Crop Profile for Beans (Snap) in Tennessee

Prepared: April, 2003

General Production Information

Snapbeans (Phaseolus vulgaris) are tender, warm-season, annuals that are grown for their fleshy, immature pods. The harvested fruit generally ripen 48-60 days after planting. Snap beans are grown mainly for fresh market in Tennessee, however some acreage does exist for processing.

Tennessee ranked 6th nationally in 2001 as fresh market producer of snap beans, harvesting approximately 7,200 acres of snapbeans valued at $8,850,000. In 2001, approximately 8,400 acres were planted for fresh market purposes and approximately 8,800 acres were planted in 2002. In 2002, the Tennessee Agricultural Statistics Service reported that 7,600 acres were harvested. Average yield per acre was 3100 lbs with total production of 236,000 lbs valued at $8,260,000 for 2002. Of the 2002 acreage, 1,500 acres were for processing. Cost of production ranges from $340.00 to 360.00 per acre. Tennessee contributes to just under 8% of the national fresh market snap bean production.

Cultural Practices

Worker Safety and Re-Entry Intervals

Most large scale snapbean producers hire migrant workers or individuals located near their community. Tennessee producers are required by federal and state laws to follow safety standards known as the Worker Protection Standards (WPS). The Worker Protection Standards are regulations which cover pesticide usage in agricultural, forest, nursery and greenhouse production. Any Tennessee producer employing individuals to work in agricultural production must inform and/or train workers concerning the Worker Protection Standards. Worker Protection Standards are standards which are to be followed by employers to help eliminate possible pesticide contamination of pesticide applicators, handlers or workers. Information pertaining to pesticide application must be posted in a central location. Information concerning products used, location of application and re-entry interval is posted at the central location. Also, other items pertaining to safety are provided to workers, applicators and/or handlers. Table 1, includes re-entry intervals of products commonly used in Tennessee snapbean production. If workers, handlers and/or applicators must enter the field earlier than indicated by the pesticide label, individuals

maybe required to wear certain personal protective equipment. In most cases this includes boots, gloves, hat, long sleeve shirts, and long legged trousers. The Signal Word indicated by Caution, Warning or Danger are indicators of the level of human hazard which may vary between formulations containing the same active ingredient. The Signal Word lets the applicator, handler or worker know the relative toxicity of a product. Early re-entry is generally not necessary in Tennessee snapbean production. Treated areas are also posted to inform workers that treatments have been made and re-entry is restricted. If employers and employees follow WPS regulations, harvest interval and re-entry intervals, agricultural workers are less likely to be at risk to pesticide exposure in Tennessee agricultural production.

Table 1. Re-entry Interval of Products Commonly Used in Snapbean Production

Pesticide Type	Active Ingredient	Re-entry Interval	Signal Word
Fungicides	Benomyl**	24 hrs	Caution
	Chloroneb		
	Chlorothalonil	48 hrs	Caution
	Chlorothalonil 6L	48 hrs	Danger
	Mefenoxam	48 hrs	Caution
	Streptomycin	12 hrs	Caution
	Myclobutanil	24 hrs	Caution
	Basic Copper Sulfate	24 hrs	Caution
	Sulfur	24 hrs	Caution
	Iprodione	12 hrs	Caution
	Thiothanate-methyl	12 hrs	Caution
	Dicloran	12 hrs	Caution
	Fixed Copper	24 hrs	Caution - Danger
	PCNB	12 hrs	Caution
Herbicides	Bentazon	48 hrs	Caution

	EPTC	12 hrs	Caution
	Lactofen	12 hrs	Danger
	Metolachlor	24 hrs	Caution
	Pendimethalin	24 hrs	Caution
	Trifluralin	12 hrs	Caution
	Sethoxydim	12 hrs	Warning
Insecticides	Dimethoate	48 hrs	Warning
	Endosulfan	24 hrs	Danger
	Bifenthrin*	24 hrs	Warning
	Acephate	24 hrs	Caution
	Carbaryl	12 hrs	Caution
	Esfenvalerate	12 hrs	Warning
	Diazinon	24 hrs	Caution
	Dicofol	12 hrs	Danger
	Methomyl	48 hrs	Danger
	Disulfoton*	72 hrs	Danger
	Phorate*	48 hrs	Danger
	Naled	48 hrs	Danger
	Spinosad	4 hrs	Caution
	Bacillus thuringiensis	4 hrs	Caution

* Restricted Use Pesticide
** Dupont announced that it would discontinue the manufacture of benomyl.
Uses include products left over in trade channels.

Worker Activities

Land Preparation: Soils are generally freshened prior to planting or during the seeding process. This activity involves one person driving an open or enclosed-cab tractor. Snap bean production is done on bare ground and no workers are required for bed formation.

Planting Method: Seed and fertilizer are placed mechanically at planting. This process requires one operator in an open or enclosed-cab tractor. Seedling germination is generally 85-95 percent, however occasionally germination may be lowered when weather conditions and seedling diseases are favored. No thinning operations necessary.

Irrigation: No irrigation occurs in snap bean production in Tennessee. This would increase the cost of production.

Cultivation: Fields are cultivated mechanically at least once and sometimes two or three times before the crop is harvested. Low clearance tractors may only allow for one cultivation, however snap beans generally do not get tall enough to cause clearance issues. This process also requires only one operator in an open or enclosed-cab tractor. Most cultivation is done with open cab tractors.

Scouting: Progressive growers scout at least weekly. Farm managers, farm advisors and their assistants review their findings and often consult with county agents or area specialist concerning crop protection methods. Disease and insect control is most critical prior to and during bloom and pest levels should be monitored closely during this time.

Harvest: The only time agricultural workers come in contact with the snap beans is during harvest. Approximately 95 percent of snap bean acreage is machine harvested. Most bush varieties are machine harvested (90% plus), while 50% of the half runner types are machine harvested and all pole types are hand harvested. Fields that are machine harvested are picked only once. The remaining snap bean acreage is hand harvested. Hand harvested fields may be harvested one to seven times depending on pod production. Generally, most hand harvest fields are picked 4 times. Workers generally dress in long-sleeve shirts and pants during harvest. Workers often wear cloth or leather gloves during harvest.

The plant residue is eventually incorporated by tillage equipment into the soil. Growers planting large acreage may plant at staggered dates so that harvest can be spread over several days in the event of poor weather, loss may be lessened. Most importantly, multiple plantings are used to ensure a consistent supply of product over the entire season. During grading, initially machines are used to remove trash and shriveled, discolored pods. After machine grading, pods are inspected by two to four workers that are responsible removing remaining trash or shriveled pods. Workers normally wear cotton gloves during the grading process. After harvesting and grading, beans they are immediately shipped by truck to market or the processor.

Varieties

Cultivar or variety selection may be one of the more important components to successful snapbean production. Most snapbeans grown commercially are of the bush type, however there are a few growers who prefer pole types. At this time pods should be full of fruit and not dried. Bush type beans are generally planted with varying planting dates. Many large scale growers may spread out planting over a 50-60 day period. This allows for continued harvest throughout the season. Also, this may reduce risks

of loss caused damage by pests and or the environment.

Listed below are several varieties recommend during 2001 and 2002. Table 2, lists the estimated percent of varieties planted during the 2002 season.

Bush types

- Bronco is a dark green-podded, small sieve-size, fresh market cultivar which may be harvested within 53 days.
- Capricorn is a round-podded, fresh market cultivar. This cultivar has a white seed and a medium green pod which may be harvested within 59 days.
- Carlo is a round-podded, small-sieve cultivar. This cultivar has white seeds with medium-green pods and is best suited for fresh market and is ready for harvest within 55 days.
- Cloudburst is a round-podded fresh market cultivar with white seeds and has medium-green pods and may be harvested within 55 days of planting.
- Eureka is a round-podded waxy cultivar produced for the fresh market. It is white seeded with medium-yellow pods and may be harvested within 56 days of planting.
- Greencrop is a flat pole-type pod suitable for machine harvest for the fresh market and may be harvested within 52 days of planting.
- Hialeah is a fresh market standard, which has a very smooth long pod. This variety may be harvested within 53 days of planting.
- Magnum is a flat, pole-type suitable for machine harvest for fresh market which is dark seeded and is ready for harvest 51 days after planting.
- Provider is a early fresh market cultivar, high yielding potential which has large pods with dark seeds and is ready for harvest within 50 days of planting.
- Roma II is a flat-podded, multi-purpose cultivar which has good flavor with light-green pods and does not ship well. It is ready for harvest within 58 days of planting.
- Romano 942 is a plat-podded, fresh market cultivar with good flavor which has medium-green pods and is ready for harvest withing 57 days of planting.
- Sonato is a round-podded, fresh market cultivar with white seeds and medium-green pods which

is ready for harvest within 53 days of planting.

- Strike is a round-podded, fresh market cultivar, which has high yield potential with a high percentage of medium sieve-size pods and is ready for harvest within 55 days of planting.

- Opus is moderately rust resistant which is round-podded produced for the fresh market. It matures within 53 days.

- Trueblue, is a Blue-Lake Type which requires lower nitrogen levels than other types because of its tendency to lodge. Trueblue is a round-podded processing cultivar, which has a high yield potential with medium to dark-green pods and matures within 54 days.

Pole types

Pole type snapbeans include: Blue Lake, Blue Ribbon, Dade, Kentucky Blue, Kentucky Wonder 191, McCaslan, and Romano. These are usually planted once or twice per season. All pole types are hand harvested

Half-runner types

Half-Runner types include: Mountaineer, State, Striped, Volunteer and White. Half runner types are normally planted once and no more than twice per season.

Table 2. Estimated Percent of Varieties Planted

Variety	% Planted
Bronco	15
Capricorn	5
Carlo	65
Eureka	<1
Greencrop	5
Hialeah	5
Magnum	1
Provider	<1
Roma II	1

Romano 942	<1
Trueblue	<1
Blue Lake	<1
Blue Ribbon	<1
Dade	<1
Kentucky Wonder 191	<1
McCaslan	<1
Romano	<1
Mountaineer	<1
State	<1
Striped	<1
Volunteer	<1
White	<1
OTHERS	1

* plantings will be spread out through the season.

Fertility

Since snap beans prefer a pH of 5.5 to 6.2, very high levels of calcium are not necessary. The soil pH has a profound effect upon the response of snap beans to fertilizer, because it determines whether or not plants are able to extract nutrients from the soil. Thus, if the pH is not correct, snap beans may not be able to use any fertilizer that is applied. When this happens, the cost of production goes up and there is reduced potential for return. Calcitic lime is normally used to avoid a magnesium deficiency situation if lime is needed.

Nitrogen content in the soil varies greatly from season to season due to its leachable nature. Therefore, the soil testing laboratory does not test for nitrogen. The amount of nitrogen recommended for snap beans is made according to the cultivar being grown. Since Blue Lake types are more vigorous foliage producers than the non-Blue Lake types, lower amounts are applied to them. Recommendations are listed below in Table 3. Phosphate and potash should be applied at rates recommended in Table 4.

Zinc deficiencies are likely to occur at a pH above 6.0. To avoid zinc deficiencies, two pounds of actual zinc fertilizer should be applied at planting if soil has been tested low in zinc or if lime has been applied

to the soil.

Table 3. Recommended Nitrogen Amounts for Snap Bean Production

Snap bean Type	Cultivar	Pounds N per Acre
Non-Blue Lake	Blueridge, Eagle, Greencrop, Hialeah, Provider, Roma II, Strike, Opus, Tidal Wave	45
Blue Lake	Benton, Blue Lake 47, Tenderlake Trueblue	15

Table 4. Recommended Phosphate and Potash Applied Per Acre

Soil Test Level	Pounds Per Acre	
	P_2O_5	K_2O
Low	90	60
Medium	60	30
High	30	0
Very High	0	0

Seeding Dates

The time of planting varies with the geographical region of the state. Snap beans could be seeded in the west and southern Middle Tennessee from April 15 - 20. Plantings can be made in the Central Basin from April 20 - 25, on the Highland Rim and Cumberland Plateau from May 1 to August 1 and in the Upper East Tennessee from May 10 until July 20. This would enable the availability of a harvested crop from about the middle of June until mid-September. Growers often plant until mid-August on the

Highland Rim, in order to harvest through mid-October.

Snapbeans grow best at temperatures between 75 and 85F. Daytime temperatures above 90F and night-time temperatures above 70F during bloom greatly reduce pod set. Most varieties may be harvested within 48 - 60 days of planting. Frost and drought are major perils affecting snap beans. Snap bean plants are very sensitive to cold temperatures and will freeze from a slight frost. Snap beans are also sensitive to moisture stress, particularly during flowering and pod development. Moisture stress during flowering will most likely cause blossoms to fall off the plant and consequently result in a substantial decline in yields. Moisture deprivation during pod development can also lengthen the maturity period and result in small, shrivelled pods. Excess moisture can also result in low yields.

Diseases

Diseases can cause widespread, severe damage to the snap bean crop every year. Serious seedling diseases result in poor stands. Damaging stem, foliage and pod diseases further reduce yields. Disease control is necessary to produce the best quality and highest yields of both processing and fresh market snap beans.

Beans, along with many vegetable crops, may be subject to many diseases during the growing cycle. Root rot, damping-off, and seed rots are major diseases of snap beans. Proper crop rotations, field selection, sanitation, plant spacings, fertilization, irrigation, and the use of resistant varieties can reduce the risk of many diseases.

Diseases causing the greatest losses to snap beans in Tennessee are seedling rots, nematodes, rust, anthracnose, bacterial blight, white mold, and mosaic virus. There are several other diseases of minor importance in snap bean production. The primary snap bean diseases are seedling diseases, root rots, Rhizoctonia pod tip rot and rust. The most prevalent seedling diseases are Pythium and Rhizoctonia root rots. However, there are also problems with Ashy stem blight and Fusarium. These are considered mostly secondary invaders. Table 5, lists the disease loss estimate for 2002.

Table 5. Snap Bean Disease Loss Estimate for 2002 *

Disease	% Loss
Anthracnose	0.5
Bacterial Blights	trace
Gray Mold (Botrytis)	0.1

Mosaic Viruses	trace
Pod Tip Rot (Rhizoctonia)	5
Powdery Mildew	0
Root, seedling rots	30
Rust	2
White Mold	trace
Nematodes	0.1
Others	0.1

* Estimated percent loss of entire crop grown during 2002

Anthracnose
(*Colletotrichum lindemuthianum)*

Anthracnose, is favored by cool, wet weather. It may cease to be active during hot, dry weather. It is more common on the Cumberland Plateau than in other parts of the state, and occurs more commonly in home gardens where locally grown seed kept from the previous year is used.

Disease Cycle:

The fungus survives the winter primarily in bean seed. Survival in soil or in plant residue varies greatly, depending on environmental conditions. Research conducted in Canada has shown that the fungus can survive 5 years in infected bean pods and seeds that are air-dried and stored at 4E C. Survival is drastically reduced, however, when infected materials are buried in the field and come in contact with water. Alternating wet-dry cycles in soil reduce survival of the fungus.

Cool to moderate temperatures and prolonged periods of high humidity or free water on the foliage and young pods promote anthracnose development. Moisture is required for development, spread, and germination of the spores as well as for infection of the plant. A prolonged wet period is necessary for the fungus to establish its infection. The time from infection to visible symptoms ranges from 4 to 9 days, depending on the temperature, bean variety, and age of the tissues. The fungal spores are easily carried to healthy plants in wind-blown rain and by people and machinery moving through contaminated fields when the plants are wet. Frequent rainy weather increases disease occurrence and severity.

This fungus overwinters inside bean seed and diseased bean plants left in the field after harvest. This fungus can live in the seed as long as they remain viable. Fungus spores will survive in old bean debris under field conditions for more than two years. Once the disease is brought into a field on the seed, it can be spread by splashing rain and insects, or by people and equipment when the beans are wet.

Symptoms:

The disease may show up on the leaves, stems or pods of bean plants. Dark brown to black, oval-shaped cankers with purple borders often occur on the bean stems and leaf veins. However, the most easily recognized symptom of anthracnose occurs on the pods as small, rust to reddish colored spots. This is the first evidence of the disease. These spots enlarge, turn dark brown to black and sink into the pods. A brownish, sometimes slightly raised border develops around each sunken spot, whose center may be covered with a pinkish ooze during wet weather.

Control:

Disease-Free Seed: Seed grown in dry regions of the west are usually free of the anthracnose fungus. It should always be used in preference to locally produced seed. Seed produced under wet, humid weather conditions quite often have the fungus present inside the seedcoat. Work should not be conducted in the field when the foliage is wet to help reduce spread of disease.

Crop Rotation: Do not grow beans on the same soil more often than once every three years. This fungus survives in old plant material in the field, but is not usually spread to new uninfected sites from the old, infected debris.

Sanitation: Do not work in bean fields when plants are wet. The seed-like spores, present in the diseased spots as a sticky mass, are more easily spread from diseased to healthy plants when plant parts are wet. Plow infested bean trash deeply into soil.

Spraying: In commercial plantings where disease-free seed and crop rotation are used, spraying is seldom necessary due to applications made for rust control. The products used for rust will also protect against anthracnose. Although anthracnose is rarely a problem, it is advisable to use at least one application of chlorothalonil in the pin bean stage to prevent other diseases.

Cultural control is best achieved by using anthracnose-free seed. Western-grown, certified seed is highly recommended. Anthracnose development is unlikely on seed produced in semiarid areas, which have little rainfall and high temperatures during the growing season. In contrast, seeds produced in the Northeast are exposed to summer rains and high humidity during the growing season, and the risk of developing anthracnose is increased.

The fungus survives best on bean seed and to a lesser extent on dried pods and straw. Cleaning and bagging stations in areas where anthracnose has been a problem may be sources of contaminated dust.

Thus these stations should be cleaned of debris between shipments and the shipments isolated. Since the fungus is disseminated in the presence of water, fields should not be entered for cultivation or pesticide applications when the plants are wet. Avoiding unnecessary movement in infested fields will minimize the spread of the disease. Because the fungus does not survive well under field conditions, infested bean debris should be incorporated in the soil after harvest to reduce winter survival. A two-year crop rotation is highly recommended as insurance against winter survival, and it provides some control of root-rotting organisms.

Bean varieties resistant to anthracnose are available from seed companies. The use of resistant varieties, however, is complicated by the presence of several forms or races of the fungus, and plants resistant to one race may be susceptible to another Varieties must be tested where they are to be grown to determine their tolerance to the locally prevalent races.

Bacterial Blights
(*Xanthomonas phaseoli*)

Bacterial blight, overwinters inside bean seed and diseased bean plant debris in the soil. The bacteria survive only one year in old bean plants after the crop is harvested. The disease organism may be introduced by seed into a new field. It is spread from plant to plant by splashing rain and equipment used in the field when the plants are wet.

Symptoms:

The symptoms first appear as small, water-soaked or somewhat transparent spots on the underside of the leaves. These spots enlarge and run together. As they develop, the centers become dry and reddish or brown, surrounded by a narrow yellow halo. On very susceptible varieties, the spots expand until the leaves appear scorched or sunscalded. These leaves soon become ragged and torn by the wind and rain. They later wither and drop off.

Pod lesions start as round, water-soaked dots that enlarge, run together, dry and form sunken blotches, surrounded by a reddish or brick-red margin. Entire pods may shrivel. The bacterium causing this disease may also attack the stems of young seedlings, causing water-soaked, sunken areas that enlarge and develop into reddish streaks. Infected areas may have a yellow ooze or whitish crust during wet or humid weather.

Control:

Crop rotation can reduce infections. Do not plant beans for at least two years behind beans or soybeans.

Sanitation: Plow under all infested plant material immediately after harvest. Do not cultivate or handle

plants when they are wet with dew or rain -- this may spread the bacteria from plant to plant. Do not work in fields when foliage is wet.

Disease-Free Seed: Plant only disease-free seed grown in the blight-free regions of the western United States. Rainfall and humidity are normally too low for the causal bacteria to infect the plants there.

Sprays: Spray at weekly intervals. Copper fungicides applied will aid in control of common bacterial blight.

Gray Mold
(*Botrytis cinerea*)

Gray Mold is also known as Botrytis. It is called gray mold due to its gray appearance on the foliage or pod surface. The fungus causes reduced photosynthesis when infecting the leaves however, pod infection is the most devastating.

Symptoms usually noticed when the fungus infects the ripening pods. It may be observed during bloom development if favorable weather conditions exist. If heavy infections occur during bloom, reduced yield may result. Lesions on the pods develop slowly and with favorable weather may engulf the entire pod. A key diagnostic feature of Botrytis is the grayish mass of mycelium, conidiophores and conidia formed on the surface of infected tissues.

Botrytis infects various plants, however is rarely a problem in snapbean production unless cool wet weather conditions prevail for a period of time.

Several cultural practices may suppress the incidence of gray mold. such as rotation and plant in areas which have good air movement. Planting plants further apart within the rows and widened row spacing may help reducing moisture on succulent plants.

Control may be achieved with fungicides by beginning spraying when plants are 25% - 50% bloom and repeat a peak bloom.

Mosaic Viruses

A number of viruses, including **common bean mosaic, Southern bean mosaic** and **yellow bean mosaic,** may affect snap beans. Common bean mosaic and Southern bean mosaic may be seed transmitted. All three virus diseases may be spread by insects. Yellow bean mosaic is usually spread from clover to beans by aphids. It is usually widespread only where beans are planted after clover or

adjacent to clover fields. Mosaic is considered a minor bean disease in Tennessee, except when grown near areas where clover is grown.

Symptoms:

Symptoms of the different virus diseases are very similar and difficult to separate. All the mosaic virus diseases cause some stunting and reduced yields. The affected bean leaves have irregular, light green or yellow areas merging with darker green patches, which produce the familiar mottling or mosaic effect. The mottling of contrasting yellow and green areas serves as a means of distinguishing yellow bean mosaic from common bean mosaic.

Plants infected by yellow bean mosaic are more dwarfed and bunchy. Bean pods on infected plants are quite often undersized and sometimes curled. They may contain fewer beans than those produced on normal plants. Leaves may be long and narrow and show some puckering or downward cuppings at the margin. The overall symptoms may differ slightly with the variety and age of the plants and, to some extent, with growing conditions.

Control:

Outbreaks may be reduced by following the below recommendations.

Rotation: Fields planted to beans or red clover should not be planted back to beans the following year.

Sanitation: Clean up all weed host plants adjacent to the bean field that could serve as a reservoir for the virus. Do not plant within 700 feet of red or white clover fields.

Certified Seed: Since common bean mosaic and Southern bean mosaic may be seed transmitted, use certified seed.

Resistant Varieties: Using resistant varieties is of doubtful value in the case of yellow bean mosaic. There are several varieties which have some degree of resistance to common bean mosaic.

Powdery Mildew

(*Erysiphe polygoni*)

Powdery mildew can affect all aerial parts of snap beans however seldom causes extensive damage to snap beans in Tennessee. It is favored during times of high humidity.

Symptoms:

Slightly darkened, mottled spots develop on the upper surfaces of leaves and subsequently become covered by a circular growth of white, superficial powdery substance known as the mycelium. The entire leaf or multiple leave may become covered with this thin white covering. Premature senescence may occur during heavy infections from this pathogen reducing photosynthesis of the plant. Stems and pods may later become infected, leading to additional yield loss. Seed transmission results from infection of the seed coat. Infected pods may become stunted, malformed or shrivel and die.

Control:

Certain cultivars have some resistance to infection by *E. Polygoni*, however the fungus is variable and resistance may not be stable over time. Chemical sprays are rarely needed but aid in its control.

Rusts

(*Uromyces appendiculatus* formerly known as *U. phaseoli* var. *typica*)

Rust, caused by the fungus *Uromyces appendiculatus*, attacks all above ground parts of the bean plant, but is most commonly seen on the underside of the leaves. Rust is a disease which occurs primarily in the fall. It becomes most prevalent during periods of low rainfall and high humidity. The rust usually begins on the foliage. It can become serious enough to defoliate the plants and ultimately cause lesions on the pods making them non-marketable. The rust fungus is not seed-borne, but overwinters on old bean plants. Spores produced on old bean plants are spread to new bean foliage by the wind. Early symptoms of the disease may be seen approximately five days after spores land on the leaves. A new crop of spores is produced about every 10 days. The development of rust is favored by cloudy, humid weather and an optimum temperature around 75 degrees F.

Symptoms:

The first symptoms of rust on the foliage are very small, white, slightly raised spots or pimples which may be surrounded by a yellow halo. The white pimples later become raised, reddish, orange to brown pustules. These rupture and release a powdery mass of spores (seed-like bodies) which give a rust color to the fingers if rubbed across an infected leaf. As many as 2,000 individual spots may be found on a single leaf. Heavily infected leaves usually turn yellow, shrivel and fall, resulting in premature defoliation.

Control:

Spraying a timely application of chlorothalonil with Sulfur will protect susceptible bean foliage from rust infection. To spray, use chemical in enough water to thoroughly cover the top and bottom leaf surfaces. Make the first application at the first sign of rust infection on a few plants. Repeat at weekly

intervals until rust is no longer a problem. One to three applications are usually adequate.

Crop Rotation: The rust fungus will live for one year on old bean plant material left in the field. Beans planted in these fields can become infected earlier and be more severely damaged by rust. Therefore, a two year rotation with crops other than beans is important.

Resistant Varieties: Most of the recommended commercial varieties do not have resistance to rust. However, the Opus variety has resistance to many races. Mountaineer, which is grown primarily in home gardens, is resistant to many races of rust.

Chemical Control: Nova has a section 2(ee) registration and may be used at lower than labeled rates for rust control. Nova is limited to 1.25 lbs formulation or 0.5 lbs active ingredient per acre per crop. Chlorothalonil is another product used for rust control. Plants should be sprayed when rust first appears and sprays should be repeated at 7-10 day intervals.

White Mold or Sclerotinia

(*Sclerotinia sclerotiorum*)

White mold can infect all aerial parts of snap beans in the field as well as the succulent pods in transit and storage. This disease is most serious in plants with dense canopies which have had a history of the disease. It is usually observed during cool, moist conditions occur soon after flowering. This disease can survive in the soil for 5 or more years.

Symptoms:

Symptoms include infected flowers that develop a white cottony appearance as mycelium grows on the surface. Lesions soon develop on the leaves, stems and pods. These lesions are initially small, circular, dark green, and water soaked. However, lesions rapidly increase in size and become slimy and encompass and kill the entire infected organ. Entire stems of the plants may die and infected tissues soon become dried out and have a bleached appearance.

Control:

Selecting varieties with upright characteristics with open architecture may avoid infection from this disease. A fungicide spray during bloom may be effective. Rotation with nonhost crops may reduces disease by reducing initial inoculum. Rows should be planted parallel to the prevailing wind, excessive and late season irrigation and excessive amounts of nitrogen fertilizer should be avoided. Wide row spacing and increased spacing within the row should be considered. A timely harvest, followed by a rapid cooling and storage of healthy pods may provide effective control of white mold.

Rhizoctonia Pod Tip Rot (*Rhizoctonia* spp.)

Rhizoctonia pod tip rot usually occurs during periods of high rainfall, especially near harvest. The rain splashes soil containing Rhizoctonia onto the pods resulting in a Awebbing@ or lesion on the pod.

Control may be achieved by applying several of the foliar fungicides.

Seedling rots
(*Rhizoctonia*, *Pythium*, *Phytophthora*, and *Fusarium*)

Snap beans are generally very susceptible to fungi causing damping-off. In order to minimize losses from damping-off, most commercially available bean seed have been treated with a fungicide. This is readily apparent by the distinct color imparted to the seed by the fungicide coating applied by the seed supplier. If, by chance, seed has not been treated, growers may use a seed treatment, such as certain commercial preparations of chloroneb or metalaxyl.

Chloroneb can be applied at 4 oz of the 65% wettable powder per 100 lb of seed.

Apron 25W is a formulation of metalaxyl approved for use on snapbeans as a seed treatment only. Apply 2 oz of Apron 25W per 100 lb of seed. Metalaxyl is specific only for *Pythium* and closely related fungi. Also, while this seed treatment will provide excellent protection against *Pythium* and related fungi it is **not** effective against *Rhizoctonia*, *Fusarium*, and other non-pythiaceous fungi. In addition, this fungicide will not control the aerial blight phase of *Pythium* on mature plants. NOTE: extensive use of this product may result in selection of resistant strains of fungal pathogens.

Of course, treated seed should never be used as food or fed to animals. There are several preplant or at-planting chemical options that growers may use. One is primarily an in-furrow spray, with chloroneb and/or metalaxyl. Growers are referred to labels for particulars.

In recent years it has been almost impossible to get a good stand of late planted snapbeans in Tennessee. Most beans planted after mid-June begin to die about the time they come up to a stand. A number of different soil-borne fungi may attack beans. *Pythium* has been most commonly associated with stand failure of fall beans. However, *Rhizoctonia* and *Fusarium* may also cause seedling disease. Bean seedlings may be attacked from the time they first begin to germinate until they are several weeks old. They are much more susceptible in the young, tender, succulent stage. In addition to the above mentioned fungi, *Sclerotium rolfsii* (the southern blight fungus) can be involved in the loss of stands. If fields have had a history with southern blight it is recommended for growers to plow deep the debris and following the recommendations given below should help control the incidence of seedling disease

caused by this fungus.

Symptoms:

Rhizoctonia and *Pythium* cause young been seedlings to wilt and collapse or damp-off from water-soaked rotting of the stem near the soil line. With *Pythium*, the stem has a more watery rot that is colorless to dark brown. The slimy outer tissue of the stem slips easily from the central core. With *Rhizoctonia*, the stem initially appears water-soaked, but may dry and turn brown or form reddish-brown to brick red, slightly sunken cankers on the stem. The plants may recover, but they will be stunted.

Control may achieved with the used of a seed treatment. Seeds should be treated with Arasan unless they were treated when purchased. To treat with Arasan, place one pound of bean seed in a quart jar and add 1/4 teaspoonful of Arasan. Then shake the container until good coverage is obtained. To treat 50 pounds of seed, add 4 tablespoonsful of Arasan in a rotating drum seed treater or other suitable mixing container and mix until seed are coated with the fungicide. Use Ridomil PC 11G in-furrow at seeding. Rotation, litter destruction and Ridomil PC 11G.

Sanitation: Do not throw infested soil against the bean stems during cultivation. Throwing soil around the stems of beans increases the incidence of seedling disease even when PC 11G is used.

Other diseases that are occasionally observed include Southern Blight (Sclerotium rolfsii)

Root Knot Nematodes
(*Meloidogyne* spp.)

Several different nematodes, including root-knot (*Meloidogyne* spp.), lesion (*Pratylenchus* spp.), sting (*Belonolaimus* spp.), stubby-root (*Trichodorus* spp.) and cyst (*Heterodera* spp.) may affect snapbeans. All parasitic nematodes cause similar above ground symptoms on beans. However, the most commonly observed nematode in Tennessee is *Meloidogyne* spp. commonly called the root-knot nematode.

Root-knot nematodes are the most common nematode that causes the most damage to snapbeans in Tennessee. Due to the buildup of nematodes during the summer months, fall beans are more apt to be severely affected than are spring beans. Recommended bean varieties are susceptible to root-knot nematodes. If a high population of root-knot is present in the soil, beans may be stunted, produce low yields or plants may die. Root-knot damage is usually more severe on light, sandy soils.

Symptoms:

Usually, root-knot nematodes are not evenly distributed over a field. Thus, symptoms may appear in round to irregular areas in the field. The most noticeable symptom may be irregular plant height and

vigor. Symptoms often appear to similar to potash deficiency. Nematodes damage the roots making the plant susceptible to root invading fungi and bacteria. Above ground symptoms are those of a plant with a damaged root system: pale green to yellow foliage, stunting and abnormal wilting during the warmer part of the day. Below ground symptoms furnish the positive proof of root-knot problems. Affected roots have swellings or galls, ranging from very small pinhead size to one-half inch or more in diameter on the larger roots. These galls are enlargements of the root tissue and cannot be detached without breaking the root. Soil samples are sent to The University of Tennessee, Plant and Pest Diagnostic Center, 5201 Marchant Drive, Nashville, TN 37211-5112 to be checked for other parasitic types of nematodes which may also damage beans.

Control:

Rotation: Rotations have some value if a single species of nematode is present. If several genera or species are in a field, it is difficult to find a rotational crop that will not favor the buildup of at least one kind of nematode. Fall beans should not be planted behind a root-knot susceptible crop, such as cucumbers, tobacco, cotton, squash, tomatoes, cantaloupes, peas or beans. Leaving the land fallow during the summer or planting rye in the field in the fall should reduce the root-knot nematode population.

Fumigation: The application of a fumigant type nematicide in the row before planting is one way to control nematodes in snapbeans. Fumigants can be applied by a gravity-flow applicator, and should be placed 6 to 8 inches deep in the row. Most fumigants require a two-week waiting period between application and planting. Fumigation is usually the last alternative for control.

Recommended Fungicides for 2002

Table 6. Estimated Snap Bean Fungicide Applications

Fungicide	% Acreage Treated	Average Number of Applications Made
Basic Copper Sulfate	<5	1
Fixed Copper	<5	1
Benlate 50WP	1	1
Rovral 50WP	1	1

Topsin M 70WP	1	1
Chlorothalonil	75	3-4
Nova 40W	1	1
Sulfur	5	1
Botran 75WP	0	0
Chloroneb 65W (Demosan)	25	1
Apron XL LS	99	1
Maxim*	75	1
Streptomycin sulfate	99	1
Ridomil GOLD PC	<5	1
Terraclor 10G	0	0
Terraclor 75WP	0	0
Arasan	1	1

* Maxim was substituted for chloroneb by the seed company in 2002.

- **Basic Copper Sulfate** (Basic 53W) (3lb) has a 0-day PHI. Is applied at the rate of 3 lbs formulation per acre per application at a cost of $2.70 per application. Rate of active ingredient per acre is 1.59 lbs. This product is used to control anthracnose.

- **Fixed Copper** (various formulations and rates) Products containing fixed coppers have a 0-day PHI. Generally these products are applied at 2-4 lbs formulation per acre ranging in cost of $3.12 - 6.24 per acre per application. Copper hydroxide (Kocide 2000) used at the formulation rate of 0.75 - 2.25 lbs per acre or 0.4 - 1.21 lbs active ingredient per acre. This product has a warning as the signal word and a 24 hr REI. This product is used to control bacterial blights in snapbeans.

- **Benomyl** (Benlate 50WP) has a 14-day PHI. This product is applied at 1.5-2.0 lbs formulation per acre per application. Rate ranges from 0.75 - 1 lb active ingredient per acre per application. Cost ranges from $28.35 - 37.80 per application. This product has been discontinued and will no longer be available for crop production. This product was used to control gray mold and white

mold. This product is no longer being manufactured.

- **Dicloran** (Botran 75WP) has a 2-day PHI, is applied at 3-4 lbs formulation per acre per application. Is applied at the rate range of 2.25 - 3 lbs active ingredient per acre. This product is used to control white mold.

- **Iprodione** (Rovral 50WP) has a 14-day PHI. Is applied at the formulation rate range of 1.5 - 2.0 lbs per acre per application. Active ingredient rate ranges from 0.75 - 1.0 lb per acre at a cost ranging from $33.90 - 45.20 per application per acre. Rovral is used to control gray mold, and white mold.

- **Thiophanate-methyl** (Topsin M 70WP) has a 14-day PHI. Is applied at 1.5 - 2 lbs per acre. Rate ranges 1.05- 1.4 lbs active ingredient per acre per application. This product is used to control gray and white mold.

- **Chlorothalonil** (Bravo, etc) has a 7-day PHI. Is applied at the rate of 2.25 lbs active ingredient per acre per application. There are two formulations commonly used in Tennessee which include the 6L and 82.5 WDG. Cost per application is $17.18 for the 6L formulation and $18.30 for the 82.5WDG formulation. This product is used to control gray mold and rust. Some formulations also contain sulfur which is applied at the rate of 1.48 -2.96 lbs active ingredient per acre sulfur and 1.04 - 2.08 lbs per acre of chlorothalonil.

- **Myclobutanil** (Nova 40W, Rally 40W) has a 0-day PHI. Is applied at the rate of 4-5oz per acre per application. Rate range of 0.0625-0.125 lbs active ingredient per acre. Cost ranging from $15.44 - 19.30 per application per acre. Nova may be used at lower than labeled rates for rust control under EPA FIFRA Section 2(ee). Normally, 2.5 - 3 oz formulation per acre can provide good control of rust. Myclobutanil is limited to 1.25 lbs formulation per acre per crop. This product is used to control pod tip rot and rust.

- **Sulfur** (various formulations) 0-day PHI and is applied at 3 - 4 lbs formulation per acre at a cost of $0.34/lb. Sulfur is used to control powdery mildew and aids in spider mite control when used at higher rates. Sulfur is often used in combination with chlorothalonil (Bravo S) and applied at the rate of 1.48 - 2.96 lbs of active ingredient of sulfur per acre.

- **Metalaxyl and Pentachloronitrobenzene** (Ridomil Gold PC 11G) are a mixture of materials developed for control of several damping off pathogen. Ridomil Gold PC 11G is applied at the rate of 0.75 lbs formulation per 1000 linear row feet. These active ingredients are used to control, *Pythium, Phytophthora,* and *Rhizoctonia*. They are applied in the furrow at planting. If applied at 30 inch row spacing the cost for an application is approximately $24.96 per acre and would be 13.068 lbs formulation per acre and 0.0627 lbs active ingredient of metalaxyl and 1.3068 lbs active ingredient of PCNB. If applied on wider row spacing the cost will decrease and the amount of active ingredient should decrease.

- **Pentachloronitrobenzene** (Terraclor 10G or 75WP) has a 0-day PHI. The 10G formulation is applied at the rate range of 15-20 lbs with rate range of 1.5 lbs - 2 lbs active ingredient per acre at a cost ranging from $13.50 - 18.09 per acre. The 75 WP formulation is applied at the rate of 2 lbs formulation in 10 gallons of water or 1.5 lbs active ingredient at a cost of $19.95 per acre. The active ingredient of this product is for control of Rhizoctonia root rot.

Alternatives:

No labeled chemical alternatives at this time. Breeding programs may develop varieties resistant to various pathogens.

Seed treatments

- **Chloroneb** (Chloroneb 65W, Demosan) is applied at 4oz formulation per 100 lbs of seed.
- **Fludioxonil** (Maxim 4FS) is applied at the rate of 0.16floz per 100 lbs of seed or 0.0025 - 0.005 lbs active ingredient per 100 lbs of seed. Has a 12 hr REI with caution as the signal word.
- **Metalaxyl or mefenoxam** (Apron XL LS) is applied at 0.32 - 0.64 fl oz. per 100 lbs of seed.
- **Streptomycin** (Agrimycin) is occasionally added to seeds for control of bacterial blight.
- **Thiram** (Arasan 75WP) is used at the rate of 16 oz. per 100 lbs. of seed.

Insect Pests

Insect populations fluctuate from year to year and from field to field. Growers must pay close attention to the condition of the crop and scout regularly to determine the presence of any pests. Listed below are several insecticides commonly used in snap bean production. Table 7, lists the estimated usage of insecticide during 2002 snap bean production season.

Insecticides

Acephate (Orthene 75S) has a 14-day PHI. This product is applied at a rate range from 0.66-1.3 lbs formulation per acre or 0.5-1 lb active ingredient per acre. Cost ranging from $7.77-15.31 per application per acre. Best control is achieved with 30 to 50 gallons of water is used. Used for aphids, cutworms, cowpea curculio, Mexican bean beetle, thrips and corn earworms.

Bifenthrin (Capture 2EC) has a 3-day PHI. This product is applied at a rate range of 2.1-6.4 fl.oz. formulation per acre or 0.033 - 0.10 lbs active ingredient per acre. Cost ranging from $6.60 - 20.14 per acre per application. Used for aphids, armyworms, bean leaf beetle, corn earworm, cutworms, loopers, plant bugs spider mites, and stink bugs. This is a restricted use pesticide.

Disulfoton (Di-Syston 8E, 15G) has a 60-day PHI. The 8E formulation is applied at the rate of 1-2 pints per acre at a cost ranging from $10.64-21.28 per application. The15G formulation is applied only once at 6.7 - 13.3 lbs formulation per acre at a cost ranging from $13.47- 26.73. Both formulations are applied at 1-2 lbs active ingredient per acre per application. This product is recommended when planting early during cool, wet springs. Used for control of aphids, Mexican bean beetle and thrips.

Phorate (Thimet 15G) no preharvest interval was listed on the label. Only one application may be made at planting. Is applied at the formulation rate range 6 - 9.3 ozs./1000 linear feet at minimum 30 inch row spacing. Cost of 0.92 - $1.42 per/1000 linear feet or a maximum cost of $16.00 - 24.74 per acre if applied on a 30 inch row spacing. Cost will be lower if applied on a wider row spacing. This material is applied to side of furrow and should not be in contact with seed. Used to control aphids, thrips and the Mexican bean beetle.

Dimethoate (Digon 400, Dimethoate 2.67EC) 0-day PHI. The 2.67EC formulation is applied at a rate of 0.75-1.5 pints per acre and the 4EC formulation is applied at a rate range of 0.5-1 pint per acre. Cost ranges from $2.27 - 4.54 per application per acre. Each formulation is applied at 0.25 - 0.5 lbs active ingredient per acre. Two applications may be needed for heavy infestations of aphids. Used to control aphids, Mexican bean beetle, seedcorn maggot, and spidermites.

Naled (Dibrom 8EC) has a 1-day PHI. Dibrom is applied at the formulation rate of 1 pint per acre or 1 lb active ingredient per acre. This material is used to control aphids, spider mites, and stink bugs.

Methomyl (Lannate 90SP, 2.4LV) has a 1-day or 3-day PHI depending on rate used.

The formulation 90SP is applied at 0.5 - 1 lb per acre and the 2.4LV formulation is applied at 1.5-3 pints per acre. Each formulation is applied at the rate range of 0.45 - 0.9 lbs active ingredient per acre. The cost ranges from $10.31 -22.35 per acre depending on formulation and rate per acre used. For corn earworm apply when damaged pods are found. Use of methomyl may induce outbreaks of leafminers. Used to control armyworms, corn earworm, and western flower thrips.

Spinosad (Spin Tor 2SC) has a 3-day PHI. SpinTor is applied at the formulation rate ranging from 4 - 6 fl.oz per acre or 0.062 - 0.094 lbs active ingredient per acre. This product is used to control armyworms, corn earworms, European corn borer, loopers, and thrips. Armyworm eggs should be targeted when pests first appear to hatch or small larvae are observed. Repeat applications may be necessary for armyworms and European corn borer. No more than two consecutive applications should be made.

Carbaryl (Sevin 50WP, 80WP, 4XLR) has a 0-day PHI. Carbaryl is available in various formulations with varying costs. The 50WP formulation is applied at 1.5-2 lbs at a cost of $6.38-8.50 per acre per application. The 80WP formulation is applied at 0.625 - 1.5 lbs at a cost of $3.91-9.38 per acre per application. The 4XLR formulation is applied at 1 qt. per acre at a cost of $7.83 per acre per application. Each formulation is applied at 0.5 - 1 lb active ingredient per acre per application. Most growers use the XLR formulation because it is easier to mix in spray tanks. One application controls existing bean leaf beetles and repeat applications may be needed if reinfestations occur. Low rates should be used on young plants. Use of carbaryl may induce outbreaks of spider mites. Carbaryl is used to control bean leaf beetle, plant bugs, Mexican bean beetle, and stink bugs.

Esfenvalerate (Asana XL 0.66EC) has a 3-day PHI. This formulation is applied at a rate range of 5.8 - 9.6 fl.oz. or 0.03-0.05 lbs active ingredient per acre. Cost ranges from $4.33 - 7.16 per acre per application. No more than three applications per season may be made. Esfenvalerate is used to control corn earworm, cowpea curculio, cutworms, and Mexican bean beetle.

Diazinon (Diazinon 14G) has a 0-day PHI. This product is applied at rate range of 21-28 lbs formulation or 2.94-3.92 lbs active ingredient per acre. Cost ranges from $32.13 to 42.84 per acre. This product is applied as a broadcast just prior to planting and incorporated into the top 2-8 inches of soil. Deeper (8 inches) incorporation gives better control of wireworms.

Effective control for wireworms, seedcorn maggot, lesser corn stalk borer and slight control of cutworms.

Bacillus thuringiensis (Bt, various names) has a 0-day PHI. Bt-s should be applied at the highest rate possible when the first sign of looper infestation occurs and continued on a 5-day interval. Bt is used to control loopers.

Endosulfan (Thiodan/Phaser 50WP, 3.3EC) has a 3-day PHI. The 50WP formulation is applied at 1-2 lbs per acre and the 3EC formulation is applied at 21.33 - 42.66 fl oz per acre. Each is applied at 0.5 to 1 lb active ingredient per acre. Cost ranges from $5.70-16.90. The 3EC formulation has a lower cost. Endosulfan is used to control stink bugs.

Dicofol (Kelthane 4MF) has a 21-day PHI and caution as the signal word with a 12 hr REI. This product may only be applied twice per season. Applied at the rate of 0.5 -1.5 lbs active ingredient per acre. Used to control spidermites which are generally only a problem in late planted beans during dry weather.

Table 7. Estimated Insecticide Usage During 2002

	Processing		Fresh Market	
Insecticide	% Acreage Treated	Average # applications	% Acreage Treated	Average # applications
Acephate (Orthene)	< 1	1	0	0
Bacillus thuringiensis	< 1	1	< 1	1
Bifenthrin (Capture)	100	2	0	0
Carbaryl (Sevin)	25	1	100	2
Diazinon	< 1	1	0	0
Dimethoate	< 1	1	0	0
Disulfoton	30	1	0	0
Endosulfan (Thiodan)	50	1	95	2
Esfenvalerate (Asana)	< 1	1	95	2
Methomyl (Lannate)	50	1	0	0
Naled (Dibrom)	< 1	1	0	0
Phorate (Thimet)	< 1	1	0	0
Spinosad (SpinTor)	< 1	1	0	0
Dicofol (Kelthane)	< 1	1	0	0
Others	< 1	1	< 1	1

Alternatives

Malathion has a 1-day PHI, signal word of caution and a 12 hr REI. This product is applied at the rate of 0.62 lbs active ingredient per acre. Used to control Mexican bean beetle, Japanese beetle, and leaf hoppers.

Imidacloprid (Admire or Provado) has a 0-day PHI, and caution as the signal word and a 12 hour REI. It is limited to 0.5 lbs active ingredient per acre per season or 10.5 fl. oz. formulation. It is applied generally as a foliar application (Provado) at a 3.5 fl. oz. per acre per application.

Insects

Armyworms, **Beet armyworm** (*Spodoptera exigua*), **Fall armyworm** (Spodoptera frugiperda). Most frequently damage the young terminal growth. These insects can survive the mild winters as pupae in the upper 6 cm of the soil. Several generations occur each year. Damage is usually greater in late planted beans.

Aphids: bean aphid (Aphis fabae), cowpea aphid (Aphis craccivora), melon aphid (Aphis gossypii). Aphids are common in many succulent vegetables. Aphids vary in size and color. They extract sap from the terminal leaves and stems of plants. They may also feed on developing pods causing them to shrink, curl, partially filled or become malformed. Their feeding can result in deformation, wilting, or death of the plant depending on populations and size of the plant. Saliva injected during feeding usually causes the deformation of plant tissue. Some aphids fly while others are flightless, however during stress conditions may produce winged offspring. Aphids are also responsible for the transmission of several viruses. Insecticides have little effect on virus transmission. Aphids may be observed throughout the growing season, however population tend to be greatest in late season.

Bean leaf beetles (*Cerotoma trifurcata*). Damage is caused primarily by the foliar feeding adults. Bean leaf beetles prefer the youngest plant tissues available, when vegetative growth terminates the will feed on developing pods. Beetles may be observed from May through September. They are also known to harbor viruses that may infect snapbeans. Control is achieved by spraying insecticides on foliage when beetles appear and using infurrow applications of insecticides at planting. Adults may overwinter in leaf litter or in wooded areas near the edge of field. These are usually worse in spring planted snap beans than snap beans planted later in the season.

Cutworms, Black cutworm (*Agrotis ipsilon*), **Granulate cutworm** (*Feltia subterranea*), Spotted cutworm (*Amathes c-nigrum*). Cutworms may injure many types of vegetables. They cause greatest damage to seedlings and newly set plants. Larvae hide under clods or in cracks of the soil by day and feed at night cutting young plants near the ground or feeding on the foliage. The black cutworm is the

most destructive cutworm. The black cutworm larvae often severs several plants in a row resulting in the need to replant. Cutworms overwinter as larvae or pupae. In early spring, larvae which have overwintered resume activity and feed until they are mature. Damage usually observed in snap bean within 1 - 3 weeks of planting.

Cabbage looper (*Trichoplusia ni*). Cabbage looper feeding injury closely resembles that of the imported cabbageworm. The young caterpillars feed on the undersides of leaves. As the larvae mature, they move to more protected areas deeper within foliage. Caterpillars consume foliage voraciously for 2 - 4 weeks prior to spinning cocoons on the host plant foliage and pupating. Within 2 weeks the next generation of moths may emerge. During mild winters cabbage loopers may overwinter as pupae in Tennessee. During mild seasons Tennessee may have three or more generations to occur each year. These pests may be observed throughout the season.

Corn earworm (*Helicoverpa zea*). Corn earworms may attack foliage early in the growing season however the corn earworm will eventually feed on the fruiting stages of the host plant. Larvae may move from surrounding weeds into fields which are developing pods. First generations will feed on the foliage where following generations feed on the fruit. Larvae may feed for 2 - 4 weeks during which time they develop through five or six instars. Corn earworms are normally not a problem in snapbean production unless growers have a late season planting of snap beans.

Cowpea curculio (*Chalcodermus aeneus*). The adult beetles puncture pods with their snouts to feed or lay eggs creating small brown wart like blisters or sunken spots on the stems or fruit of the plant. When eggs are laid in pods, grubs develop within a few days and feed on developing seed. After 2 - 3 weeks of feeding grubs chew through the pod drop to the ground and pupate. Within 10 days the grub will turn into an adult. Adults overwinter on crop debris or nearby weeds. These may be observed throughout the season.

European corn borer (*Ostrinia nubilalis*). Borers begin feeding on the leaf surface. They often may be observed feeding within the main stem of the plant. Injuries to the stem allow infection by secondary invaders such as bacteria and fungi therefore reducing potential yield of the plant. Larvae may overwinter in crop debris such as standing stalks. Chemical control is not very effective since there is only a 2 - 3 day period after eggs hatch that larvae are present to be terminated. Close observations must be made to determine when adult moths are present or when eggs are laid. The use of a light trap may aid in determination of the presence of adult moths. Populations increase in the later portion of the season.

Lesser cornstalk borer (*Elasmopalpus lignosellus*). Larvae are injurious to seedlings of many plant species. Injury is caused by larvae boring into the stalk of the plant and disrupting the growth. This occurs soon after eggs are laid by adult moths. Eggs usually hatch within 2 - 7 days after being laid. Damage may be slight or it may kill the entire plant. Damage is most often observed during dry conditions. Cultural conditions include cleaning fence rows of weeds, cultivate weedy areas frequently. Observed more in late season plantings.

Mexican bean beetle (*Epilachna varivestis*). The Mexican bean beetle is one of the most injurious pests of snapbeans. If overwintering populations are high, seedling damage may occur. Both larvae and adults of this insect feed on the leaves of snapbeans. They cause skeletonizing type features within the leaf, therefore reducing photosynthesis of the plant and reducing yield. Heavy infestations resemble a burnt cast in the field with pods and stems being attacked. Adults usually deposit eggs on underside of leaves of the plant. Eggs hatch within 5 -14 days and feed for 2 to 5 weeks. Larvae then pupate on leaves and adults will emerge within 10 days. Some varieties may be less severely damaged than others. If observed, usually in mid to late season plantings.

Seedcorn maggot (*Hylemya platura*). Seedcorn maggots damage newly planted seeds by feeding on seed contents often leaving empty shells and resulting in poor germination. Occasionally, maggots may tunnel into seedling stems allowing entry for other organisms. All stages of this pest may overwinter in mild environments. Cultural control such as planting in a shallow seed bed may speed up germination and reduce injury by this pest. Areas high in organic matter should be plowed in early fall to reduce overwintering sites for this pest. Combination insecticide-fungicides applied at planting may reduce infestation by this pest and other secondary invaders.

Twospotted spider mite (*Tetranychus urticae*). Spider mites are generally only a problem during prolonged periods of dry weather. During periods of heavy infestation mites pierce and extract sap from the undersides of leaves. Infested foliage soon appears to be whitish to bronze in color. Also, webbing may be observed on plants heavily infested with mites. Adults are often observed in dry weather however, larvae cause the most damage during this time. Spider mites migrate from nearby weeds, so removing weedy areas surrounding the field may aid in control, if done early in the season. Late season removal may cause movement of mites into the field. Mites may spread into the field from heavily infested areas by migration or by natural air movement or mechanical movement.

Green stink bug (*Acrosternum hilare*). Stink bugs feed on various plants. Nymphs and adults both pierce plants with their needlelike mouthparts and suck sap from pods, buds, blossoms and seeds. The degree of damage depends to some extent, on the developmental stage of the plant when feeding occurs. Immature pods punctured by bugs become deformed as they develop. Seeds are often flattened and shriveled, and germination is reduced. This pest is observed in mid to late season plantings.

Flea Beetles palestriped flea beetle (*Systena blanda*) and *Epitrix* spp. Adult flea beetles attack the foliage, leaving small round holes in leaf tissue. Early season infestations may kill leaves reducing photosynthesis within the plant therefore reducing yield potential. Root feeding by flea beetle larvae causes little significant injury to most plants, however it may scar roots increasing susceptibility to disease organisms. Flea beetles may be observed throughout the season and inflict greatest damage during early plant development. Flea beetles overwinter as adults among debris in or near fields of host plants. They resume activity in spring and feed on weedy hosts until snap beans are ready to be fed on.

Control: Keeping fields clean of weeds and removal of crop residues prevents buildups of these pests. Late plantings generally have less damage than early season crops. Several soil applied insecticides

reduce damage by these pests.

Other insects occasionally observed include: Harlequin bug (*Murgantia histrionica*), Leaffooted bug (*Leptoglossus phyllopus*), Garden Flea hopper (*Halticus bractatus*), Onion thrips (*Thrips tabaci*), flower thrips (*Frankliniella tritici*), greenhouse whitefly, blister beetles, Japanese beetle, limabean vine borer, vegetable leafminer, white grubs, yellow woollybear or salt marsh caterpillar, yellowstriped armyworm, Spring rose beetle, stalk borer (*Strigoderma arboricola*), striped cumcumber beetle, tarnished plant bug, tobacco wireworm, Southern armyworm, spotted cucumber beetle, and potato leafhopper.

Table 8. 2002 Estimated Yield Loss from Insect Infestations

Pest	**% Loss**
Aphids	< 0.1
Armyworms	1.5
Bean leaf beetles	3
Cabbage looper	0.25
Corn earworm	0.75
Cowpea curculio	trace
Cutworms	< 0.1
European corn borer	trace
Green stink bug	0.75
Lesser cornstalk borer	0.1
Mexican bean beetle	0
Seedcorn maggot	trace
Flea beetle	2
Twospotted spider mite	1
Others	trace

Weed Management in Snap Bean Production

Weeds can be serious in snap bean production and any weed can cause competition for nutrients and

water. There are some broadleaf weeds such as common purslane where the stem may break into small pieces (about the size of a bean pods), making it very difficult to remove by the sorting and grading equipment. Foreign substances within the harvested containers reduce prices received from the buyer. Other troublesome weeds in snap bean production are red root pigweed, common ragweed, and morningglory. In West Tennessee, hophornbeam cofferleaf may cause serious problems. Table 9, lists the estimated herbicide use for snap bean production during 2002.

Herbicide Use

The majority of pre-emergent or pre-plant herbicides have no post-harvest interval listed on the label.

Post emergent herbicides:

- **Bentazon** (Basagran 4L) has a 0-day PHI. Bentazon is applied at the formulation rate range of 1-2 pints per acre or 0.5-1.0 lbs active ingredient per acre. Cost for an application ranges from $9.98 to 19.95 per acre. Basagran will not control pigweed in beans. Bentazon is applied as an early postemergence when broadleaf weeds are small and actively growing, but before they reach the leaf stage specified on the label. This product is not to be applied before the first true leaves have fully expanded on beans. Occasionally one quart per acre of oil concentrate is added to aid in control of ragweed and lambsquarter.

- **Sethoxydim** (Poast 1.5E) is applied at the formulation rate range of 1-1.5 pints per acre or 0.19-0.28 lbs active ingredient per acre. Cost per application ranges from $8.50 - 12.75 per acre per application. This product is used for control of annual grasses up to 4 inches in height and johnsongrass up to 15-25 inches in height that is actively growing. A higher rate is needed for perennial grasses. This product requires the use of a crop oil concentrate at 2 pints per acre for effective control. This product should not be applied within 15 days of harvest of succulent beans or within 30 days of harvest of dry beans.

Preplant or pre-emergent herbicides:

- **EPTC** (Eptam 7E) is applied at the formulation rate of 3.5 pints per acre or 3 lbs active ingredient per acre. Cost of an application is priced at $14.44 per acre. This product is applied as a pre-plant and incorporated into the top 2-3 inches of soil immediately after application. Provides yellow nutsedge and grass control but limited activity towards broadleaf weeds. Proper incorporation is necessary or injury to crop may occur. This product should not be applied when soil is too wet or dry since this herbicide can volatilize very rapidly.

- **Lactofen** (Cobra 2L) is applied at the formulation rate range of 10-16 fl. oz. per acre or 0.16 - 0.25 lbs active ingredient per acre. Cost of an application ranges from $10.23 - 16.38 per acre.

This product is used as a preemergence soil applied herbicide for control of hairy and black nightshade and red root pigweed. This product should not be applied later than 48 hours after planting. Injury may result if applied at the ground cracking or later stage.

- **Metolachlor** (Dual 8E, Dual II, Dual Magnum, Dual II Magnum) is applied at the rates ranging from 0.5 - 1.5 lbs active ingredient per acre. Cost ranges from $12.46 - 22.52 depending on formulation or rate used. This material is used as a preemergence herbicide. This product should not be preplant incorporated or crop injury may result. Applications should be made soon after planting or before weeds emerge. This product provides activity on most grasses, yellow nutsedge, pigweed, ground cherry and nightshades.

- **Pendimethalin** (Prowl 3.3EC) is applied at the formulation rate range of 1.2 - 3.6 pints per acre or 0.5 - 1.5 lbs active ingredient per acre. Cost of an application ranges from $3.40 - 10.22 per acre. This product is applied as a pre-plant incorporated material into the top 1-2 inches of soil. This product provides activity towards grasses and pigweed but has weak activity on most other broadleaf weeds. This product should not be applied after planting as a surface treatment or serious crop injury can result. Spinach is very sensitive to this product and should not follow within 12 months of application.

- **Trifluralin** (Treflan 4EC) is applied at 1-1.5 pints per acre or 0.5-0.75 lbs active ingredient per acre. Cost of an application ranges from $3.35-5.03 per acre. Trifluralin is applied as a preplant incorporated into the top 2-3 inches of soil. It provides good to excellent control of grasses and pigweed but weak activity on most other broadleaf weeds. This product should not be applied to wet soils. Spinach is sensitive to this product, if following treated areas.

Table 9. Estimated Herbicide Usage During 2002 Snapbean Production

Herbicide	% Acreage Treated	Average Number of Applications
Bentazon	25	1
EPTC	<5	1
Lactofen	5	1
Metolachlor	25	1
Pendimethalin	25	1
Trifluralin	<5	1
Sethoxydim	25	1
OTHERS	<5	1

Alternatives:

Clomazone (Command 3ME) is now labeled for use on snap beans. The use rate is 0.4 to 0.67 pints of product per acre (0.15 to 0.25 lb ai/A). Cost ranges from $4.20 - $7.04 per acre. It may be applied as a preemergent for the control of grasses and some small seeded broadleaf weeds. It is weak on pigweed.

Quizalofop-p-ethyl (Assure II 0.88EC) is labeled for postemergence control of grasses. The use rate is 6 to 12 fl oz/A (0.04 to 0.08 lb ai/A). Cost ranges from $6.10 - 12.20 per application per acre. Little or no use of this product in Tennessee presently.

Paraquat (Gramoxone) is a non-selective, restricted use herbicide. It has danger as the signal word and a 12 hour REI. It may be applied at the rate ranges of 0.78-0.94 lbs active ingredient per acre. It is usually applied prior to planting as a burn down.

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