Crop Profile for Snap Beans in Virginia

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Fig. 1. *Phaseolus vulgaris* bean plant with pods.
Image Credit: Photo by H. F. Schwartz, Colorado State University, http://www.ipmimages.org

GENERAL PRODUCTION INFORMATION

- During 2009, 5,500 acres of snap beans were planted in Virginia, of which 5,200 acres were harvested.
- The 2009 snap bean production rate was 34 cwt per acre, for a total of 177,000 cwt worth $4,425,000.
- The total harvested yield was up by 1 hundredweight per acre from 2008.
- All of the acreage reported in 2009 was grown for the fresh market.
- Virginia ranked 7th in the United States, producing 3.64 percent of the country's snap beans in 2009.

PRODUCTION REGIONS

The majority of the snap bean acreage is located on the Eastern Shore of Virginia in Accomack and Northampton counties. Snap beans are also produced to a smaller degree in southeastern Virginia within Chesapeake and Virginia Beach counties and in the southwestern counties of Carroll, Floyd, and Washington.

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.

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

Snap beans can be produced in two cropping cycles within eastern portions of Virginia. Spring snap beans are typically planted in Virginia from April 1 to May 15 and are usually machine harvested from June 10 to July 10. Fall snap beans are planted August 1 to 25 and are harvested from October 1 to 31. Snap bean varieties typically require 58 to 62 days to reach full maturity.

Snap bean varieties differ in their pest resistance and yield potentials. However, all varieties thrive in warm weather and do not tolerate frost. In Virginia, there are many fresh market snap bean varieties, including *Advantage*, *Ambition*, *Ambra*, *Boone*, *Bronco*, *Caprice*, *Carlo*, *Charon*, *Crockett*, *Dusky*, *Foremost*, *Greencrop* (flat, flavorful), *Hickok*, *Inspiration*, *Maxibel*, *Nash*, *Nickel*, *Pike*, *Prevail*, *Provider* (early), *Roma II* (Italian flat pod), *Secretariat*, *Strike*, *Valentino*, and *Tema*. Fresh market wax bean varieties include *Eureka*, *Golden Rod*, *Goldrush*, *Rocdor*, and *Uranus*. The bean varieties grown for processing are *Brio*, *Dandy* (small sieve, 3" pods), *Hystyle*, *Roma II*, and *Slenderette* (more resistant to blossom drop at high temperatures, so this variety is good for plantings that mature in late July/early August). Other bean varieties grown in Virginia include the trellised beans *Volunteer*, *Mountaineer*, and *State White Half-Runner* along with the horticultural beans *French Horticultural* and *Supremo*.

Most of the fields used for snap bean production on the Eastern Shore have irrigation capabilities. Under ideal conditions, snap beans will receive about one inch of rain per week during the growing season. If plants become droughted, irrigation is recommended to maintain optimum growth. Producers typically apply a weekly average of two inches of irrigated water for spring-planted and fall-planted snap beans.

The majority of 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 to 50°F) by room cooling, forced-air cooling, or hydrocooling. The relative humidity must be maintained at 90 percent 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.

WORKER ACTIVITIES

During snap bean production, worker activities include soil preparation and fertilization, planting, irrigation, and harvesting. For larger producers, planting, irrigation and harvesting activities are mechanized, thus reducing worker exposure during these activities. Preemergent herbicides are typically applied to the beds in early spring using tractor-mounted spray equipment. Postemergence weed controls are also applied using tractor-mounted sprayers, although backpack sprayers may also be used occasionally. Insecticides and fungicides are applied beginning in early spring through harvest time, primarily with airblast, aerial, or boom sprayers.

SPECIAL USE LABELS

Section 18 Emergency Use Exemption and Special Local Need 24 (c) labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified, specialists submit the proper documentation for the Emergency Use/Special Local Need label. Thus far, Extension specialists have been successful in obtaining these labels. Special Local Need (SLN) labels in Virginia are granted by the Virginia Department of Agriculture and Consumer Services (VDACS) and are usually only valid for limited time intervals. However, a fee must be paid annually by the registrant to keep the product registered for us in Virginia. Section 18 Emergency Use labels are evaluated and granted by the Environmental Protection Agency (EPA) and can be renewed annually. In Virginia, Section 18 Emergency Use Exemptions and Special Local Need 24(c) labels are often requested to help with problem weeds in snap bean fields. See the *Weed Pests* section for more information.

ARTHROPOD PESTS

Thrips (*Neohydrathrips variabilis*) are a serious pest of spring-planted snap beans. Bean leaf beetles (*Cerotoma trifurca*), corn earworms (*Helicoverpa zea*), and European corn borers (*Ostrinia nubilalis*), however, are more common insect pests in fall snap beans. In addition, the Mexican bean beetle (*Epilachna varivestis*) may be a problem in wet years, while the two-spotted spider mite (*Tetranychus urticae*) is more common during dry years. The seed corn maggot (*Hylemya platura*) is more likely to occur in early plantings under cool, wet conditions when organic matter is prevalent. Cutworms (*Agrotis ipsilon*, *Peridroma saucia*, and *Feltia subterranae*) may also be occasional, but potentially troublesome, pests of snap beans. Bean aphids (*Aphis fabae*), beet armyworms (*Spodoptera exigua*), leafminers (*Liriomyza* spp.), stink bugs (*Acrosternum hilare* and *Euschistus servus*), tarnished plant bugs (*Lygus* spp.), cabbage loopers (*Trichoplusia ni*), and whiteflies (Family Aleyrodidae) are occasional pests of snap beans but are not usually recurring problems in most fields.

INSECTS

Bean Leaf Beetle, *Cerotoma trifurcate*

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 of BLB per year in Virginia. The second generation causes greater damage to fall snap beans.

MONITORING: Snap bean plants should be monitored for defoliation resulting from BLB feeding. Chemical treatment is recommended if defoliation exceeds 20 percent during prebloom,

or 10 percent during podding with a population potential for further defoliation. Fields should be monitored for the early appearance of virus symptoms and treated with an insecticide to kill BLB if virus detection has been confirmed.

CHEMICAL CONTROL: Insecticides should be applied during hatch or adult emergence when both eggs and pupae are present. *Capture* and *Warrior* work better than *Asana* at controlling BLB. See the *Chemical Arthropod Control* section for more information.

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

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 percent of growers in Virginia say CEW is a problem, particularly due to pod scarring.

MONITORING: Growers should 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 under the *Monitoring* section above. In general, CEW is easy to control with the currently labeled insecticides. See the *Chemical Arthropod Control* section for more information.

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.

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

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. Fortunately, cutworms are sporadic pests in Virginia 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 the *Chemical Arthropod Control* section for more information.

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.

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 one 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 greater than five per night. However, sprays are most critical during the bud to early bloom and pin stages of the beans. 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 of the beans until harvest. This usually results in one to three applications per season. See the *Chemical Arthropod Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: No effective commercial controls are recommended.

Lesser Cornstalk Borer, *Elasmopalpus lignosellus*

The lesser cornstalk borer is a major problem in specific fields. In particular, it is prevalent anywhere near sweet or field corn. Borer caterpillars damage bean plants in two ways: by feeding on the foliage and also by tunneling through the stem. Infested snap beans will then wilt and die. The lesser cornstalk borer caterpillars may be identified by the silk feeding tubes constructed at, or just below, the soil surface.

MONITORING: No specific monitoring protocol is recommended.

CHEMICAL CONTROL: See the *Chemical Arthropod Control* section for more information.

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

CULTURAL CONTROL: No effective commercial controls are recommended.

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 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 percent after the bloom period. Economic damage tends not to occur before late July.

MONITORING: Each week, growers should monitor snap bean plants for defoliation resulting from MBB feeding along field margins adjacent to potential overwintering sites. If plants are young, all plants within three feet of row should be examined. The number of adults and larvae should be counted, and the percentage of defoliation estimated. Large plants can be checked using a sweep net or drop cloth. Chemical treatment is recommended if the population is greater than six beetles per row-foot at the pretrifoliate stage of the beans, greater than two beetles per plant and/or defoliation exceeds 20 percent during prebloom, or defoliation greater than 10 percent and populations are increasing between the bud stage and harvest.

CHEMICAL CONTROL: Insecticides should be applied during hatch or adult emergence when both eggs and pupae are present. See the *Chemical Arthropod Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended. 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 can then be destroyed using chemical controls, or simply plowed under.

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. 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. 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 the *Chemical Arthropod Control* section for more information.

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.

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 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 of SCM occur annually.

MONITORING: Treatments are ineffective once seed corn maggots 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. See the *Chemical Arthropod Control* section for more information.

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 over fertilization with manure, especially around planting time; and plowing under crop debris immediately after harvest to prevent plant remnants.

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. Even so, thrips are a major source of damage in Virginia. More than 10 percent 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: Scouting for thrips should begin 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.

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 the *Chemical Arthropod Control* section for more information.

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. Thrips are not generally a problem in fall snap beans.

ALTERNATIVE CONTROL: Insecticidal oils or soaps may be used for thrips control.

Other Insect Pests of Snap Beans

Examples of some sporadic pests of snap beans include bean aphids (*Aphis fabae*: 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: The treatment threshold for tarnished plant bugs and stink bugs 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 30 are found per three feet of row. Treatment should begin for whiteflies when more than five adults are found per expanded leaflet. Aphids are treated only if greater than 50 percent of terminals have more than five individuals, when weather conditions favor aphid problems, and if natural enemies are absent.

CHEMICAL CONTROL: See the *Chemical Arthropod Control* section for more information.

BIOLOGICAL CONTROL: No commercial controls are recommended.

CULTURAL CONTROL: No commercial controls are recommended.

ARACHNIDS

Two-Spotted Spider Mite, *Tetranychus urticae*

Spider mites feed mainly on the undersides of the leaves. Their feeding first causes white stippling and leaf yellowing 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 percent of Virginia snap bean growers said mites are important pests.

MONITORING: Scouting fields for mites should begin early in the season, especially in areas that border roadsides or grassy, weedy edges. From early July to mid-August, growers should examine five leaflets in 10 locations throughout the field. Both the upper and lower sides of the leaves should be searched 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. Treatment should be started if there is white stippling and if more than 20 mites per leaflet are found. 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 greater than 10 mites per trifoliate are observed. *Kelthane MF* and *Capture* 2EC are excellent miticides. See the *Chemical Arthropod Control* section for more information.

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, producers should avoid these activities until after snap beans are harvested to help prevent infestations. Horticultural oils may help control spider mites.

CHEMICAL ARTHROPOD CONTROL

Always read the label before applying any chemicals, and be sure to follow the rates specified for the crop of interest. For chemical control recommendations specific to snap beans, please refer to the Virginia Pest Management Guide: Home Grounds and Animals, which is updated and published annually. A current PDF version can be downloaded from the following URL: http://pubs.ext.vt.edu/456/456-018/456-018.html.

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 diseases 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 caused by the fungus *Colletotrichum lindemuthianum* is common in cool, wet weather; a long wet period is necessary for the disease to proliferate. This disease is spread via wind-blown rain, insects, field workers, and infected machinery. It overwinters in bean seeds and some plant material.

MONITORING: Symptoms appear on leaves, stems, and pods. Cankers appear on stems or leaf veins. They are dark brown or black, ovular, and have purple edges. However, pods with anthracnose 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 the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Growers should 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.

Bacterial Blight, *Xanthomonas campestris*

Xanthomonas campestris is a bacterium that overwinters in seeds and plant debris. Plant material may remain infective for up to one year. This disease 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. Affected leaves later dry up and drop off. 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 to control bacterial blight when disease pressure is low. See the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Producers should rotate crops and avoid planting beans within two years of planting other legumes. Sanitation is key; plant material should always be plowed under immediately after harvest. To minimize the spread of disease, growers should avoid working in wet fields or with wet plants and clean all contaminated equipment. The use disease-free western-grown seed is also recommended.

Gray Mold, *Botrytis cinerea*

Gray mold, also referred to as 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: Insecticidal sprays should be applied when 25 to 50 percent of plants are in the bloom stage and repeat at peak bloom. See the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Recommended cultural controls include crop rotation; planting in areas with good airflow; keeping plants well separated within rows; and plowing rows farther apart.

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. Common bean mosaic and southern bean mosaic 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: Growers should not plant snap beans in fields where red clover was planted or within 700 feet of red clover fields. It is also important that they clean up weeds surrounding bean fields, use resistant bean varieties, and plant only certified seed.

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

Pod rot is caused by three different types of fungi (*Pythium* spp., *Botrytis* spp. and *Rhizoctonia* spp.). It 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. In the coastal plains, the disease seems to occur more often in particular fields and is frequently found in bottom areas.

MONITORING: No thresholds have been established for snap beans.

CHEMICAL CONTROL: See the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Beans should be rotated with crops other than legumes. Poorly drained soils should be avoided and previous crop residue should be plowed under rather than disked. To reduce pod to soil contact, growers should select varieties where the pod sets high in the plant and use close row spacing.

Powdery Mildew, *Erysiphe polygoni*

Powdery mildew is a fungal disease that 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 the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Resistant cultivars should be used when available.

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

Root rot, damping-off, and seed rot are caused by a complex of soil-borne fungi including *Fusarium, Rhizoctonia,* and *Pythium* species. Fusarium prefers hot weather conditions, while rhizoctonia is better suited to the moist, cool weather common during fall plantings. Pythium thrives wet weather in both hot and cold temperatures. Although damping-off and seed rot can cause extensive damage in certain situations, root rot in particular, is a very serious problem and is the major factor limiting snap bean yield in Virginia. *Pythium spp.* is the primary pathogen causing root rot in the mid-Atlantic region.

Fusarium root rot results from infection by *Fusarium solani* (formerly *F. phaseoli*). This disease occurs in hot weather in acidic and/or poorly fertilized soils. *Fusarium solani* is able to survive in the soil for several years without the presence of bean plants. Infection 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 best to control disease. Other control methods include subsoiling, bed shaping to improve drainage, shallow cultivation, and nematode (which are vectors for the fungi) control.

Rhizoctonia root rot is caused by *Rhizoctonia solani*. This pathogen 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* also leads to damping-off and seedling death. This disease attacks the stems of young plants near the soil surface. Older plants develop reddish brown cankers that extend longitudinally along the stem at the soil surface. Crop rotation is not a good way 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 is also called damping-off, stem rot or hollow stem and can cause extensive bean loss. Infection sets in rapidly during wet weather, whether temperatures are hot or cold. This disease-causing fungi can survive for several years in the soil and attack a variety of crops. Many different species of pythium cause the development of a 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 pythium stem and root rot, especially when fertilizer is applied and seeds are planted around the same time.

NOTE: Factors such as mechanical injury, excessive irrigation and/or precipitation, and pest damage can cause disease-like symptoms to appear.

MONITORING: No thresholds have been established for snap beans.

CHEMICAL CONTROL: Treatment with either *Ridomil Gold* or *Ridomil Gold PC* is recommended at planting, especially during periods of humid, warm weather. In Virginia, fungicide application is most often a standard practice at planting. See the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Although crop rotations do not always work since fungi are ubiquitous and can survive in the soil for many years, snap beans should be alternated with nonlegume crops when possible. Growers should also 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. Seed should be planted only in properly fertilized, well-prepared soils, with a pH of approximately 6.5. Also, seed should be planted approximately one-inch deep only during good weather in warm soils on top of beds to avoid drowning. Growers should use western-grown seed and rotate crops to allow two years between bean plantings to control web blight.

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: Growers should begin chemical treatment when the disease appears and repeat at seven-day intervals. See the *Chemical Disease Control* section for more information.

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.

Soybean Rust, *Phakopsora pachyrizi*

Soybean rust, also called Asian soybean rust, is caused by the fungus *Phakopsora pachyrizi*. Its 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 Virginia. 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 the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: Snap-bean cultivars that are less susceptible to rust should be planted.

White Mold, *Sclerotinia sclerotiorum*

White mold is caused by a fungus that proliferates in moist conditions within the bean plant's 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. This disease 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: Growers should apply a preventive treatment when 70 to 80 percent 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 the *Chemical Disease Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

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

CHEMICAL DISEASE CONTROL

Always read the label before applying any chemicals, and be sure to follow the rates specified for the crop of interest. For chemical control recommendations specific to snap beans, please refer to the Virginia Pest Management Guide: Home Grounds and Animals, which is updated and published annually. A current PDF version can be downloaded from the following URL: http://pubs.ext.vt.edu/456/456-018/456-018.html.

NEMATODE PESTS

Races 1, 3, 5, and 9 of the soybean cyst nematode are present in soybeans in Virginia. Snap beans are also susceptible. Therefore, producers who rotate snap beans with soybeans should be alert to the possibility of nematode infestation. 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. Snap bean nematodes tend to be a localized problem and are not a large concern in Virginia.

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 for a nominal fee 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. The level of infestation should always be determined before applying any chemical controls. See the *Chemical Nematode Control* section for more information.

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 non host 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.

CHEMICAL NEMATODE CONTROL

Always read the label before applying any chemicals, and be sure to follow the rates specified for the crop of interest. For chemical control recommendations specific to snap beans, please refer to the Virginia Pest Management Guide: Home Grounds and Animals, which is updated

and published annually. A current PDF version can be downloaded from the following URL: http://pubs.ext.vt.edu/456/456-018/456-018.html.

WEED PESTS

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 to 80 percent 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. Each field should be scouted and records kept of the weed species present, their location, and population density.

CHEMICAL CONTROL: See the *Chemical Weed Control* section for more information.

BIOLOGICAL CONTROL: No effective commercial controls are recommended.

CULTURAL CONTROL: No effective commercial controls are recommended.

CHEMICAL WEED CONTROL

Always read the label before applying any chemicals, and be sure to follow the rates specified for the crop of interest. For chemical control recommendations specific to snap beans, please refer to the Virginia Pest Management Guide: Home Grounds and Animals, which is updated and published annually. A current PDF version can be downloaded from the following URL: http://pubs.ext.vt.edu/456/456-018/456-018.html.

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ON-LINE RESOURCES

Greenbook Group Chemical Database Solution Guide
http://www.greenbook.net

Virginia Agricultural Statistics Service
http://www.nass.usda.gov/va

Virginia Cooperative Extension – Commercial Vegetable Production Recommendations
http://pubs.ext.vt.edu/456/456-420/456-420.html

Virginia Cooperative Extension – Virginia Pest Management Guide: Home Grounds and Animals
http://pubs.ext.vt.edu/456/456-018/456-018.html

Virginia Tech Insect Identification Laboratory – Common Insect and Mite Pests of Vegetables
http://www.idlab.ento.vt.edu/IDLab/vegpests/vegfact.html

Virginia Tech Pesticide Programs
http://www.vtpp.org

Virginia Tech Weed Identification Guide
http://www.ppws.vt.edu/weedindex.htm

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