionex 3EC*) - Organochlorine. PHI = 3 days.
- **esfenvalerate** (*Asana XL*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1-3 days. **RESTRICTED-USE PESTICIDE.**

BIOLOGICAL CONTROL: No effective commercial controls are recommended. *Bacillus thuringiensis* kurstaki is a natural biocontrol agent.

CULTURAL CONTROL: No effective commercial controls are recommended. Some growers may scatter bran mixed with *Bacillus thuringiensis* kurstaki and molasses on the bed surface or use protective collars as a physical barrier.

TO DO: None.

European Corn Borer, *Ostrinia nubilalis*

The European corn borer (ECB) is a major pest of fall snap beans and is the most important perennial pest of snap beans in the United States. Shipping from ECB-infested areas to ECB-free areas is difficult. There is little tolerance by processors due to their quality control methods. European corn borers feed on the foliage and pods of snap beans and also bore into stems, thus reducing plant stability. As with CEW, ECB larvae can cause contamination problems during harvest besides direct damage due to feeding and tunneling. There are three to four generations of this pest per year in Virginia.

MONITORING: Blacklight and pheromone traps can be used to monitor moth flight and alert producers of peak moth activity. Traps should be positioned within 1 mile of each bean field and checked three to seven times per week, depending on moth activity. Treatment is recommended when trap catches of ECB moths average >5 per night. However, sprays are most critical during the bud-early bloom and pin stages. Preventive applications should be made at these times, even if trap averages have not reached the treatment threshold.

CHEMICAL CONTROL: In general, insecticides should be applied at three- to seven-day intervals (depending on trap catch numbers) from the pin stage until harvest. This usually results in one to three applications per season. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **acephate** (*Acephate 75WSP*) – Organophosphate. PHI = 14 days.
- **bifenthrin** (*Capture 2EC*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **carbaryl** (*Sevin 80S*) – Carbamate. PHI = 3 days.
- **gamma-cyhalothrin** (*ProAxis 0.5EC*) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **lambda-cyhalothrin** (*Warrior 11M*) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **cypermethrin** (*Mustang Max 0.8EC*) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**
- **esfenvalerate** (*Asana XL*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1-3 days. **RESTRICTED-USE PESTICIDE.**
- **methoxyfenozide** (*Intrepid 2F*) – Diacylhydrazine IGR. PHI = 7 days.
- **spinetoram** (*Radiant 11.7SC*) – Spinosad. PHI = 3 days.

- **spinosyn** (*SpinTor*) – Spinosad. PHI = 3 days.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: No effective commercial controls are recommended.

TO DO:

- Keep acephate (*Orthene*) labeled as a tool for resistance management.
- Research new chemistries and secure new labels.
- Keep less expensive insecticides on market. New materials are cost prohibitive depending on the market and the intended use of the bean crop.

Lesser Cornstalk Borer, *Elasmopalpus lignosellus*

Lesser cornstalk borer is a major problem in specific fields. In particular, it is prevalent anywhere near sweet or field corn. It is not a pest of snap beans in Delaware.

MONITORING: No specific monitoring protocol is recommended.

CHEMICAL CONTROL: See “Summary – Chemical Arthropod Control” for application rates and other information.

- **gamma-cyhalothrin** (*ProAxis* 0.5EC) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **lambda-cyhalothrin** (*Warrior* 11M) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **cypermethrin** (*Mustang Max* 0.8EC) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**

BIOLOGICAL CONTROL: No effective commercial controls are recommended. Natural enemies include lacewings and flower bugs.

CULTURAL CONTROL: No effective commercial controls are recommended.

TO DO:

- Research efficacy of *Cruiser* and other seed insecticides.
- Educate growers on identification, scouting, and control of lesser cornstalk borer.
- Develop scouting regimens, and determine a treatment threshold by monitoring previous crops to prevent infestations in future crops.

Mexican Bean Beetle, *Epilachna varivestis*

The Mexican bean beetle (MBB) and its larvae can be particularly devastating in wet years. Otherwise, these pests are not usually a problem in Virginia, Delaware, and North Carolina snap bean fields. There are two to three generations per year in Virginia. Adults overwinter in hedgerows, ditch banks, and woodlands near host plants, becoming active in late April to early May. MBB adults and larvae feed between the veins on the surface of leaves and leave a skeletonized network of tough tissues. The remaining tissues eventually die and turn brown. This diminishes photosynthesis and productivity, leading to reduced yields and poor pod quality if defoliation is greater than 10% after the bloom period. Economic damage tends not to occur before late July.

MONITORING: Each week, monitor snap bean plants for defoliation resulting from MBB feeding along field margins adjacent to potential overwintering sites. If plants are young,

examine all plants within 3 feet of row. Count the number of adults and larvae, and estimate the percentage of defoliation. Large plants can be checked using a sweep net or drop cloth. Chemical treatment is recommended if the population is >6 beetles/row foot (pretrifoliate stage), >2 beetles/plant and/or defoliation exceeds 20% during prebloom, or defoliation >10% and populations are increasing between the bud stage and harvest.

CHEMICAL CONTROL: Apply insecticides during hatch or adult emergence when both eggs and pupae are present. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **acephate** (*Acephate* 75WSP) – Organophosphate. PHI = 14 days.
- **acetamiprid** (*Assail* 30SG) – Neonicotinoid. PHI = 7 days.
- **azadirachtin** (*Aza-Direct* 1.2EC) – Limonoid IGR. PHI = 0 days.
- **carbaryl** (*Sevin* 80S) – Carbamate. PHI = 3 days.
- **gamma-cyhalothrin** (*ProAxis* 0.5EC) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **lambda-cyhalothrin** (*Warrior* 11M) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **cypermethrin** (*Mustang Max* 0.8EC) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**
- **dimethoate** (Dimethoate 4EC) – Organophosphate. PHI = 7 days.
- **disulfoton** (*Di-Syston* 15G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**
- **endosulfan** (*Thionex* 3EC) - Organochlorine. PHI = 3 days.
- **esfenvalerate** (*Asana XL*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **malathion** (*Malathion* 5EC) – Organophosphate. PHI = 1 day.
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1-3 days. **RESTRICTED-USE PESTICIDE.**
- **phorate** (*Thimet* 20G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**
- **pyrethrin** (*Bug Buster-O* 1.4EC) – Botanical.
- **thiamethoxam** (*Cruiser 5FS* 48SC) – Neonicotinoid.

BIOLOGICAL CONTROL: North Carolina and Delaware growers use *Pediobius foveolatus* (parasitic wasps) to provide control. Natural enemies include lacewings and flower bugs.

CULTURAL CONTROL: No practical control options exist, although trap crops may be effective. A mixture of snap beans and soybeans may be planted early (at least three weeks before the main crop) to control overwintered beetles. Trapped beetles could then be destroyed using chemical controls, or simply plowed under.

TO DO:

- Determine why MBB is no longer a problem. Did biocontrol work?

Potato Leafhopper, *Empoasca fabae*

Both potato leafhopper (PLH) nymphs and adults feed by piercing the undersides of leaves and sucking out the plant sap. These pests also produce a toxin in their saliva that damages photosynthetic tissue. The toxin leaves a characteristic “hopper burn” that affects the plant’s ability to produce food. Initially, leafhopper feeding causes stippling of the leaf surface followed by rolling and yellowing of leaves and, in severe cases, leaf or plant death. Yield losses may be

high with large PLH populations. Damage is typically worse in dry years. In Delaware, 35% of the snap bean acreage is treated for leafhoppers. Potato leafhoppers are present in the South but are not a problem on snap beans in Virginia and North Carolina. Additionally, PLH populations are less likely to cause damage once pods have developed.

MONITORING: Sampling for PLH is usually done by examining the leaves or by sweep net each week from the seedling stage through the time when pods appear. In Delaware, treatment is usually begun when >250 individuals are found per 20 sweeps during prebloom, or >500 individuals per 20 sweeps during pod development. Treatment is begun when more than one or two adults are found per sweep.

CHEMICAL CONTROL: See “Summary – Chemical Arthropod Control” for application rates and other information.

- **acephate** (*Acephate* 75WSP) – Organophosphate. PHI = 14 days.
- **acetamiprid** (*Assail* 30SG) – Neonicotinoid. PHI = 7 days
- **azadirachtin** (*Aza-Direct* 1.2EC) – Limonoid IGR. PHI = 0 days.
- **bifenthrin** (*Capture* 2EC) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **carbaryl** (*Sevin* 80S) – Carbamate. PHI = 3 days.
- **lambda-cyhalothrin** (*Warrior* 11M) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **cypermethrin** (*Mustang Max* 0.8EC) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**
- **dimethoate** (*Dimethoate* 4EC) – Organophosphate. PHI = 7 days.
- **endosulfan** (*Thionex* 3EC) - Organochlorine. PHI = 3 days.
- **esfenvalerate** (*Asana XL*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **imidacloprid** (*Provado* 1.6F) – Neonicotinoid. PHI = 7 days.
- **malathion** (*Malathion* 5EC) – Organophosphate. PHI = 1 day.
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1-3 days. **RESTRICTED-USE PESTICIDE.**
- **phorate** (*Thimet* 20G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**
- **pyrethrin** (*Bug Buster-O* 1.4EC) – Botanical.
- **thiamethoxam** (*Cruiser 5FS* 48SC) – Neonicotinoid.

BIOLOGICAL CONTROL: No effective commercial controls are recommended. Natural predators of potato leafhoppers include lacewings and flower bugs, which should be conserved if possible.

CULTURAL CONTROL: Alternative control procedures include the use of insecticidal soap/oil, neem, rotenone, or *Bacillus thuringiensis* kurstaki.

TO DO:

- Maintain dimethoate labeling for potato leafhopper for its low cost and to facilitate resistance management.
- Research which varieties are most susceptible to leafhopper infestations.

Seed Corn Maggot, *Hylemya platura*

The seed corn maggot (SCM) is most noted for its damage to sprouting seeds (particularly those planted early), which may completely inhibit or harm plant development. Adults emerge as early as late February to feed and lay their eggs in newly plowed, moist, organically rich soils. Flies are also known to oviposit (lay eggs) at the base of overwintered spinach plants. Problems tend to be most severe during cool, wet growing seasons. Larvae, or maggots, hatch from the eggs and bore into seeds, cotyledons, or rotting crop debris. The maggots feed for one to three weeks before tunneling into the soil, where they either pupate for about one to four weeks or for the rest of the winter. Multiple generations occur annually.

MONITORING: Treatments are ineffective once seed corn maggot damage has been observed. Therefore, any pesticide(s) must be applied to high-risk fields before planting. (High-risk fields are those with prior infestations of SCM.)

CHEMICAL CONTROL: Optimal control is achieved by using seed treatments such as *Thiram 65WP* + *Chloroneb 65WP* or *Apron XS LS*. Seed protectants containing diazinon or chlorpyrifos are also effective. In Delaware, 50% of the snap beans are treated using *Lorsban*. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **chlorpyrifos** (*Lorsban 50W*) – Organophosphate.
- **cypermethrin** (*Mustang Max 0.8EC*) – Synthetic pyrethroid. PHI = 1 day.

RESTRICTED-USE PESTICIDE.

- **phorate** (*Thimet 20G*) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**
- **thiamethoxam** (*Cruiser 5FS 48SC*) – Neonicotinoid.

BIOLOGICAL CONTROL: No effective commercial controls are recommended. Natural enemies include parasitic nematodes and wasps.

CULTURAL CONTROL: Several management practices can be used to reduce the potential for damage resulting from SCM infestations. These include plowing weeds or cover crops at least two weeks before planting; avoiding overfertilization with manure, especially around planting time; and plowing under crop debris immediately after harvest to prevent plant remnants.

TO DO:

- Research and develop alternate controls. The loss of organophosphate pesticides may leave growers with few, if any, controls. *Cruiser* is a viable control, but only a few acres have been treated to date.
- Conduct research on SCM monitoring methods and disseminate information to growers via Extension activities.

Thrips, *Neohydrathrips variabilis*

Thrips are tiny, spindle-shaped insects that feed primarily on the developing leaflets of seedling snap bean plants within the first six to eight weeks after planting. Their feeding results in leaf crinkling, yellowed leaves, delayed maturity, reduced yields, and plant stunting. If seasonal growing conditions are favorable, beans will outgrow early injuries with no reduction in yield. However, thrips are a major source of damage in North Carolina, Virginia, and Delaware. More than 10% of the snap beans are treated for this pest. Virginia farmers ranked thrips as their most important pest in a 2004 survey. Snap bean growers are particularly concerned with thrips feeding on flower buds and developing beans. This feeding activity leaves small brown scars

that make the beans unmarketable. Thrips may complete several generations per season in Virginia under favorable conditions.

MONITORING: Scout snap beans beginning at plant emergence and continue for approximately six weeks after planting. Alternatively, thrips populations can be monitored and insecticide applications should be made if the pests are present from cotyledon stage to when the first true leaves are established and/or when the first blossoms form. In Delaware, it is recommended that samples be taken from when the plants emerge to the bloom stage. Collect five leaves in each of 10 locations throughout the field and count the number of thrips per leaflet. Leaves should be taken from the middle and from the top half of nonconsecutive plants. If the thrips population is >6 per leaflet, treatment may be necessary. However, if plants are stressed due to drought or the presence of other pests, the treatment threshold may be lowered to two to three thrips/leaflet.

CHEMICAL CONTROL: Insecticides may be applied at planting to help prevent thrips infestations. However, foliar applications are often needed from the cotyledon stage to when the first true leaves appear and/or when the first blossoms emerge. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **acephate** (*Acephate* 75WSP) – Organophosphate. PHI = 14 days.
- **acetamiprid** (*Assail* 30SG) – Neonicotinoid. PHI = 7 days.
- **azadirachtin** (*Aza-Direct* 1.2EC) – Limonoid IGR. PHI = 0 days.
- **bifenthrin** (*Capture* 2EC) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **boric acid** (*Prev-Am* 1EC) – Inorganic.
- **carbaryl** (*Sevin* 80S) – Carbamate. PHI = 3 days.
- **gamma-cyhalothrin** (*ProAxis* 0.5EC) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **cypermethrin** (*Mustang Max* 0.8EC) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.**
- **disulfoton** (*Di-Syston* 15G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1-3 days. **RESTRICTED-USE PESTICIDE.**
- **phorate** (*Thimet* 20G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**
- **pyrethrin** (*Bug Buster-O* 1.4EC) – Botanical.
- **spinetoram** (*Radiant* 11.7SC) – Spinosad. PHI = 3 days.
- **spinosyn** (*SpinTor*) – Spinosad. PHI = 3 days.
- **thiamethoxam** (*Cruiser 5FS* 48SC) – Neonicotinoid.

BIOLOGICAL CONTROL: No effective commercial controls are recommended. Natural enemies include flower bugs, lacewings, and predatory mites.

CULTURAL CONTROL: Later planting in spring often helps to reduce thrips pressure in snap beans. Insecticidal oils or soaps may be used for thrips control. Thrips are not generally a problem in fall snap beans.

TO DO:

- Give information to growers describing how to identify thrips damage.
- Determine the impact of thrips on crop yield (demo plots in Northampton County, VA).

- Conduct research to determine efficacy of all currently labeled materials.
- Conduct research to identify which thrips species are present on snap beans.
- Keep acephate (*Orthene*) labeled for resistance management.

Other Insect Pests of Snap Beans

Examples of some sporadic pests of snap beans include bean aphids (*Aphis fabae*: in Virginia, soybean aphids are a problem only in upper Accomack County); beet armyworms (*Spodoptera exigua*: sporadic from year to year, but devastating when an infestation occurs); tarnished plant bugs (*Lygus* spp.); stink bugs (*Acrosternum hilare* and *Euschistus servus*); cabbage loopers (*Trichoplusia ni*); leafminers (*Liriomyza* spp.); and whiteflies (Family Aleyrodidae).

MONITORING: In North Carolina, the treatment threshold for tarnished plant bug is more than 15 adults or nymphs per 50 sweeps from pin-pod stage to harvest. Beet armyworms and cabbage loopers should be treated when more than 15 are found per 3 feet of row. Treatment should begin for whiteflies when more than five adults are found per expanded leaflet. Aphids are treated only if >50% of terminals have more than five individuals, when weather conditions favor aphid problems, and if natural enemies are absent.

CHEMICAL CONTROL: See “Summary – Chemical Arthropod Control” for treatment options and application rates.

BIOLOGICAL CONTROL: No commercial controls are recommended.

CULTURAL CONTROL: No commercial controls are recommended.

TO DO:

- Create educational programs or distribute fact sheets on insect identification to prevent misidentification. For example, aphids may be confused with other insects.
- Develop newer, cheaper chemicals to control beet armyworms.

MITES

Two-Spotted Spider Mite, *Tetranychus urticae*

Spider mites feed mainly on the undersides of the leaves. Their feeding causes white stippling and leaf yellowing at first, followed by leaf browning and death. Typically, two-spotted spider mites are devastating in hot, dry weather. Severe infestations may result in reduced yield, poor quality beans, or plant death. During the past several years, mite problems have become more numerous in Virginia. In a recent survey, 20% of Virginia snap bean growers said mites are important pests. Spider mites are only a sporadic pest in North Carolina snap beans. During outbreak years in Delaware, 10% of the acreage is treated for mites.

MONITORING: Scout fields early in the season, especially in areas that border roadsides or grassy, weedy edges. From early July to mid-August, examine five leaflets in 10 locations throughout the field. Pay attention to both the upper and lower sides of the leaves, and look for white stippling along the base of the leaflets, at the midrib, and along the veins. Mites can be counted either by shaking leaves onto white paper and observing their movement, or by using a hand lens. Begin treatment if there is white stippling and if you see more than 20 mites per leaflet. Once populations explode, it is very difficult to control spider mites effectively.

CHEMICAL CONTROL: Spot treatment of “hot spots” and areas along the edges of fields is recommended to control mite populations when white stippling along veins on the undersides of leaves is first noticed and when >10 mites per trifoliolate are observed. *Kelthane MF* and *Capture 2EC* are excellent miticides. See “Summary – Chemical Arthropod Control” for application rates and other information.

- **azadirachtin** (*Aza-Direct* 1.2EC) – Limonoid IGR. PHI = 0 days.
- **bifenthrin** (*Capture* 2EC) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.**
- **boric acid** (*Prev-Am* 1EC) – Inorganic.
- **gamma-cyhalothrin** (*ProAxis* 0.5EC) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.**
- **dicofol** (*Kelthane MF*) – Organochlorine. PHI = 21 days.
- **dimethoate** (Dimethoate 4EC) – Organophosphate. PHI = 7 days.
- **disulfoton** (*Di-Syston* 15G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**
- **malathion** (*Malathion* 5EC) – Organophosphate. PHI = 1 day.
- **phorate** (*Thimet* 20G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.**

BIOLOGICAL CONTROL: Natural enemies (e.g., predatory mites, lady beetles, and lacewings) and diseases often keep mite populations under control. Spraying for CEW and other insect pests can disrupt beneficial populations and cause mite populations to grow rapidly.

CULTURAL CONTROL: Spider mites will readily move into snap beans when corn dries or is harvested, and if infested weedy borders are mowed. If possible, avoid these activities until after snap beans are harvested to help prevent infestations. Horticultural oils may help control spider mites.

TO DO:

- Need labels for new chemicals. Many are out there but are not yet labeled for use on snap beans.

SUMMARY – CHEMICAL ARTHROPOD CONTROL

The most recent pesticide use survey for snap beans grown in Virginia was completed in 1992. According to this report, insecticides were used by 73.1% of producers on 4,223 treatment acres of snap beans grown in Virginia. However, producers vary in the types of insecticides they are applying. Therefore, anecdotal data were used to estimate insecticide usage on snap beans. North Carolina Agricultural Statistics for 2007 indicate that the most commonly applied insecticides were acephate (85% of snap bean area), esfenvalerate (10% of snap bean area), endosulfan (3% of snap bean area), and carbaryl (2% of snap bean area). Snap bean acreage for North Carolina in 2006 was 7,200 acres.

Always read the label before applying any chemicals, and be sure to follow the rates specified for the crop of interest. The following recommendations are from the 2008 Virginia Pest Management Guide, the 2008 Vegetable Crop Handbook for Southeastern United States, the 2007 Commercial Vegetable Production Recommendations for Virginia, and labels acquired

from the Kelley Registration Systems Pesticide Database for Virginia (<http://www.kellysolutions.com/va/pesticideindex.htm>).

- **acephate** (*Acephate* 75WSP) – Organophosphate. PHI = 14 days. For control of aphids, armyworms, BLB, bean leafrollers, cabbage loopers, CEW, cutworms, ECB, fleahoppers, leafhoppers, Lygus bugs, MBB, plant bugs, soybean loopers, thrips, and whiteflies, apply at a rate of 0.5 – 1.0 lb. a.i./A. Reapply every 7 to 10 days, as necessary. Do not feed treated vines to livestock. Almost all of the snap bean acreage in Virginia is sprayed for thrips control. Acephate accounts for approximately 50% of the product used in this general application. REI = 24 hours.
- **acetamiprid** (*Assail* 30SG) – Neonicotinoid. PHI = 7 days. For control of aphids, leafhoppers, cucumber beetles, BLB, MBB, whiteflies, and thrips, apply 0.047 – 0.100 lb. a.i./A (2.5 – 5.3 oz. product). Begin applications when treatment thresholds have been reached, do not make more than 3 applications per season, do not apply more than once every 7 days, and do not exceed 0.3 lb. a.i. (16 oz. product)/A/growing season. REI = 12 hrs.
- **azadirachtin** (*Aza-Direct* 1.2EC) – Limonoid IGR. PHI = 0 days. For control of MBB, Japanese beetles, aphids, borers, true bugs, caterpillars, flies, leafhoppers, leafminers, whiteflies, mites, thrips, and other pests on beans, use 1 – 2 pts./A. Up to 3.5 pts. may be used if infestation is heavy. Do not use less than 5 oz./A product alone. REI = 4 hours.
- ***Bacillus thuringiensis*** (*XenTari* Dry Flowable) – Bacterial biological. PHI = 0 days. For control of loopers, green cloverworms, velvetbean caterpillars, armyworms, and podworms, apply 0.5 to 2.0 lbs./A. REI = 4 hours.
- **bifenthrin** (*Capture* 2EC) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.** For control of aphids, armyworms, cucumber beetles, Japanese beetles, plant bugs, stink bugs, loopers, cutworms, whiteflies, BLB, CEW, ECB, spider mites (higher rate), and thrips, apply at a rate of 0.025 – 0.10 lb. a.i. (1.6 – 6.4 fl. oz.)/A. Do not exceed 0.20 lb. a.i./A/season. Bifenthrin is typically applied twice during the growing season, first for early control of BLB and later for control of CEW. It was estimated that this chemical was used on 50% of the snap bean acreage during the 2000 growing season. REI = 9 hours.
- **boric acid** (*Prev-Am* 1EC) – Inorganic. For control of downy mildew and powdery mildew, brown rust, aphids, beet armyworms, mites, Lygus bugs, thrips, and whiteflies, apply at a rate of 50 – 100 fl. oz./100 gal. water. Spray every 7 – 10 days. REI = 12 hrs.
- **buprofezin** (*Courier* 40SC) – Thiadiazine IGR. PHI = 14 days. For control of whiteflies in snap beans, use at a rate of 9.0 – 13.6 fl. oz./A. Wait at least 14 days between applications. Do not use more than 0.76 lb. a.i./A/crop cycle. REI = 12 hrs.
- **carbaryl** (*Sevin* 80S) – Carbamate. PHI = 3 days. For control of BLB, Japanese beetles, MBB, velvetbean caterpillars, CEW, CPB, flea beetles, leafhoppers, thrips, cutworms, armyworms, ECB, plant bugs, and loopers, apply at a rate of 0.625 – 1.875 lbs. product/A. Repeat applications as necessary up to 4 times, but not more than once every 7 days. Wait 14 days before allowing livestock to graze or harvesting for forage. Do not apply more than 7.5 lbs./A/crop. Carbaryl may cause mite populations to flare and should not be used if they are present. Carbaryl is not often used by producers but is functional as a control option. REI = 12 hours.
- **chlorpyrifos** (*Lorsban* 50W) – Organophosphate. For use on snap beans as preplant slurry seed treatment to protect seeds and seedlings from seed corn beetles and seed corn maggots,

apply at a rate of 2 oz./100 lbs. seed. Not for on-farm use, but seeds can be purchased pretreated with this chemical. REI = 24 hrs.

- **gamma-cyhalothrin** (*ProAxis* 0.5EC) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.** For control of cutworms, caterpillars, beetles, aphids, CEW, ECB, armyworms, grasshoppers, Japanese beetles, loopers, stalk borers, thrips, stink bugs, lesser cornstalk borers, whiteflies, mites, and other pests, apply at a rate of 0.0075 – 0.0150 lb. a.i./A (1.92 – 3.84 fl. oz./A). Wait at least 5 days before reapplying. Do not apply more than 0.06 lb. a.i. (0.96 pt.)/A/season. Do not graze livestock in treated areas or harvest vines for storage or hay. REI = 24 hrs.
- **lambda-cyhalothrin** (*Warrior* 11M) – Synthetic pyrethroid. PHI = 7 days. **RESTRICTED-USE PESTICIDE.** For control of MBB, BLB, CEW, cutworms, ECB, beet armyworms, leafhoppers, stinkbugs, lesser cornstalk borers, and Lygus bugs, apply at a rate of 0.015 – 0.030 lb. a.i./A. Do not graze livestock in treated areas or harvest vines for storage or hay. REI = 24 hours.
- **cypermethrin** (*Mustang Max* 0.8EC) – Synthetic pyrethroid. PHI = 1 day. **RESTRICTED-USE PESTICIDE.** For control of cutworms, armyworms, BLB, ECB, CEW, corn rootworms, cucumber beetles, ICW, Japanese beetles, leafhoppers, leafminers, MBB, pea weevils, plant bugs, PLH, seedcorn beetles, SCM, other caterpillars, aphids, grasshoppers, lesser cornstalk borers, loopers, stink bugs, thrips, and whiteflies, apply 1.28 – 4.00 oz. (0.008 – 0.025 lb. a.i.)/A. Wait at least 5 days before reapplying. Do not apply more than 0.15 lb. a.i./A/season. REI = 12 hours.
- **diazinon** (*Diazinon* 50W) – Organophosphate. **RESTRICTED-USE PESTICIDE.** For control of cutworms and wireworms, apply 4 – 8 lbs./A. Do not apply more than once per year. Broadcast just before planting and immediately incorporate into the soil. REI = 3 days.
- **dicofol** (*Kelthane* MF) – Organochlorine. PHI = 21 days. For control of spider mites, apply at a rate of 0.38 – 0.50 lb. a.i./A. Do not feed treated crops or crop residues to animals. Dicofol is used only for mite outbreaks, which are usually common during periods of hot, dry weather. REI = 12 hours.
- **dimethoate** (*Dimethoate* 4EC) – Organophosphate. PHI = 7 days. For control of BLB, spider mites, aphids, grasshoppers, leafhoppers, leafminers, Lygus bugs, and MBB, apply at a rate of 0.5 – 1.0 pt./A. Do not ensile or feed bean refuse from treated crops to livestock. Do not apply if bees are visiting the areas to be treated when crops or weeds are in bloom. As mentioned under the listing for acephate, almost all of the snap bean acreage in Virginia is sprayed for thrips. Dimethoate accounts for the remaining 50% of the product used in this application. REI = 48 hours.
- **disulfoton** (*Di-Syston* 15G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.** For early-season control of mites and thrips, and to reduce MBB injury, apply granules at planting at a rate of 1 – 2 lbs. a.i./A. Do not place granules in contact with seed. Applications will generally last 4 to 6 weeks. Do not apply more than once per season. Not often used by producers but functional as a control option. REI = 48 hours.
- **endosulfan** (*Thionex* 3EC) - Organochlorine. PHI = 3 days. For control of aphids, cucumber beetles, flea beetles, green stink bugs, leafhoppers, MBB, armyworms, cutworms, and whiteflies, apply at a rate of 0.67 – 1.30 qts. product (0.5 – 1.0 lb. a.i.)/A. Do not apply more than 3 times/year. Do not apply more than 3 lbs. a.i. (4 qts. product)/A/year. REI = 24 hrs.
- **esfenvalerate** (*Asana XL*) – Pyrethroid. PHI = 3 days. **RESTRICTED-USE PESTICIDE.** For control of MBB, CEW, ECB, leafhoppers, cutworms, and soybean aphids, apply at a rate

of 0.015 – 0.050 lb. a.i./A. Do not exceed 0.20 lb. a.i./A/season. Do not feed treated vines to livestock. The use of bifenthrin has reduced the use of esfenvalerate. However, it is still an important tool for producers. REI = 12 hours.

- **imidacloprid** (*Provado* 1.6F) – Neonicotinoid. PHI = 7 days. For control of aphids, leafhoppers, and whiteflies, use 3.5 fl. oz./A. The maximum interval between applications is 7 days. Do not use more than 10.5 fl. oz/A (0.13 lb. a.i./A) per season. REI = 12 hours.
- **malathion** (*Malathion* 5EC) – Organophosphate. PHI = 1 day. For control of MBB, leafhoppers, aphids, cucumber beetles, BLB, blister beetles, Lygus bugs, spider mites, and Japanese beetles, apply 1.5 – 2.0 pts./A. Do not feed treated vines/forage to livestock or allow livestock to graze in treated fields. REI = 12 hours.
- **methomyl** (*Lannate LV*) – Carbamate. PHI = 1 – 3 days. **RESTRICTED-USE PESTICIDE.** For control of leafhoppers, MBB, armyworms, cutworms, CEW, Lygus bugs, thrips, aphids, loopers, ECB, and cucumber beetles, apply at a rate of 0.75 – 3.00 pts./A. Do not apply more than 4.5 lbs. a.i./A/crop. Do not make more than 10 applications/crop. Wait 3 days before feeding vines to livestock and 7 days before using as hay. Methomyl may be used by producers in certain years, especially for pests such as beet armyworm, but it is often replaced with bifenthrin. REI = 48 hours.
- **methoxyfenozide** (*Intrepid* 2F) – Diacylhydrazine IGR. PHI = 7 days. For control of loopers, armyworms, ECB, hornworms, CEW, and tomato pinworms on succulent legumes, including snap beans, apply at a rate of 4 – 16 fl. oz./A (0.06 – 0.25 lb. a.i./A), using lower rates for early-season applications and higher rates when infestations reach threshold levels. Reapply at 7-day intervals. Do not make more than 4 applications/A/season. Do not apply more than 16 fl. oz./A/application or 64 fl. oz. product/A/season (1 lb. a.i.). REI = 4 hrs.
- **phorate** (*Thimet* 20G) – Organophosphate. PHI = 60 days. **RESTRICTED-USE PESTICIDE.** For early-season control of MBB, leafhoppers, aphids, Lygus bugs, thrips, mites, and seed corn maggots, apply granules at planting time at a rate of 4.5 – 9.4 oz. product per 1,000 ft. of row. Do not place granules in contact with seed. Applications will generally last 4 to 6 weeks. Do not graze or feed hay or forage to livestock. Do not make more than one application/crop/season. Phorate is not often used by producers but is functional as a control option. REI = 48 hours.
- **pyrethrin** (*Bug Buster-O* 1.4EC) – Botanical. For control of beetles, caterpillars, aphids, leafhoppers, thrips, bugs, and other pests on snap beans, use 2.5 tbsp./gal. water. Spray thoroughly, making contact with pests on upper and lower leaf surfaces. Begin spraying when insects first appear, not when infestations become heavy. Apply in early morning or late evening to avoid harming honeybees.
- **pyriproxyfen** (*Knack*) – Pyridine IGR. PHI = 7 days. For control of whiteflies on snap beans, apply at a rate of 8 – 10 fl. oz. Do not apply more than twice per growing season. Do not use more than 20 fl. oz. product/A/season. Wait at least 14 days between treatments. Do not allow livestock to graze treated areas. Do not use on legume vegetables grown for livestock feed. REI = 12 hrs.
- **spinetoram** (*Radiant* 11.7SC) – Spinosad. PHI = 3 days. For control of ECB, armyworms, CEW, loopers, dipterous leafminers, and thrips on snap beans, apply 3 – 8 fl. oz/A. Do not apply more than 28 fl. oz. product (0.219 lb. a.i./A)/crop. Do not make more than 6 applications per crop. Do not make applications more than 3 or 4 days apart. REI = 4 hrs.
- **spinosyn** (*SpinTor*) – Spinosad. PHI = 3 days. For control of ECB, armyworms, CEW, loopers, leafminers, and thrips on succulent and dried beans and peas (including snaps), apply

3 – 5 fl. oz./A. Do not make more than 6 applications per crop. Do not apply more than 0.45 lb. a.i./A/season. REI = 4 hours.

- **thiamethoxam** (*Cruiser 5FS 48SC*) – Neonicotinoid. PBI = 120 days. For early-season control of aphids, BLB, MBB, plant leafhoppers, SCM, thrips, and wireworms in seedlings, apply 0.04 lb. a.i./100 lbs. of seed. REI = 12 hours.

SNAP BEAN DISEASES

The most troublesome diseases for snap bean producers over the last five years have been snap bean rust, root rots, and white mold. Weather conditions greatly affect the incidence of disease, and certain conditions favor some more than others do. For the most part, proper management techniques, including preventive sprays, can greatly reduce disease problems. Anthracnose and bacterial blight may also damage snap beans in certain areas under specific conditions.

However, occurrence of these diseases is rare and can usually be prevented by proper crop rotation and use of western-grown seed.

Anthracnose, *Colletotrichum lindemuthianum*

Anthracnose is common in cool, wet weather; a long wet period is necessary for the disease to proliferate. Anthracnose is spread via wind-blown rain, insects, field workers, and infected machinery. The disease overwinters in bean seed and some plant material.

MONITORING: Symptoms appear on leaves, stems, and pods. Cankers appear on stems or leaf veins and are dark brown or black, ovular, and have purple edges. However, pods may develop small reddish spots. A brown border develops around sunken spots, and the centers may exude a pink slime in wet weather.

CHEMICAL CONTROL: Chemicals applied to control rust usually control anthracnose as well. See “Summary – Chemical Disease Control” for application rates and other information.

- **azoxystrobin** (*Quadris Flowable 2F*) – Methoxyacrylate. PHI = 0 days (succulent, but not dry, beans).
- **potassium bicarbonate** (*Greencure*) – Inorganic. PHI = 0 days.
- **pyraclostrobin** (*Headline 23.6EC*) – Strobilurin. PHI = 7 days.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Use disease-free western-grown seed, avoid working in wet fields or with wet plants, rotate beans every three years, and plow infected plant material deeply into the ground. Anthracnose-resistant bean varieties are available, but they are only resistant to certain races of the disease, so control may not be complete.

TO DO: None.

Bacterial Blight, *Xanthomonas campestris*

Xanthomonas campestris overwinters in seeds and plant debris. Plant material may remain infective for up to one year. Bacterial blight spreads via infected soil splashing onto healthy plants when it rains as well as on contaminated equipment.

MONITORING: The first symptoms are small, water-soaked or transparent spots on the underside of leaves. The spots then grow larger, fuse, and develop a dry, reddish brown center with a yellow border. Bean leaves later dry up and drop off. The bean pods may develop similar lesions and become shriveled. Seedlings exhibit lesions with yellow ooze or white crust in wet or humid weather.

CHEMICAL CONTROL: Copper fungicides help control bacterial blight when disease pressure is low. See “Summary – Chemical Disease Control” for application rates and other information.

- **copper** (*KOP-R-Spray Concentrate* 0.8EC) – Inorganic. PHI = 0 days.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Rotate crops, and avoid planting beans within two years of planting other legumes. Sanitation is key; be sure to plow under plant material immediately after harvest. Do not work in wet fields or with wet plants to avoid spreading pathogens. Use disease-free western-grown seed. Clean contaminated equipment to minimize the spread of disease.

TO DO: None.

Gray Mold, *Botrytis cinerea*

Gray mold, or Botrytis, appears as gray fungal growth on leaves or pods. This fungus reduces the photosynthetic potential of leaves, but pod damage is the most economically harmful. Gray mold is rarely a problem in snap beans unless cool, wet weather occurs for an extended period.

MONITORING: Gray mold can be identified by the presence of a gray mass of mycelium on various plant parts.

CHEMICAL CONTROL: Spray when 25% – 50% of plants are in the bloom stage and repeat at peak bloom. See “Summary – Chemical Disease Control” for application rates and other information.

- **boscalid** (*Endura* 70WDG) – Carboxamide/anilide. PHI = 7 days.
- **cyprodinil + fludioxinil** (*Switch* 62.5WG) – Anilinopyrimidine + phenylamide. PHI = 7 days.
- **potassium bicarbonate** (*Greencure*) – Inorganic. PHI = 0 days.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Practice crop rotation, plant in areas with good airflow, keep plants well separated within rows, and plow rows farther apart.

TO DO: None.

Mosaic Viruses

Mosaic viruses (e.g., common bean mosaic, southern bean mosaic, and yellow bean mosaic) are spread among snap bean plants by way of insect vectors. The first two viruses listed are also seed borne. Mosaic viruses are usually only problematic when planted after clover or next to clover fields.

MONITORING: These viruses cause stunting, reduced yields, and leaf mottling. Bean plants also tend to be smaller and bunchier. There may be fewer bean pods that are smaller than normal and curled.

CHEMICAL CONTROL: Chemical products do not control mosaic viruses. However, chemicals used to control the insect vectors may offer some protection.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Do not plant snap beans in fields where red clover was planted or within 700 feet of red clover fields. Clean up weeds surrounding bean fields, use resistant varieties, and plant only certified seed.

TO DO: None.

Pod Rot (*Pythium* spp., *Botrytis* spp., and *Rhizoctonia* spp.)

Pod rot can be a moderate to severe problem in snap bean fields but occurs sporadically from year to year. Virginia growers rank pod rot as the third most important disease occurring in snap beans. It is a consistent problem in the mountains of North Carolina during the fall. In the Coastal Plains, the disease seems to occur more often in particular fields and is frequently found in bottoms.

MONITORING: No thresholds have been established for snap beans.

CHEMICAL CONTROL: See “Summary – Chemical Disease Control” for application rates and other information.

- **azoxystrobin** (*Quadris Flowable 2F*) – Methoxyacrylate. PHI = 0 days (succulent, but not dry, beans).
- **boscalid** (*Endura 70WDG*) – Carboxamide/anilide. PHI = 7 days.
- **cyprodinil + fludioxinil** (*Switch 62.5WG*) – Anilinopyrimidine + phenylamide. PHI = 7 days.
- **metalaxyl** (*Ridomil Gold PC GR*) – Acylalanine.
- **myclobutanil** (*Rally 40WSP*) – Triazole. PHI = 0 days.
- **potassium bicarbonate** (*Greencure*) – Inorganic. PHI = 0 days.
- **trichoderma harzianum** (*T-22 HC 1.15WP*) – Bacterial biofungicide.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Rotate beans with crops other than legumes. Avoid poorly drained soils. Plow under previous crop residue rather than disking it. Select varieties that set high in the plant. Use a close row spacing to avoid pod contact with the soil to reduce disease incidence.

TO DO:

- Identify the etiology or conditions that contribute to pod rot.
- Ensure there is an effective prevention program in place because pod rot cannot be stopped once beans become infected.
- Research alternative controls, and develop a broad spectrum of materials available for control.
- In particular, develop controls for *Pythium* spp.

Powdery Mildew, *Erysiphe polygoni*

Powdery mildew affects all aerial parts of snap beans. It occurs during periods of high humidity but is not usually serious. Symptoms include dark, round spots on the upper parts of leaves that later develop white, powdery mycelia that may cover the entire leaf. Premature leaf drop may occur when severe infection reduces photosynthetic potential. Pods can also be stunted or shriveled.

MONITORING: No thresholds have been established for snap beans.

CHEMICAL CONTROL: Chemical sprays are rarely necessary. See “Summary – Chemical Disease Control” for application rates and other information.

- *Bacillus pumilis* (Sonata 1.38EC) – Bacterial biofungicide. PHI = 0 days.
- **boric acid** (Prev-Am 1EC) – Inorganic.
- **potassium bicarbonate** (Greencure) – Inorganic. PHI = 0 days.
- **pyraclostrobin** (Headline 23.6EC) – Strobilurin. PHI = 7 days.
- **sulfur** (THAT Flowable Sulfur 6F) – Inorganic.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Use resistant cultivars when available.

TO DO: None.

Root Rot, Damping-off, and Seed Rots *Rhizoctonia* spp., *Fusarium* spp., *Pythium* spp.

Root rot is caused by a complex of soilborne fungi including *Fusarium*, *Rhizoctonia*, and *Pythium* species. *Pythium* is the primary fungus causing root rot in the mid-Atlantic region. This disease thrives in moist, warm environments and causes extensive damage in the summer when these conditions are most common. However, *Rhizoctonia* is better suited to the moist, cool weather common during fall plantings. Root rot is a very serious problem and is the major factor limiting snap bean yield in Virginia, North Carolina, and Delaware.

Fusarium root rot results from infection by *Fusarium solani*. It is the most serious and most common root rot of beans in North Carolina, and snap beans are the main hosts. This root rot occurs in hot weather in acidic and/or poorly fertilized soils. *Fusarium solani* (formerly *F. phaseoli*) is able to survive in the soil for several years without the presence of bean plants. *Fusarium* root rot can be identified by the reddish discoloration that appears on the taproot and grows larger over time. Losses from *Fusarium* root rot can be more severe than those resulting from other root rots. Long-term (four- to five-year) crop rotations with nonlegumes work better to control disease. Other control methods include subsoiling, bed shaping to improve drainage, shallow cultivation, and nematode control.

Rhizoctonia root rot is caused by *Rhizoctonia solani*. It is common during warm weather, but occurs in cooler conditions than those conducive to the development of *Fusarium*. Crop losses vary from year to year. Infection by *R. solani* leads to damping-off and seedling death. This disease attacks the stems of young plants near the soil surface. Older plants, however, develop reddish brown cankers that extend longitudinally along the stem at the soil surface. Crop rotation is not a good option to control *R. solani* because the disease affects so many crops. However, shallow seeding and cultivation may help reduce disease severity. It is also helpful to plant chemically treated seeds and make in-furrow chemical applications at planting time.

Pythium root rot/damping-off/stem rot/hollow stem causes extensive losses on beans in North Carolina. Infection sets in rapidly during wet weather whether temperatures are hot or cold. Disease-causing fungi can survive for several years in the soil and attack many different crops. Many different species of *Pythium* cause the development of cottony white growth on infected stems if humidity is high. Seedbeds that are well drained are less likely to harbor *Pythium*.

Overfertilization is another cause of stem and root rot, especially when fertilizer is applied and seeds are planted around the same time.

MONITORING: No thresholds have been established for snap beans.

CHEMICAL CONTROL: Other factors such as mechanical injury, excessive irrigation and/or precipitation, and pest damage can cause disease-like symptoms to appear. Treatment with either *Ridomil Gold* or *Ridomil Gold PC* is recommended at planting, especially during periods of humid, warm weather. In Virginia, fungicide application for root rot is most often a standard practice at planting. See “Summary – Chemical Disease Control” for application rates and other information.

- **azoxystrobin** (*Quadris Flowable 2F/Dynasty 0.8S*) – Methoxyacrylate. PHI = 0 days (succulent, but not dry, beans).
- **captan** (*Captan 400*) – Carboximide.
- **metalaxyl** (*Ridomil Gold PC GR*) – Acylalanine.
- **PCNB** (*Terraclor 75WP*) – Chlorinated hydrocarbon.
- **thiram** (*Thiram 42S*) – Dithiocarbamate.
- ***Trichoderma harzianum*** (*T-22 HC 1.15WP*) – Bacterial biofungicide.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Avoid continuous rotations of snap beans in areas or fields with poor drainage and/or a history of infection. Residue from previous crops should be plowed under rather than disked into the soil. Snap beans should be alternated with nonlegume crops. Plant seed only in properly fertilized, well-prepared soils, with a pH of approximately 6.5. Also, plant seeds approximately 1 inch deep only during good weather in warm soils on top of beds to avoid drowning. Crop rotations do not always work since fungi are ubiquitous and can survive in the soil for many years.

TO DO:

- Encourage growers to implement crop rotation because it is the most effective method to control this disease.
- Determine control efficacy for spectrum of products and cost effectiveness for seed treatments.
- Research efficacy and costs of bacterial suspensions (e.g., SC27, Actinovate), some of which are applied in furrow or soil incorporated.
- Continue objective research and Extension programs as they relate to pest management.
- Identify alternatives to *Terraclor*.

Snap Bean Rust, *Uromyces appendiculatus*

Snap bean rust is typically only a problem in late summer when warm, humid conditions prevail. The fungus attacks all aboveground green portions of the snap bean plant. Initially, white blisters form on the upper sides of the leaves. Brown powdery spots follow, and then finally black powdery spots appear on both the upper and lower portions of the leaves. In the case of a severe infection, many leaves may die, thus reducing crop productivity. In addition, the appearance of rust on beans repels consumers and reduces the market value. Snap bean rust is less obvious on darker varieties of beans.

MONITORING: No thresholds have been established for snap beans.

CHEMICAL CONTROL: Treat beginning when the disease appears and repeat at seven-day intervals. See “Summary – Chemical Disease Control” for application rates and other information.

- **azoxystrobin** (*Quadris Flowable 2F*) – Methoxyacrylate. PHI = 0 days (succulent, but not dry, beans).
- ***Bacillus subtilis*** (*Serenade Max 14.6WP*) – Bacterial biofungicide. PHI = 0 days.
- ***Bacillus pumilis*** (*Sonata 1.38EC*) – Bacterial biofungicide. PHI = 0 days.
- **chlorothalonil** (*Bravo, Bravo 720, Bravo Ultrex, Terranil*) – Nitrile. PHI = 7 days.
- **myclobutanil** (*Rally 40WSP*) – Triazole. PHI = 0 days.
- **pyraclostrobin** (*Headline 23.6EC*) – Strobilurin. PHI = 7 days.
- **sulfur** (*THAT Flowable Sulfur 6F*) – Inorganic.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: The use of resistant varieties is very common and effective in areas where this disease is prevalent.

TO DO:

- Educate growers and brokers on rust identification because it is often confused with mites, pod spot, thrips, or other brown spots on beans.
- Create an identification fact sheet for brokers and growers.
- Research and screen resistant varieties for adaptability.

Soybean Rust, *Phakopsora pachyrizi*

Asian soybean rust spores can travel long distances via the wind. Optimal disease conditions are wet leaf surfaces (at least six to 12 hours of moisture) and temperatures between 59°F and 82°F. It is currently unknown if soybean rust will become a serious problem in mid-Atlantic snap beans. However, if so, prevention will most likely be the best control method. Asian soybean rust has been detected previously in several states, including North Carolina and Virginia, but not Delaware. Spores have a tough time overwintering in crops but may be able to survive in other hosts, such as kudzu, located in warmer suburban areas of the state.

MONITORING: No specific monitoring protocol is currently recommended.

CHEMICAL CONTROL: See “Summary – Chemical Disease Control” for application rates and other information.

- **azoxystrobin** (*Quadris Flowable 2F*) – Methoxyacrylate. PHI = 0 days (succulent, but not dry, beans).
- ***Bacillus subtilis*** (*Serenade Max 14.6WP*) – Bacterial biofungicide. PHI = 0 days.
- ***Bacillus pumilis*** (*Sonata 1.38EC*) – Bacterial biofungicide. PHI = 0 days.
- **myclobutanil** (*Rally 40WSP*) – Triazole. PHI = 0 days.
- **pyraclostrobin** (*Headline 23.6EC*) – Strobilurin. PHI = 7 days.
- **sulfur** (*THAT Flowable Sulfur 6F*) – Inorganic.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Plant snapbean cultivars that are less susceptible to rust.

TO DO:

- Continue to monitor this disease as it infects snap beans.
- Ensure Section 18 or Section 3 labels are in place in case soybean rust begins to seriously impact snap beans.

Web Blight, *Rhizoctonia solani*

MONITORING: No specific monitoring protocol is currently recommended.

CHEMICAL CONTROL: See “Summary – Chemical Disease Control” for application rates and other information.

- **azoxystrobin** (*Quadris Flowable 2F*) – Methoxyacrylate. PHI = 0 days (succulent, but not dry, beans).
- **metalaxyl** (*Ridomil Gold PC GR*) – Acylalanine.
- **trichoderma harzianum** (*T-22 HC 1.15WP*) – Bacterial biofungicide.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Use western-grown seed. Rotate crops to allow two years between bean plantings.

TO DO: None.

White Mold, *Sclerotinia sclerotiorum*

White mold is caused by a fungus that proliferates in moist conditions within the plant canopy. As the name suggests, white mold is composed of a mass of white mycelia that can invade any part of the bean plant once it has been infected. It can be confused with Pythium pod rot or southern blight. Generally, white mold is only a problem in narrow row plantings or in areas where airflow is limited. However, if the foliage remains constantly wet (e.g., from rain, dew, or irrigation practices), white mold can develop. The wider row spacing (36 inches) found in Virginia typically helps to prevent incidence of this disease, but serious infections may proliferate in wet years. White mold may cause stem rot under certain conditions, especially during periods of warm, moist weather. Virginia growers rank white mold as the second most important snap bean disease.

MONITORING: No thresholds have been established for snap beans.

CHEMICAL CONTROL: Apply a preventive treatment when 70% – 80% of the plants have one or more blossoms. If environmental conditions continue to favor disease development a second application may be necessary, especially if blossoms are still present. See “Summary – Chemical Disease Control” for application rates and other information.

- **Bacillus subtilis** (*Serenade Max 14.6WP*) – Bacterial biofungicide. PHI = 0 days.
- **boscalid** (*Endura 70WDG*) – Carboxamide/anilide. PHI = 7 days.
- **dicloran/dinitril** (*Botran 75W*) – Chloronitrobenzene. PHI = 2 days.
- **cyprodinil + fludioxinil** (*Switch 62.5WG*) – Anilinopyrimidine + phenylamide. PHI = 7 days.
- **iprodione** (*Rovral*) – Dicarboximide. PHI = 0 days.
- **thiophanate-methyl** (*Topsin M*) – Benzimidazole. PHI = 28 days.
- **vinclozolin** (*Ronilan, Curalan*) – Dicarboximide. PHI = 10 days.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Good air circulation is important. Avoid close plantings if possible. No resistant bean varieties are available.

TO DO:

- An educational program on the etiology of the disease is necessary. Identify conditions that favor disease.
- Establish an effective prevention program because the disease cannot be stopped once it starts.
- Develop alternative controls, and ensure a spectrum of materials is available for control.

SUMMARY – CHEMICAL DISEASE CONTROL

The most recent pesticide usage data available were gathered in 1992. The report based on these data estimated that fungicides were used by 31% of producers on 892 treatment acres of snap beans grown in Virginia. Currently producers are using chemicals not included in the survey; therefore, anecdotal data were used to estimate usage for these products.

- **azoxystrobin** (*Quadris Flowable* 2F) – Methoxyacrylate. PHI = 0 days (succulent, but not dry, beans). For control of bean rust (*Uromyces appendiculatus*), anthracnose (*Colletotrichum lindemuthianum*), Alternaria leaf spot (*Alternaria alternata*), Ascochyta leaf spot (*A. phaseolorum*), Ascochyta blight (*Mycosphaerella pinodes*), Ascochyta leaf and pod spot (*Ascochyta* spp.), rust (*Phakopsora* spp.), southern blight (*Sclerotium rolfsii*), web blight (*Rhizoctonia solani*), and Alternaria blight (*Alternaria* spp.), apply at a rate of 6.0 – 15.5 fl. oz. product (0.10 – 0.25 lb. a.i.)/A beginning before disease development and continuing throughout the season at 7- to 14-day intervals. For control of Rhizoctonia root rot (*R. solani*), apply at a rate of 0.40 – 0.80 fl. oz./1,000 row feet. Do not apply more than 1.5 lbs. a.i./A/season of azoxystrobin-containing products. REI = 4 hours.
 - (*Dynasty* 0.8S) – For control of seed-borne and soilborne fungi causing decay, damping-off, seedling blight, and seedling damping-off (*Rhizoctonia solani*), apply at a rate of 0.153 – 0.765 fl. oz. product/100 lbs. seed. REI = 4 hrs.
- **Bacillus subtilis** (*Serenade Max* 14.6WP) – Bacterial biofungicide. PHI = 0 days. For control of rusts and white mold on snap beans, apply at a rate of 1 – 3 lbs./A. Repeat at 7- to 10-day intervals, as necessary. REI = 4 hrs.
- **Bacillus pumilis** (*Sonata* 1.38EC) – Bacterial biofungicide. PHI = 0 days. For control of rust and powdery mildew on snap beans, apply 2 – 4 qts./A beginning applications when environmental conditions favor disease development. Continue at 7- to 14-day intervals or as needed. Use higher rates and shorter application intervals under heavy disease pressure. REI = 4 hrs.
- **boric acid** (*Prev-Am* 1EC) – Inorganic. For control of downy mildew, powdery mildew, brown rust, aphids, beet armyworms, mites, Lygus bugs, thrips, and whiteflies, apply at a rate of 50 – 100 fl. oz./100 gal. water. Spray every 7 – 10 days. REI = 12 hrs.
- **boscalid** (*Endura* 70WDG) – Carboxamide/anilide. PHI = 7 days. For control of Ascochyta blight, Botrytis gray mold, and white mold, apply 8 – 11 oz./A. Maximum rate/A/application = 11 oz. Do not make more than two applications per season. Max. rate/A/season = 22 oz. product. REI = 12 hrs.
- **captan** (*Captan* 400) – Carboximide. For preventive treatment of seed-borne and soilborne molds and fungi that cause decay, damping-off, and seedling blights in snap bean seeds and seedlings, apply at a rate of 2 – 3 oz./100 lbs. seed. Not for use on agricultural establishments in hopper-box, planter-box, slurry-box, or other seed-treatment applications at or immediately before planting.

- **chlorothalonil** (*Bravo, Bravo 720, Bravo Ultrex, Terranil*) – Nitrile. PHI = 7 days. Apply at a rate of 2.25 lbs. a.i./acre as soon as snap bean rust has been noticed. Repeat application every 7 days as necessary. Do not use treated area for grazing or feed plant parts to livestock. In 1992, chlorothalonil was used by 15.4% of producers on 235 treatment acres. Current estimates suggest that chlorothalonil is used on 10% – 15% of the snap bean acreage in Virginia. Use may vary according to disease incidence and weather conditions. REI = 48 hours.
- **copper** (*KOP-R-Spray Concentrate 0.8EC*) – Inorganic. PHI = 0 days. For control of bacterial blight and halo blight in snap beans, begin applying 1 – 3 tsp. in 1 gal. water per 200 sq. ft. of garden area when plants are 3 to 5 inches high and before diseases appear. Wet foliage to point of runoff and hit all plant surfaces. Repeat at 7- to 10-day intervals or at 5- to 7-day intervals if disease pressure is severe.
- **cyprodinil + fludioxinil** (*Switch 62.5WG*) – Anilinopyrimidine + phenylamide. PHI = 7 days. For control of white mold and gray mold on snap beans, apply at a rate of 11 – 14 oz./A. Begin applications before the onset of disease and reapply at 7-day intervals, if necessary. Do not apply more than 56 oz./A product per plot per year. Do not apply more than 1.3 lbs. a.i./A of cyprodinil-containing products and 0.9 lb. a.i./A of fludioxinil-containing products/plot/year. REI = 12 hrs.
- **dicloran/dinitril** (*Botran 75W*) – Chloronitrobenzene. PHI = 2 days. For control of white mold, apply at a rate of 2.25 lbs./A (bush varieties) to 4 lbs./A (pole varieties). Begin applications when disease conditions are right; reapply at 7-day intervals during periods favorable to disease development. Do not feed treated foliage to livestock. REI = 12 hrs.
- **iprodione** (*Rovral*) – Dicarboximide. PHI = 0 days. For control of white mold, apply at a rate of 0.75 – 1.00 lb. a.i./acre after adding a surfactant. As was true of benomyl, iprodione is used only if white mold is a problem. REI = 12 hours.
- **metalaxyl** (*Ridomil Gold PC GR*) – Acylalanine. For control of damping-off and seed and seedling rots of dry and green beans (bush and pole types) caused by *Pythium* and *Rhizoctonia*, apply 0.75 lb. (12 oz.) product/1,000 linear ft. of row at planting. Adjust the application equipment so the granules are mixed with the soil surrounding the seed. Do not allow the feeding of vines or grazing of foliage by livestock. Metalaxyl was used by 11.5% on 469 acres of the surveyed acreage in 1992. Metalaxyl is the only chemical included in this list that is routinely used by many producers for control of root rot at planting. REI = 48 hours.
- **myclobutanil** (*Rally 40WSP*) – Triazole. PHI = 0 days. For control of rust and pod tip rot in snap beans, apply at a rate of 4 – 5 oz. product (1.6 to 2 oz. a.i.)/A beginning when rust is first observed or when pods begin to develop. Reapply at 7- to 10-day intervals if disease conditions remain. Do not apply more than 1.25 lbs. product (0.5 lb. a.i.)/A/crop. PBI = 30 days. REI = 24 hours.
- **PCNB** (*Terraclor 75WP*) – Chlorinated hydrocarbon. For control of root and stem rot, apply 1.3 – 2.0 lbs. product/A (36-inch row spacing) or 1.4 – 2.2 oz./1,000 ft. of row only at planting time. Apply as a directed spray in the seed furrow and to the covering soil at planting time. REI = 12 hrs.
- **potassium bicarbonate** (*Greencure*) – Inorganic. PHI = 0 days. For control of *Alternaria* leaf spot, anthracnose, *Botrytis*, *Cercospora* leaf spot, downy mildew, fly speck, *Fusarium*, *Penicillium* spp., *Phytophthora*, powdery mildew, scab, *Septoria* leaf spot, *Phoma*, and

Phomopsis blight on snap beans, apply at a rate of 1 – 2 tbsp./gal. water to treat 450 sq. ft. REI = 1 hr.

- **pyraclostrobin** (*Headline* 23.6EC) – Strobilurin. PHI = 7 days. For control of anthracnose, Alternaria leaf and pod spot, Asian soybean rust, Ascochyta blight, Cercospora leaf spot, downy mildew, Mycosphaerella blight, powdery mildew, and rust, apply at a rate of 6 – 9 fl. oz./A. Do not make more than 2 applications per crop per season. Do not apply more than 18 fl. oz. (0.29 lb. a.i.)/A/season. Reapply at 7- to 14-day intervals. Start with the lower rate, using the higher rate when disease pressure is high. REI = 12 hrs.
- **sulfur** (*THAT Flowable Sulfur* 6F) – Inorganic. For control of leaf spot, powdery mildew, and rust, apply 4 – 8 pts./A at early leaf stage, reapplying every 14 days as necessary. REI = 24 hrs.
- **thiophanate-methyl** (*Topsin M*) – Benzimidazole. PHI = 28 days. For control of white mold, apply with a surfactant at a rate of 1.30 – 1.70 lbs. a.i./A. REI = 12 hrs.
- **thiram** (*Thiram* 42S) – Dithiocarbamate. For seed-treatment control of seed-borne and soilborne organisms that cause seed decay, damping-off, and seedling blights, apply with water in a slurry-type treater at a rate of 2 fl. oz./100 lbs. seeds. REI = 24 hrs.
- **trichoderma harzianum** (*T-22 HC* 1.15WP) – Bacterial biofungicide. For control of snap bean diseases including Pythium, Rhizoctonia, Fusarium, Cylindrocladium, and Thielaviopsis, apply at a rate of 1.5 – 3.0 fl. oz./cwt. seed. REI = 0 hrs.
- **vinclozolin** (*Ronilan, Curalan*) – Dicarboximide. PHI = 10 days. For control of white mold, apply with surfactant at a rate of 0.50 lb. a.i./A. REI = 72 hours.

SNAP BEAN NEMATODES

Races 1,3,5, and 9 of the soybean cyst nematode are present in soybeans in Virginia and Delaware. Snap beans are susceptible; therefore, producers who rotate snap beans with soybeans should be alert to the possibility of nematode infestation. Snap bean nematodes tend to be a localized problem and are not a large concern in Virginia. However, soybean cyst and root knot nematodes are a problem in eastern North Carolina. Some growers have lost an entire spring crop to soybean cyst nematodes. Root knot nematodes are not a serious problem in sandy soils. Very dry soils favor soybean cyst nematode infestations. Soybean cyst nematodes rarely kill plants in wet soils, provided crops are rotated. High populations of cysts can be found in highly organic soils. Saltwater may predispose certain fields to infestations.

MONITORING: Both diagnostic and predictive nematode assay programs in Virginia provide data to producers on the numbers and kinds of nematodes in soil along with recommendations for control. Soil samples for diagnostic assays are processed free of charge to determine the cause of production problems during the growing season. Predictive nematode assays are conducted on samples collected after harvest. These samples are analyzed at a cost of \$11 or \$19 per sample, depending on the sample type (vermiform or cyst), and must be collected in the fall no later than November 20.

CHEMICAL CONTROL: Few, if any, growers fumigate because it is not cost-effective on processed beans. This may not be the case for fresh market crops. Always determine the level of infestation before applying any chemical controls.

- **chloropicrin + dichloropropene** – (*Pic-Clor 60*) – Fumigant. **RESTRICTED-USE PESTICIDE.** For preplanting control of soil pests of beans, apply as directed on the label. REI = 5 days.
- **ethoprop** (*Mocap 15G Lock N' Load*) – Organophosphate. **RESTRICTED-USE PESTICIDE.** For control of lesion, root knot, spiral, sting, ring, and stunt nematodes, and suppression of lance nematodes, apply 2 – 3 lbs. a.i. (13 – 20 lbs. product)/A (row treatment) or 6 – 8 lbs. a.i.(40 – 54 lbs. product)/A (broadcast) and mix with the top 2 to 4 inches of soil. Do not allow Mocap to contact seeds. REI = 48 hrs.
- **metam sodium** (*Metam CLR 42%*) – Fumigant. For soil fumigation of weeds, fungi, and nematodes in beans, apply 15.0 to 74.5 gal. product/A depending on crop, target pest, and soil properties as directed on the label. REI = 48 hrs.
- **methy bromide** (*Metabrom Q*) – Fumigant. **RESTRICTED-USE PESTICIDE.** For control of pests of beans in transportation vehicles, apply as directed on the label.

BIOLOGICAL CONTROL: No commercially effective controls are recommended.

CULTURAL CONTROL: Sanitation and good cultural practices are the best preventive measures against nematodes. Examples include obtaining nematode-free transplants and washing soil from machinery and tools before using them at different locations. Crop rotation with nonhost crops is highly recommended in the event of nematode activity. This practice is the most widely used form of control among snap bean growers, even surpassing chemical application.

TO DO:

- Conduct research on soybean cyst nematodes. No nematode-resistant snap bean varieties exist.
- Assess efficacy of insecticides at controlling nematodes.
- Continue to encourage crop rotation to help control cyst nematodes and nematodes in general.

SNAP BEAN WEEDS

Herbicides currently labeled for control in snap beans work well on annual grasses and a few small-seeded broadleaf weeds. However, producers are faced with many additional broadleaf problems including cocklebur, common lambsquarters (the most important weed pest in snap beans), mustards, smooth pigweed, and spurred anoda, just to name a few. Section 18 Emergency Use Exemptions and Special Local Need 24(c) labels are often requested to help with problem weeds. During the 2000 snap bean season, a Section 18 label was approved for the herbicide fomesafen, commonly known as Reflex. Reflex was widely used on 70% – 80% of the snap bean acreage for postemergence broadleaf weed control. Without special labels, such as the one obtained for Reflex, weed control in snap beans would be extremely difficult for producers.

MONITORING: Proper identification is an important part of effective weed control. Weeds observed in previous crops within a given field should be noted to aid in future management decisions. Scout each field and keep records of the weed species present, their location, and population density.

CHEMICAL CONTROL: See “Summary – Chemical Weed Control” below.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: No effective commercial controls are recommended.

TO DO:

Research Needs:

- Determine rates and control for annual broadleaf weeds and grasses.
- Research the efficacy of early application of herbicides with dimethoate for thrips control (with *Basagran*, *Reflex*, and a surfactant).
- Study the efficacy of soil-applied broadleaf weed control.
- Test the herbicide *Raptor*, which is labeled in some states. However, only one year of data has been gathered in Virginia at this point. Research funds are needed for further study, particularly to work out an adjuvant.
- Study wild radish, wild mustard, morningglory, and eastern black nightshade, which are all increasingly prevalent in snap bean fields.
- Determine whether yield is increased by the use of preemergent herbicides.
- Develop treatment thresholds for weeds and grasses.
- Petition IR-4 for efficacy work on controls for weeds and grasses.

Educational Needs:

- Roundup Ready snap beans – issue of clearance on edible crop.
- Create and distribute publications to educate growers (e.g., production guides).

Regulatory Needs:

- Generate new herbicide labels for snap beans because few controls are currently available.
- Label postemergence herbicide products, e.g., *Reflex* (Section 3).
- Secure *Sandea* label for snap beans.

SUMMARY – CHEMICAL WEED CONTROL

The list below contains all of the fully labeled products available to producers for weed control in snap beans.* Use estimates are also included based on anecdotal data.

- **bentazon** (*Basagran* 4SC) – Benzothiadiazole. PHI = 30 days. For control of broadleaf weeds, apply at a rate of 0.50 – 1.00 lb. a.i./A when beans have fully expanded first trifoliolate leaves. Use lower rates on common cocklebur, mustards, and jimsonweed and higher rates on yellow nutsedge, common lambsquarters, common ragweed, and Canada thistle. Before the Section 18 labeling of fomesafen (*Reflex*), bentazon was the predominant choice for broadleaf weed control. However, *Reflex* does a much better job of controlling the troublesome broadleaf weeds. As a result, bentazon is currently used on only approximately 10% of the snap bean acreage in eastern Virginia. *Basagran* helps control eastern black nightshade, which is increasingly prevalent. REI = 48 hrs.
- **clethodim** (*Shadow* 2SC) – Oxime. PHI = 21 days. For control of annual and perennial grasses in snap beans, apply at a rate of 6 – 8 fl. oz./A with 1% v/v (volume of solute / volume of solution) crop oil. Do not make more than one application/A/season. Do not apply more than 8 fl. oz./A/application. Adding AMS (ammonium sulfate) has shown improved grass control for difficult-to-control species including quackgrass, red rice, johnsongrass, volunteer cereals, volunteer corn, and wild oats. REI = 24 hrs.
- **clomazone** (*Command*) – Isoxazolidinone. Growers are moving away from this product due to phytotoxicity problems.

- **DCPA** (*Dacthal Flowable* 54.9F) – Carboxylic acid. For control of annual grasses and some broadleaf weeds, apply 3.3 – 7.7 lbs. a.i./A, depending on soil texture during planting. REI = 12 hrs.
- **EPTC** (*Eptam* 7E 87.8EC) – Thiocarbamate. For good control of nutsedge, annual grasses, and some broadleaf weeds, incorporate into the soil before planting at a rate of 1.5 – 3.0 lbs. a.i./A. Used on less than 5% of the snap bean acreage in Virginia. Combined with pendamethalin (*Prowl*) and trifluralin (*Treflan*), the three herbicides would probably account for no more than 10% of the current herbicide usage. REI = 12 hrs.
- **fomesafen** (*Reflex* 22.8EC) – Diphenyl. PHI = 30 days. For control of jimsonweed, morningglory, wild radish, nightshade, common ragweed, pigweed, and other weeds, apply 0.250 – 0.375 lb. a.i./A. *Reflex + Basagran* works well on lambsquarters and other weeds. REI = 24 hrs.
- **glyphosate** (*Roundup Original* 41SC) – Phosphoric acid. PHI = 14 days. For general weed control, apply 0.41 – 1.23 lbs. a.i./A. REI = 12 hrs.
- **halosulfuron methyl** (*Sandea* 75EC) – Sulfonylurea. PHI = 30 days. For control of broadleaf weeds, apply 0.002 – 0.004 lb. a.i./A, depending on the application method. Do not apply more than 0.004 lb. a.i./A/season and not more than 0.008 lb. a.i./A/year. REI = 12 hrs.
- **imazamox** (*Raptor* 12.1EC) – Imidazolinone. For postemergence control/suppression of 1- to 3-inch broadleaf and grass weeds before snap bean bloom in Delaware, use a non-ionizing surfactant (NIS) with at least 80% a.i. at a rate of 1 qt. per 100 gal. spray solution. Do not add crop oil concentrate (COC), methylated seed oil, or fertilizer as an adjuvant. Use at broadcast rate of 0.031 lb. a.i./A (4 oz. *Raptor*/A) tank mixed with Basagran (6 – 16 oz./A). This application method must be followed to minimize crop response. Do not use more than 4 oz./A/season. Do not make more than one application/season. REI = 4 hrs.
- **imazethapyr** (*Pursuit Herbicide* 2WDG) – Imidazolinone. PHI = 30 days. For preplant incorporation and preemergence/postemergence control of common purslane, eastern black nightshade, redroot pigweed, and wild mustard in North Carolina-grown snap beans, apply at a rate of 1.5 oz./A. Do not apply after July 31. Do not apply more than once per year. Do not feed treated forage, hay, or straw to livestock. REI = 4 hrs.
- **nonanoic acid** (*Scythe* 4.2EC) – Organic fatty acids. For use on snap beans for vegetative burndown, directed and shielded sprays, and before emergence of plants from seed, perennial rootstocks, corms, and bulbs. See the label for specific directions. REI = 12 hrs.
- **paraquat** (*Gramoxone Max* 43.8EC) – Bipyridilium. **RESTRICTED-USE PESTICIDE.** For control of annual broadleaf weeds, apply 0.57 – 1.18 lbs. a.i./A. Do not apply more than 3 times per year. REI = 12 – 24 hrs.
- **pendimethalin** (*Prowl* 3.3EC) – Dinitroaniline. For control of annual grasses and some broadleaf weeds, apply at a rate of 0.50 – 0.75 lb. a.i./A up to 60 days before planting. Incorporate within 7 days of application. Currently used on less than 5% of the snap bean acreage in Virginia. REI = 24 hrs.
- **quizalofop-P-ethyl** (*Assure II* 10.3EC) – Organic. PHI = 15 days. For control of most annual and perennial grasses (except yellow nutsedge, wild onion, and broadleaf weeds), apply at a rate of 0.04 – 0.08 lb. a.i./A. Repeated applications may be needed to control certain perennial grasses. Used currently on no more than 5% of the Virginia snap bean acreage. REI = 12 hrs.
- **s-metolachlor** (*Dual Magnum* 83.7EC) – Acetamide. For control of annual grasses as a preplant incorporated, preplant emergence, or preemergence herbicide, use at a rate of 0.63 –

1.91 lbs. a.i./A. Should be incorporated into 2 – 3 inches of soil by disking. Widely used currently on approximately 90% of the snap bean acreage in Virginia. REI = 24 hrs.

- **sethoxydim** (*Poast 1.5EC*) – Oxime. PHI = 15 days. For control of annual grasses and certain perennial grasses as a postemergence herbicide, apply at a rate of 0.20 – 0.30 lb. a.i./A. Repeat applications may be necessary for additional control of tough perennial grasses. Do not tank mix with or apply within 2 to 3 days of any other pesticide unless labeled. Do not apply more than 0.75 lb. a.i./A/season. Approximately 10% to 20% of the snap bean acreage was treated with sethoxydim during the 2000 growing season. REI = 12 to 24 hrs.
- **trifluralin** (*Treflan 4E, Treflan 5G*) – Dinitroaniline. For excellent control of grasses (except nutsedge), apply before planting at a rate of 0.50 – 0.75 lb. a.i./A. Must be incorporated into 2 to 3 inches of soil within 8 hours after application. Currently used on less than 5% of the snap bean acreage in Virginia. REI = 12 to 24 hrs.

*Section 18 Emergency Use Exemptions and 24(c) Special Local Need label requests may be submitted to supplement the list above.

EFFICACY TABLES

Table 1. Efficacy ratings for various pest management tools against snap bean arthropods in Delaware, North Carolina, and Virginia. Rating scale: E = excellent; G = good; F = fair; P = poor; ? = research needed; NU = no control / not used; * = used, but not a stand alone tool.

Snap Bean Arthropod Pests																
Pest Management Tools	Aphids	Bean Leaf Beetles	Beet Armyworms	Cabbage Loopers	Corn Earworms	Cutworms	European Corn Borers	Potato Leafhoppers	Leafminers	Lesser Cornstalk Borers	Mexican Bean Beetles	Mites	Seed Maggots	Stink Bugs & Tarnished Plant Bugs	Thrips	Whiteflies
Registered Insecticides & Miticides																
acephate (Orthene)	G	F	P	G	G	G	E	E	NU	?	G	NU	NU	G	E	F-G
azadirachtin	P-F	P	P	G	P	P	P	?	P	?	?	NU	NU	P	?	?
<i>Bacillus thuringiensis</i>	NU	NU	G	G	P-F	F	P	NU	NU	?	NU	NU	NU	NU	NU	NU
bifenthrin (Capture or OLF)	G	E	F-G	E	G	G	G	E	P	?	E	G	NU	G	G	?
carbaryl (Sevin)	G	F-G	P	P	P	P	P	G	P	?	G	P	NU	F	G	P
chlorpyrifos (Lorsban seed treatment)	NU	NU	NU	NU	NU	NU	NU	NU	NU	?	NU	NU	G	NU	NU	NU
zeta-cypermethrin (Mustang Max)	G	E	F-G	E	G	G	G	E	P	?	E	G	NU	G	G	?
lambda-cyhalothrin (Warrior)	G	E	F-G	E	G	G	G	E	P	?	E	G	NU	G	G	?
dicofof (Keltthane)	NU	NU	NU	NU	NU	NU	NU	NU	NU	?	NU	F-G	NU	NU	NU	NU
dimethoate	G	P	P	P	P	P	P	E	P	?	P	F-G	NU	P	F	P-F
disulfoton (Di-Syston)	G	P	P	P	P	P	P	G	P	?	P	NU	G	NU	G	F
esfenvalerate (Asana XL)	G	F	P	E	G	G	F	E	P	?	E	NU	NU	F	G	?
ethoprop (Mocap)	NU	NU	NU	NU	NU	NU	NU	NU	NU	?	NU	NU	G	NU	NU	NU
imidacloprid (Admire, Provado)	E	G	NU	NU	NU	NU	NU	E	NU	?	G	NU	?	NU	E	E
methomyl (Lannate)	G	F	F-G	G	G	G	G	G	NU	?	G	NU	NU	G	G	?
phorate (Thimet)	G	P	P	P	P	P	P	G	P	?	P	NU	G	NU	G	F
potassium salts of fatty acids(M-Pede)	F-G	NU	NU	NU	NU	NU	NU	NU	NU	?	NU	F-G	NU	NU	F-G	G
spinosad (SpinTor, Entrust)	NU	F	G	G	G	G	E	NU	NU	?	F	NU	NU	P	G	?
thiamethoxam (Cruiser seed treatment)	E	G	NU	NU	NU	NU	NU	E	P	?	G	NU	G	NU	G	G
Unregistered & New Insecticides & Miticides																
indoxacarb (Avaunt)	NU	F	G	G	G	G	E	NU	NU	?	?	?	NU	NU	NU	NU
gamma-cyhalothrin (Proaxis)	G	E	F-G	E	G	G	G	E	P	?	E	G	NU	G	G	?
Cultural & Nonchemical Pest Management Practices																
Apply insecticidal soap, horticultural oil or neem	?	?	?	?	?	?	?	?	NU	?	?	?	NU	?	?	?
Do not exceed recommended nitrogen fertilization rates in order to reduce attractiveness of crop to insects	G	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Keep fields and field borders free of weeds and trash that can harbor insects	?	?	G	?	?	G	G	?	?	?	?	G	?	G	G	?
Plant early to minimize pests	?	?	G	?	G	?	?	?	?	G	?	?	?	?	?	G
Plant late to minimize pests	?	?	?	?	?	?	?	G	?	?	?	?	G	?	F-G	P
Practice postharvest destruction to deny food and overwintering sites to insects	?	?	?	?	?	?	F	?	?	F	?	?	?	?	?	?
Remove pests by hand																
Use good production practices to keep plants healthy and harvest earlier	G	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
Use protective collars	NU	NU	NU	NU	NU	G	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU
Wash leaves with a strong spray of water	?	?	?	?	NU	NU	NU	?	NU	NU	?	?	NU	?	?	?
Biological Controls																
<i>Bacillus thuringiensis</i>	NU	NU	G	G	P-F	F	P	NU	NU	?	NU	NU	NU	NU	NU	NU
Conservation of beneficial insects	G	?	F	?	?	?	?	?	?	?	?	G	?	?	?	F
<i>Pediobius foveolatus</i>	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	G	NU	NU	NU	NU	NU

Table 2. Efficacy ratings for various pest management tools against snap bean diseases and nematodes in Delaware, North Carolina, and Virginia. Rating scale: E = excellent; G = good; F = fair; P = poor; ? = research needed; NU = no control / not used; * = used, but not a stand alone tool.

Pest Management Tools	Snap Bean Diseases & Nematodes															
	Anthraxnose (<i>Colletotrichum lindemuthianum</i>)	Common Bacterial Blight (<i>Xanthomonas campestris</i>)	Bacterial Brown Spot (<i>Pseudomonas syringae</i>)	Gray Mold (<i>Botrytis cinerea</i>)	Mosaic Viruses	Powdery Mildew (<i>Erysiphe polygoni</i>)	Pythium Pod Rot (<i>Pythium</i> spp.)	Pythium Root Rot (<i>Pythium</i> spp.)	Pythium Damping-Off (<i>Pythium</i> spp.)	Rhizoctonia Root Rot (<i>Rhizoctonia solani</i>)	Root-Knot Nematodes	Snap Bean Rust (<i>Uromyces appendiculatus</i>)	Soybean Cyst Nematode (Races 1,3,5 and 9)	Web Blight (<i>Rhizoctonia solani</i>)	White Mold / Sclerotinia Blight (<i>Sclerotinia</i>)	White Mold / Southern Blight (<i>Sclerotium rolfsii</i>)
Registered Fungicides & Nematicides																
azoxystrobin (Amistar, Quadris)	E	NU	NU	NU	NU	?	?	P	?	G	NU	G	NU	G	NU	G
boscalid (Endura)	G	NU	NU	F	NU	?	P	NU	NU	NU	NU	G	NU	NU	E	?
boscalid + pyraclostrobin (Pristine)	E	NU	NU	F	NU	?	NU	NU	?	NU	NU	E	NU	NU	NU	NU
chloronitrobenzene (Botran)	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	G	NU
chlorothalonil (Bravo, Echo, Equus)	F-G	NU	NU	F	NU	?	P	NU	NU	NU	NU	F	NU	NU	NU	NU
copper, fixed (Basicop, Champ, Kocide, etc.)	P	F-G	F-G	P	NU	P	NU	NU	NU	NU	NU	P	NU	P	NU	NU
cyprodonil + fludioxonil (Switch)	?	NU	NU	?	NU	?	?	?	NU	?	?	?	?	?	E	P
dichloropropene (Telone II)	NU	NU	NU	NU	NU	?	NU	NU	?	NU	E	NU	E	NU	NU	NU
dichloropropene+chloropicrin (Telone)	NU	NU	NU	NU	NU	?	NU	NU	?	NU	E	NU	E	NU	?	F
ethoprop (Mocap 6EC or 10G)	NU	NU	NU	NU	NU	?	NU	NU	?	NU	F	NU	F	NU	NU	NU
iprodione (Rovral)	F	NU	NU	G	NU	NU	P	NU	NU	NU	NU	NU	NU	F	G	P
mefenoxam (Ridomil)	P	NU	NU	P	NU	NU	?	G	G	P	NU	P	NU	P	P-F	P
mefenoxam + chlorothalonil (Ridomil Gold)	F	NU	NU	F	NU	?	G	NU	?	NU	NU	F	NU	F	F	NU
mefenoxam + copper (Ridomil Gold Copper)	NU	G	G	P	NU	?	?	NU	?	NU	NU	NU	NU	NU	NU	NU
mefenoxam + PCNB (Ridomil PC 11G)	NU	NU	NU	NU	NU	?	NU	G	?	G	NU	NU	NU	NU	NU	G
metam-potassium (K-Pam HL)	NU	NU	NU	NU	NU	?	NU	NU	?	NU	F	NU	F	NU	NU	NU
metam-sodium (Vapam HL)	NU	NU	NU	NU	NU	?	NU	NU	?	NU	F	NU	F	NU	NU	G
myclobutanil (Nova)	NU	NU	NU	NU	NU	G	NU	NU	?	G	NU	G-E	NU	G	NU	NU
PCNB (Terraclor)	NU	NU	NU	NU	NU	?	NU	P	?	G	NU	NU	NU	NU	NU	F-G
pyraclostrobin (Cabrio, Headline)	G	NU	NU	NU	NU	?	NU	NU	?	NU	NU	E	NU	NU	NU	F-G
sulfur	NU	NU	NU	NU	NU	F-G	NU	NU	NU	NU	NU	E	NU	NU	NU	NU
thiophanate-methyl (Topsin M)	F-G	NU	NU	G	NU	?	NU	NU	NU	NU	NU	NU	NU	NU	G	NU
vinclozolin (Ronilan)	NU	NU	NU	F-G	NU	?	NU	NU	?	NU	NU	NU	NU	NU	E	?
Unregistered & New Fungicides & Nematicides																
Cultural & Nonchemical Pest Management Practices																
Avoid field operations when leaves are wet	E	E	?	E	NU	NU	?	?	NU	NU	NU	E	?	?	NU	NU
Avoid overhead irrigation	G-E	G-E	G	G-E	NU	NU	?	P	NU	NU	NU	G	P	?	P	P
Change planting date	F	F	?	NU	F	NU	?	?	E	E	NU	G	?	?	NU	NU
Cover cropping	NU	NU	?	NU	NU	NU	?	?	NU	NU	G	NU	?	?	NU	NU
Crop rotation	G	G-E	E	P	NU	NU	?	G	F	F	G	P	E	?	E	F
Deep plowing	E	E	E	E	NU	NU	?	F	F	F	E	P	F	?	E	E
Destroy crop residue	E	E	?	E	NU	NU	?	?	NU	NU	F	F	?	?	E	G
Encourage air movement	E	E	?	E	NU	E	?	?	NU	NU	NU	F	?	?	G	NU
Good sanitation practices	E	E	E	F	?	?	?	P	?	?	?	P	P	?	P	P
Increase between plant spacing	P	F	F	F	NU	NU	?	G	F	F	NU	F	F	?	G	F
Increase soil organic matter	NU	NU	?	NU	NU	NU	?	?	NU	NU	F	NU	?	?	NU	NU
Insecticidal oils	NU	NU	?	NU	F	NU	?	?	NU	NU	NU	NU	?	?	NU	NU
Pathogen-free planting material	E	E	?	NU	G	NU	?	?	NU	NU	NU	NU	?	?	NU	NU
pH management	NU	NU	?	NU	NU	NU	?	?	NU	NU	NU	NU	?	?	NU	NU
Plant in well drained soil	F	F	?	F	NU	NU	?	?	E	E	NU	NU	?	?	F	NU
Plant on raised beds	F	F	?	F	NU	NU	?	?	E	E	NU	NU	?	?	F	NU
Plant resistant varieties	E	E	E	P	E	E	?	P	NU	?	E	E	?	?	P-F	NU
Plastic mulch bed covers	NU	NU	?	NU	NU	NU	?	?	NU	NU	NU	NU	?	?	F	NU
Postharvest temperature control	NU	NU	?	NU	NU	NU	?	?	NU	NU	NU	NU	?	?	E	NU
Proper fertilization (balanced)	P	P	P	P	?	?	?	P	?	?	?	P	P	?	P	P
Reduce mechanical injury	NU	NU	?	NU	NU	NU	?	?	NU	NU	NU	NU	?	?	NU	NU
Reflective mulch	NU	NU	?	NU	G	NU	?	?	NU	NU	NU	NU	?	?	P	NU
Rogue diseased plants	NU	NU	?	NU	F	NU	?	?	NU	NU	NU	NU	?	?	F	NU
Row covers	NU	NU	?	NU	F	NU	?	?	NU	NU	NU	NU	?	?	NU	NU
Soil solarization	NU	NU	?	NU	NU	NU	?	?	F	G	F	NU	?	?	G	F
Weed control	F	F	?	F	E	F	?	?	NU	NU	F	F	?	?	F	P
Biological Controls																
Conservation of natural enemies	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

Table 3. Efficacy ratings for various pest management tools against snap bean grass and broadleaf weeds in Delaware, North Carolina, and Virginia. Rating scale: E = excellent; G = good; F = fair; P = poor; ? = research needed; NU = no control / not used; * = used, but not a stand alone tool.

Snap Bean Grass & Broadleaf Weed Pests																					
Pest Management Tools	Barnyardgrass	Carpetweed	Cocklebur, Common	Crabgrass, Large	Cranesbill	Fall Panicum	Foxtail spp.	Gairnsoga, Hairy	Goosegrass	Jimsonweed	Johnsongrass (seedlings)	Lambsquarters, Common	Morningglories	Nightshade, Eastern Black	Nutsedge, Yellow	Pigweed spp.	Purslane, Common	Ragweed, Common	Shepherdspurse	Smartweed, Pennsylvania	Velvetleaf
Registered Herbicides																					
Preemergence Herbicides																					
DCPA (Dacthal)	F-G	P	NU	G	P	F-G	G	NU	F-G	P	?	G	NU	NU	NU	F-G	G	NU	P	NU	NU
EPTC (Eptam)	G	G	P	G	G	G	G	NU	G	P	G	F	F	F-G	G	G	G	P	?	P	F-G
glyphosate (Roundup)	G	G	G	G	G	G	G	G	G	G	G	F	F	G	F	G	G	F	G	G	G
s-metolachlor (Dual Magnum)	G	F	NU	G	?	G	G	G	G	NU	G	P	NU	G	F-G	G	F-G	NU	?	P	P
paraquat (Gramoxone Max)	F-G	G	G	F-G	?	F-G	G	G	F-G	G	?	F-G	F-G	?	G	G	F-G	G	?	P	?
pendimethalin (Prowl)	G	G	NU	G	?	G	G	NU	?	NU	G	F-G	P	P	NU	F-G	F-G	NU	NU	F	G
trifluralin (Treflan)	G	G	NU	G	?	G	G	NU	G	NU	G	F-G	F-P	P	NU	F	G	NU	NU	F-P	NU
clomazone (Command)	G	NU	F	G	?	G	G	F	G	G	G	G	P	?	NU	P	G	F	F	G	G
imazethapyr (Pursuit)	P-F	F	?	P-F	P	P-F	P-F	F	?	G	NU	F	F	G	G	G	P	G	G	F	?
Postemergence Herbicides																					
bentazon (Basagran)	NU	NU	G	NU	?	NU	NU	F	NU	G	NU	F	P	P	F	F	F-G	G	?	G	G
clethodim (Select)	G	NU	NU	G	NU	G	G	NU	P	NU	G	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU
fomesafen (Reflex)	P	G	F	P	?	P	P	G	P	G	P	P	F-G	F	P	G	?	F	G	P	P
halosulfuron (Sandea)	NU	P	G	NU	?	NU	NU	G	NU	G	NU	NU	F	NU	G	G	P	G	?	F	G
quizalofop-P-ethyl (Assure)	G	NU	NU	G	NU	G	G	NU	G	NU	G	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU
sethoxydim (Poast)	G	NU	NU	G	NU	G	G	NU	G	NU	G	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU
imazamox (Raptor)	P	?	F-G	P	?	P	P	G	P	?	P	F	F	G	P	G	F-P	F-P	G	G	G
Unregistered or New Herbicides																					
Cultural & Nonchemical Pest Management Practices																					
Cover crops	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Crop rotation	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Cultivation	G	?	G	G	?	G	G	G	G	G	G	G	F-G	G	P-F	G	G	G	?	G	?
Biological Controls																					
Conservation of natural enemies	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU	NU

Table 4. Timeline depicting when snap bean pests and diseases are problematic in Delaware, North Carolina, and Virginia.

Arthropods	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Aphids												
Bean Leaf Beetles												
Beet Armyworms												
Cabbage Loopers												
Corn Earworms												
Cutworms												
European Corn Borers												
Potato Leafhoppers												
Leafminers												
Lesser Cornstalk Borers												
Mexican Bean Beetles												
Mites												
Seed Maggots												
Stink Bugs & Tarnished Plant Bugs												
Thrips												
Whiteflies												
Diseases												
Anthracnose (<i>Colletotrichum lindemthuanum</i>)												
Common Bacterial Blight (<i>Xanthomonas campestris</i>)												
Bacterial Brown Spot (<i>Pseudomonas syringae</i>)												
Gray Mold (<i>Botrytis cinerea</i>)												
Mosaic Viruses												
Powdery Mildew (<i>Erysiphe poygoni</i>)												
Pythium Pod Rot (<i>Pythium</i> spp.)												
Pythium Root Rot (<i>Pythium</i> spp.)												
Pythium Damping-off (<i>Pythium</i> spp.)												
Rhizoctonia Root Rot (<i>Rhizoctonia solani</i>)												
Root-knot Nematodes												
Snap Bean Rust (<i>Uromyces appendiculatus</i>)												
Soybean Cyst Nematodes												
Web Blight (<i>Rhizoctonia solani</i>)												
White Mold / Sclerotinia Blight (<i>Sclerotinia sclerotiorum</i>)												
White Mold / Southern Blight (<i>Sclerotium rolfsii</i>)												
Weeds												
Barnyardgrass												
Carpetweed												
Cocklebur, Common												
Crabgrass, Large												
Cranesbill												
Fall Panicum												
Foxtail spp.												
Galinsoga, Hairy												
Goosegrass												
Jimsonweed												
Johnsongrass (seedlings)												
Lambsquarters, Common												
Morningglories												
Nightshade, Eastern Black												
Nutsedge, Yellow												
Pigweed spp.												
Purslane, Common												
Ragweed, Common												
Shepherdspurse												
Smartweed, Pennsylvania												
Velvetleaf												

Table 5. Timeline of snap bean management activities in Delaware, North Carolina, and Virginia.

Worker Activities	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.
Soil preparation & fertilization												
Planting												
Irrigation												
Harvesting												
IPM Activities												
Soil sampling												
Arthropod pest monitoring												
Arthropod chemical control application												
Disease monitoring												
Disease chemical control application												
Weed chemical control application												

ABBREVIATIONS

AMS – ammonium sulfate
BLB – bean leaf beetle
CEW – corn earworm
COC – crop oil concentrate
CPB – Colorado potato beetle
ECB – European corn borer
FQPA – Food Quality Protection Act
ICW – imported cabbage worm
IR-4 – Interregional Project #4
MBB – Mexican bean beetle
NIS – non-ionizing surfactant
OPMP – Office of Pest Management Policy
PBI – plant-back interval
PHI – preharvest interval
PLH – potato leafhopper
PMSP – Pest Management Strategic Plan
REI – restricted-entry interval
SCM – seed corn maggot
v/v – volume of solute/volume of solution

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