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THE UNIVERSITY OF TENNESSEE
AGRICULTURAL EXTENSION SERVICE
PB897

Commercial Bush Snapbean Production

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Commercial Bush Snapbean Production

Alvin D. Rutledge, Professor
Plant and Soil Science

Introduction

Snapbean production in Tennessee ranges from 6,000 to 9,000 acres and contributes $7 to $9 million annually to the state's economy. The major production area is located within a 50-mile radius of Crossville, with some early production in the south central portion of the state. Small acreages are grown throughout the state for local sales.

Presently, the acreage is about 45 percent processing and 55 percent fresh market. Fresh market packing operations have increased about five-fold in the last few years.

The varying elevations and temperatures enable producers to plant early at lower elevations and make summer plantings at higher elevations. This enables snapbean harvest from about mid-June to late September.

Climate

Snapbeans are a warm-season crop with very little tolerance to frost. The best temperature range for growth is 70 to 80 degrees Fahrenheit. These conditions are quite prevalent in the higher elevations during the summer. Average temperatures below 50 degrees greatly slow plant growth and maturity, while temperatures above 90 degrees during blossoming may cause a high percentage of plants to drop their flowers. This may cause plants to have pods in two stages of maturity, which is undesirable for mechanical harvesting. High temperatures in the west, the Tennessee Valley and south central Tennessee usually cause blossom drop if snapbeans are grown during the summer. Spring crops are more desirable in those areas.

Soil temperature is important for uniform seed germination and seedling development. The best soil temperature range is 60 to 85 degrees Fahrenheit. Poor germination results at temperatures below 50 degrees. This problem is very likely to occur in fields which do not warm-up rapidly in the spring.

Market Options

The greatest market potential for snapbeans includes processing, fresh market, wholesale or local retail sales for small volumes. Processor sales are usually done on contract and for a limited number of acres. Fresh market wholesale sales usually are at market risk and require that the product be graded, packed and cooled to meet market specifications.

Length of Growing Season

Snapbeans grown for both the processing and fresh market require 52 to 60 days from planting to harvest. Therefore, they could fit into a double-cropping system with other crops in many areas of the state. If this is practiced, growers must be aware of potential disease and herbicide residue problems which are likely to occur when certain other crops are grown in rotation with snapbeans. Root rot is likely to increase very rapidly, if a snapbean-soybean or continuous snapbean rotation is practiced.

Costs and Returns

In general, it will cost $325 to $350 to produce an acre of machine-harvested bush snapbeans. The returns, however, may fluctuate more than the costs. They are dependent upon the type market on which sales are made, the production skill of the grower, soil type, pest control and other factors. If a grower can produce at least 140 bushels per acre, he or she has the potential of netting $300 or more per acre on the fresh market and $25 to $100 on processing contracts. With contracts, a grower has a greater assurance of selling than on the fresh market.

Soils

Snapbeans grow best on medium-textured, well-drained, fine, sandy and silt loams. Soils should have good drainage, contain good organic matter to reduce soil crusting, maintain good moisture and be friable enough to enhance uniform germination and emergence.

Tillage, planting and harvesting equipment operate best and the crop matures more uniformly if fields have a uniform soil type and the topography is gently sloping to level. Uniform maturity of the pods is of extreme importance in harvesting highest yields. Large rocks in a field can damage equipment and interfere with efficient and effective operation of planters, harvesters, sprayers and other equipment.

Crop Rotation

Intervals of three to five years are recommended between snapbean crops grown on the same land. Long rotations minimize the build-up of soil-borne disease organisms such as rhizoctonia and fusarium which cause root rots. Rotation also lessens the possibility of carryover of disease organisms which survive in crop residue. Unfortunately, most growers do not have sufficient land for a long-term rotation, but they can be reasonably successful with two successive crops and rotate to an unrelated crop for two years.

Snapbeans can fit into rotations with many other crops. They can follow corn, small grains, grass, legumes and almost all vegetables as long as the necessary precautions are observed. If long residual herbicides, such as atrazine, have been used in other crop production programs, the necessary time to allow dissipation of the herbicide must be followed. Growers should read the label of all chemicals (herbicides, insecticides, fungicides) used on other crops to insure that there will be no residual problems.

Soil Management

Soil management practices which snapbean growers must consider if high yields are maintained include water and soil conservation practices. Severe erosion is occurring in the snapbean growing areas, espe-

cially where fields are being heavily cropped and they have slopes or rolling terrain. Water is the major agent responsible for the soil loss. It is especially great on shallow soils that have subsurface rock close to the top. Therefore, water conservation practices provide increased moisture for crop growth and reduced soil erosion. If good conservation practices are not used, snapbean yields will decrease and Tennessee will become less competitive with other growing areas. This will favor production in other areas and will tend to force Tennessee out of the business. This could be damaging to the economy, since snapbeans are a $7 to $9 million industry.

Water and soil conservation practices that can be implemented into existing production programs include the use of grassed waterways in natural drainage areas of fields, production on the contour, strip-cropping, combined contour and strip-cropping, permanent grass strips and increased utilization of winter cover crops. Minimum tillage and strip tillage is being researched and may someday be a practice that can be used. At the present time, however, refinements in weed control and planting techniques are needed before these systems will be successful.

Lime and Fertilizer

Lime

Since snapbeans 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 snapbeans to fertilizer, because it determines whether or not plants are able to extract nutrients from the soil. Thus, if the pH is not correct, snapbeans 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.

The effect of pH on nutrient availability is shown in the chart below. To evaluate the effect of pH, follow the bar width with a change in pH. The wider the bar, the more available the nutrient. For example, nitrogen is much more available at a pH of 6.0 than at 5.5

To determine the soil pH, obtain soil sample boxes from your county Extension office and sample the soil according to the directions. When the report sheet is completed, be sure that you indicate the crop is snapbeans. If you do not, it is possible that you could receive recommendations for soybeans.

If lime is required, apply the recommended amount of a finely ground limestone ahead of planting. Lime recommendations are based on buffer value and water pH. A finely ground limestone will increase the pH much quicker and raise it higher than a coarsely ground material.

Nitrogen

Nitrogen content in the soil varies greatly from season to season because of its leachable nature. Therefore, the soil testing laboratory does not test for nitrogen.

The amount of nitrogen recommended for snapbeans 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 made as follows:

Type Snapbean	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

Phosphate and Potash

Apply phosphate and potash at planting according to the following recommendations:

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

Zinc

Zinc deficiencies are likely to occur at a pH above 6.0. To avoid zinc deficiencies, apply two pounds of actual zinc per acre in the fertilizer at planting time if zinc tests deficient or if lime has been applied. The addition of zinc in the fertilizer is a good safety practice if liming has been done or if snapbeans follow another crop that required a high pH for best growth.

Other Nutrients

Snapbeans have shown little response to other fertilizer nutrients. However, if calcitic lime is used, a magnesium deficiency could result.

Time of Fertilizer Application

Since snapbeans only require 52 to 60 days from seeding to harvest, all fertilizer should be applied at planting. It is usually not necessary to sidedress with nitrogen, since it often causes excessive vine growth with no increase in yields. Excessive vine growth increases plant lodging and the amount of plant debris that is added to the harvested product. This reduces harvesting efficiency, reduces product grade at the processor or increases labor requirements for grading fresh market products.

Fertilizer Placement

Banding is the most efficient method of fertilizing snapbeans. If fertilizer is banded, it should be placed 2 inches to each side and 3 inches below the seed. It should never be placed in direct contact with the seed, because it will cause the germinating seeds to be severely injured or killed.

When planters are operating on hillsides, they are likely to slip, causing fertilizer to be placed too near or too far away from the seed. This results in non-uniform snapbean emergence and growth which reduces the yields. The fertilizer shoe should be mounted ahead of and operated independently of the seed shoe. This mounting allows either the fertilizer or seed shoe to rise over obstructions independently and reduces spot fertilizer injury to the seed. If the fertilizer shoe is mounted far enough ahead of the seed shoe, it will prevent rocks, roots or other debris from plugging the space between them and causing fertilizer misplacement.

Foliar Fertilizer Applications

The most efficient and productive method of applying fertilizers to plants is through the root system. The major function of the roots is to absorb nutrients and water for plant use. The major function of the leaves is to absorb sunlight for the conversion of carbon dioxide and water into carbohydrates. The leaves have small, microscopic openings called stomates which function in carbon dioxide and oxygen exchange. Therefore, it is difficult for sufficient levels of the major nutrients to be foliar absorbed in large enough quantities to sustain yields.

From a minor element standpoint, zinc is the only element that has resulted in visible responses. Foliar applications of zinc have improved leaf color, but yields did not improve until the soil pH was corrected.

Seeding

Seedbed Preparation

Seedbed preparation is the beginning of the planting operation and is important in obtaining uniform maturity and reducing the amount of soil picked up by the harvester. Proper seedbed preparation promotes uniform germination and plant growth. Tillage practices should be used which develop firm, friable seedbeds that are level and free of excessive clods. Clods interfere with the seeds' contact with the soil and delay or interfere with seedling emergence. Practices should be used which avoid excessive soil compaction, because it interferes with water and root penetration, reduces aeration and delays warming of the soil, thus reducing germination of early spring plantings.

When plowing is done, alter the depth of plowing each year to reduce the formation of "plow pans." Plow pans, if allowed to form, reduce root penetration into moisture- and nutrient-containing areas. Varying the plow depth will keep the plow pans broken up and allow deeper root penetration and greater storage of moisture.

Seeding Dates

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

Seeding Rates and Spacings

When planting snapbeans, the seed size and percentage germination should be considered. The smaller the seed, the less pounds per acre are required to obtain the desired plant stand. By the same token, the less the percentage of germination, the greater the number of pounds required to produce the desired stand.

Almost all snapbeans grown in Tennessee are spaced 24 to 42 inches between rows, depending upon harvesting equipment available. Plant spacings within the row often varies among growers, but research at the Plateau Experiment Station has shown that the highest marketable yields are obtained when there are eight to 10 plants per foot of row (24 to 30 per yard) in 38-inch rows.

The relationship between the pounds of seed required to seed an acre, seed size and percentage germination is given in Table 1. The approximate number of seed to drop per foot of row is indicated in Table 2.

Table 1. Approximate pounds of snapbean seed required to plant an acre resulting in a stand of 6 to 10 plants per foot of row in 38-inch rows, when the percentage germination and number of seed per pound is indicated.

		Percent Germination					
Plants Per Foot	Seed Per Pound1/	100	95	90	85	80	75
6 (82,536 per acre)	1100	75	80	83	88	94	99
	1200	69	72	76	80	86	92
	1300	63	66	70	74	79	85
	1400	58	61	64	68	73	77
	1500	54	57	60	63	68	73
8 (110,048 per acre)	1100	100	107	111	118	125	133
	1200	92	96	103	107	114	122
	1300	84	88	95	99	105	113
	1400	77	81	88	91	97	102
	1500	72	76	80	84	90	97
10 (137,560 per acre)	1100	125	133	140	147	157	166
	1200	114	122	128	134	144	153
	1300	105	113	118	124	132	141
	1400	97	102	108	114	122	128
	1500	90	97	100	105	114	121

1/ The more seeds per pound, the smaller the seed size. If the number of seed is not listed, weigh out 0.5 pound and count the seed. Multiply by 2 to obtain the number per pound.

Table 2. Approximate number of seed to drop per foot of row resulting in 6 to 10 plants per foot when the percentage germination is known.

Desired Plants Per Foot	Percent Germination*					
	100	95	90	85	80	75
6	6	7	8	9	10	11
8	8	9	10	11	12	13
10	10	11	12	13	14	15*

* When the percentage germination is known, growers should add an additional 10 percent to compensate for losses due to planter problems and unfavorable soil conditions.

Planting Depth

Plant snapbeans 3/4 to 1 inches deep depending upon the soil temperature and soil moisture. In the early spring when the soil is cool and moisture is adequate, plant seeds about 3/4 inch deep. Increase the depth of planting up to 1 inch as the soil warms up and the surface moisture decreases.

When the soil is dry, germination is irregular and often poor. When it is dry, uniformity of emergence can be improved by attaching a firming wheel directly behind the seed shoe or disc to place the seed in firm contact with soil and moisture.

Furrow Planting

Avoid leaving furrows during the planting operation that are deeper than about 1 inch if beans are to be machine harvested. Deep furrows may create conditions that result in the "pick-up" of considerable soil debris during the harvesting operation.

Seed Inoculation

Two years of research at the Plateau Experiment Station have not shown that snapbeans respond to inoculation. Yields have not been any higher from inoculated seeds than from recommended levels of nitrogen.

Planter Speed

When the planter speed is maintained at two or three miles per hour, there is less seed cracking, more uniform spacing, coverage and emergence of seedlings. The influence that planting speed has on the number of seeds that must pass through the planter plate is as follows:

	Number of Seeds Per Second That Must Pass Through a Planter Plate at Various Planter Speeds		
	Speed (mph)		
Desired Seed Per Foot	1	2	3
6	9	18	27
8	12	24	36
10	15	30	45

As speed is increased, planter plates may increase the percentage of cracked seed coats or make skip plantings. Damaged seed will emerge as weak seedlings which may die or remain as non-productive plants. Severely damaged seed may not emerge at all. Skip plantings provide no return for your efforts. Therefore, growers must be very careful about their planter speed to obtain a high plant population per acre.

Planter Plate Size

Planter plate size is important in obtaining uniform emergence of strong, productive plants. If the planter plate cell is too small, seed will be cracked. If it is too large, multiple seed droppings will occur. Therefore, it is imperative to match the cell size of the plate to the seed size.

Seed Source

When snapbeans are grown for processing purposes, the processing company's field personnel will usually provide information about the company requirements and suggest suitable seed sources. Otherwise, growers should utilize Western-grown seed or buy from reliable dealers to reduce potential germination and disease problems. The low humidity and limited rainfall in Western areas are unfavorable to the development of bacterial or halo blight and anthracnose.

Handling Seed

Seed bags should not be pitched on and off trucks and into storage rooms. Avoid stepping on stacked bags and pouring seed from heights into seed hopper boxes, because they are easily cracked by rough handling. They are especially easy to crack if they are handled roughly during cold weather. Hairline cracks in the seed coat impede seed germination.

Planting Schedules

Daily planting schedules should be in accordance with the existing soil temperature, the number of harvesters available and the potential delivery schedule to the processor or fresh market. If the soil is cold, overplanting should be avoided because this may cause too many plantings to be ready for harvest the same day.

To avoid this, the Heat Unit System is used by some growers and processors as a guideline to schedule plantings, but they do not rely on it entirely. For those who desire to use it, the number of heat units varies from about 900 to 1100 per cultivar. When the accumulated number reaches the number for the cultivar, harvesting occurs. The system is determined as follows:

1. Determine the maximum and minimum temperatures for each 24-hour period, beginning the day of planting. These figures may be available for the past years at a nearby weather station.
2. Add both the maximum and minimum temperatures and divide by two to obtain the daily average.
3. Subtract a base of 50 F. from the daily average. The difference is the daily heat unit.
4. Accumulate the daily heat units from the time of planting by repeating the above procedure for each 24-hour period.
5. When 25 to 30 heat units have accumulated, many growers will make another planting.
6. When the desired heat units have been accumulated for the desired variety, harvesting can usually be done. The procedure is illustrated in Table 3.

Previous plantings are often used to determine when to make additional plantings. No new seed are planted until seed already planted show signs of germination or growth. Little difficulty is encountered with planting schedules after soils warm up if soil moisture is favorable for germination. When these conditions exist, each day's planting will usually be ready for harvest in the order in which it was planted.

Table 3. Hypotheitcal Illustration of Heat Unit Determination Formula:

$$\textbf{Heat Units} = \frac{\textbf{(Max. Temp. - Min. Temp.) - 50F}}{\textbf{2}}$$

	Temperature F					
Day	Max.	Min.	Total	Average	-50F. base	Accumulated Heat Units
1	68	42	110	55	+5	5
2	55	40	95	47.5	+0	5
3	65	55	120	60	+10	15
4	68	50	118	59	+9	24
5	70	55	125	62.5	+12.5	6.5
6	71	56	127	63.5	+13.5	50.0
7	74	52	126	63	+13	63
8	75	60	130	67.5	+17.5	80.5
9	79	60	139	69.5	+10.5	100.0
10	72	47	119	59.5	+9.5	109.5
60	89	72	161	80.5	+30.5	1115.0

Cultivars

Many new and improved cultivars (varieties) have been released since the introduction of mechanical harvesters. If snapbeans are grown for processing purposes, the processor will quite often specify the desired cultivar. Fresh market requirements, however, are not as rigid as processor requirements. This enables a wider range of cultivars available to fresh market growers. Characteristics of recommended cultivars are given in Table 4.

Weed Control

Controlling weeds in snapbeans is important. Weeds not only reduce the yield and quality of harvested beans, but they also reduce the efficiency of mechanical harvesters. Since it only requires 52 to 60 days from planting until maturity, weed control early in the growing season is very important. The first step is a seedbed with no germinated weeds. When emerged weeds are not present at planting time, snapbeans can get off to a rapid start without excessive competition from weed growth during the growing season.

Table 4. Characteristics of Recommended Snapbean Cultivars

Blueridge	Can be used for fresh market and processing purposes. Long, uniform pods.
Eagle	Good freezer. Tender. Plant lodges slightly.
Greencrop	Flat, pole-type pods suitable for machine harvest. Fresh market.
Hialeah	Processor. Has a very smooth, long pod and produces a very attractive pack.
Peak	For processing use. Good performer.
Provider	Early. High yielder. Large pods. Dark seeds. Fresh market use.
Roma II	Flat-podded. Good flavor. Does not ship well.
Strike	Processor and fresh market. High yielder with a high percentage of medium sieve-size pods.
Rust-Resistant Cultivars Opus	Fresh market, moderately rust-resistant variety.
Tidal Wave	Blue Lake types. Good rust tolerance. Processor. Smooth pods.
Blue Lake Types	Blue Lakes require low nitrogen levels.
Benton	Tall plant, but does not lodge badly. Good yields.
Bush Blue Lake 47	High quality pods. Produces high percentage of sieve sizes 4 and 5.
Tenderlake	Produces high percentage of No. 5 sieve. Short plant.
Trueblue	Late. High yields. Upright plants.

Cultivation

Cultivation should begin when weeds are small and then repeated as often as necessary to keep weeds from competing with the snapbeans. All cultivation should be shallow to avoid breaking the roots. During cultivation, avoid throwing a ridge around the plants because it enables the harvester to pick up a great amount of soil and deposit it in the harvesting container. This reduces quality and grade of the product.

Chemicals

Several herbicides are available to reduce the necessity of cultivation. These materials are available as both pre-emergence and post-emergence herbicides. Some of the pre-emergence materials can be used in combination with post-emergence materials to provide more effective grass and broadleaf control. Since snapbeans are a short season crop, it is important to maintain good weed control early, especially if it is wet for several days after planting. If it turns wet, the effects of a pre-emergence herbicide are very beneficial.

When using any herbicide, always read the label to be sure that snapbeans are tolerant of the material. Avoid planting snapbeans when long residual herbicides have been used in producing other crops ahead of snapbeans.

Due to frequent changes in herbicide recommendations, they will not be discussed in this publication. Annual revisions are made in PB 1282, **Commercial Vegetable Disease, Insect and Weed Control**, available at your county Extension office.

Disease Control

Snapbeans are subject to attack by several fungal, bacterial and viral diseases. These include root rot organisms composed of Rhizoctonia and Pythium; foliage and pod diseases such as Anthracnose, Rust, Bacterial Blight, viruses and various pod rots. A description of snapbean diseases is summarized in Table 5.

Snapbean markets, either processor or fresh market, will not tolerate a high infestation of diseases in the harvested product. Therefore, effective control of snapbean diseases requires excellent sanitation and chemical practices. Control begins with the purchase of Western-grown seed from a reliable dealer. Crop rotation and destruction of plant residue are highly recommended to reduce the build-up of soil-borne organisms. Spray programs to control aphids which are vectors of virus diseases should be conducted. Final methods of control are the use of recommended chemicals found in PB 1282, **Chemical Vegetable Disease, Insect and Weed Control**, available at your county Extension office.

Table 5. Description of Common Diseases of Snapbean

Disease	Description
Anthracnose	Brown spots on leaves. Sunken spots on pods with pinkish fluid exudate in the center of the spot.
Bacterial Blights	Water-soaked spots on leaves and pods. Red margin and sometimes a yellow halo around the spot.
Gray Mold (Botytris)	Gray moldy growth on pods and stems.
Mosaic Viruses	Yellowed leaves with or without crinkling. Leaves cupped. Runners killed.
Powdery Mildew	White powdery mold on surface of leaves.
Rhizoctonia Root Rot	Reddish, sunken lesions on lower stem and roots.
Rhizoctonia and Pythium Root Rot	The entire stem will be rotted, girdled and collapsed below the soil line.
Rust	Reddish brown pustules develop on leaves. Usually more noticeable in hot, humid weather.
White Mold (Sclerotinia)	White, moldy growth on pods and stems.

Insects

Insect infestation can be reduced by crop rotation and by the control of weeds which harbor insects in and around fields. However, these measures will not eliminate the necessity of timely applications of insecticides. Improved insecticides have reduced the need for a preventative spray program if fields are inspected every four or five days and sprayed when a build-up of insects occurs. This serves to reduce chemical cost and the potential for chemical residues on the harvested product.

The major insects which attack snapbeans are cabbage loopers, corn earworms, cutworms, Mexican bean beetles, stinkbugs and thrips. A description of these insects is given in Table 6.

Harvesting Equipment

Snapbeans can be mechanically harvested with either a one-row or a multi-row harvester. The larger growers use multi-row bean stalkers that cost about $135,000 each while the single row tractor pulled unit is much less expensive.

The larger bean stalkers are used in Florida and South Georgia during the winter months and in Tennessee during the summer.

Table 6. Description of Common Insects of Snapbeans

Insect	Description
Cabbage Looper	Pale green, smooth-skinned worms up to 1 1/4 inches long. As they move along on the plant, they make a loop in the middle portion of the body. Commonly called an "inch worm."
Corn Earworm	Fully grown worms are up to 1 3/4 inches long. They vary in color from light green to pink to brown or nearly black. They are marked with alternating light to dark stripes running lengthwise of the body. The head is yellow and unspotted and the legs are dark or nearly black. The skin of the worm is coarse with short, black hairs (similar to a 2-day beard).
Cutworms	Plump, smooth-skinned, greasy looking caterpillars up to 1 inch long often found curled up at the base of plants.
Mexican Bean Beetles	The adult is coppery-brown rounded beetle about 1/4 inch long, with 16 black spots on the back. The larvae is yellowish, soft-bodied and fuzzy. Both the adult beetle and larvae can be found at the same time on the plant.
Seed Corn Maggot	Pale, dirty-colored or yellowish white maggots without legs or distinct head. They are about 1/3 inch long and feed on snapbean seed, reducing stands.
Stinkbugs	Adults are shield-shaped, flat, bright green or brown, about 5/8 inches long with wings and a narrow head. They release a "very bad, repulsive" odor when crushed.
Thrips	The adult thrip is an extremely small (requires magnification to see) yellow-or brown-winged insect. They usually feed in flowers or on very young "pin beans" and foliage tips. When exposed to sunlight, they become very active. They cause whitish-linear markings on mature pods.
Wireworms	Shiny, slick, slender, reddish-brown, hard-bodied, 6-legged worms that range in length from 1 to 1 1/2 inches long.

Insecticides recommended for controlling snapbean insects are found in Extension PB 1282, **Commercial Vegetable Disease, Insect and Weed Contro**l, available at your county Extension office.

Applying Fungicides and Insecticides

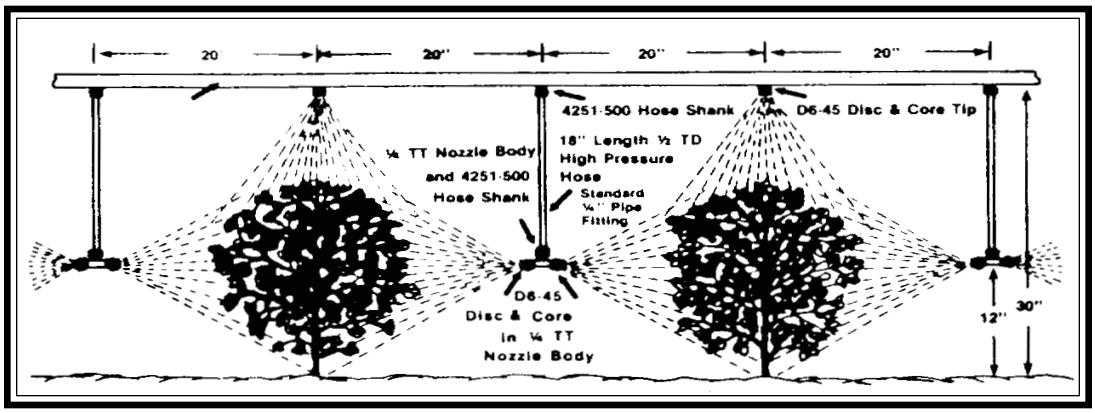
The effectiveness of any pesticide is no better than the method used to deliver the chemical to a target area at sufficient rates to provide control. The following information is included to give some guidelines in properly designing a sprayer to cover the foliage thoroughly.

Most snapbean growers will want to be able to spray snapbeans grown in about 38- to 42-inch rows and will want to cover the entire plant at full growth, which is about 20 inches high. Good sprayer conditions are 100 gallons per acre applied at 100 PSI at a ground speed of 3 mph.

Since most currently owned and available sprayers are boom type with 20-inch nozzle spacings, the following sprayer components and nozzle arrangement will meet the needs with least cost to the grower.

Irrigation

Snapbeans respond to irrigation during dry periods which occasionally occur in snapbean-growing areas. Less water is usually needed in the early spring than during the summer and fall. However, adequate moisture is needed during the time of blossom and pod set. Moisture stress during this period may cause blossom or pod drop. When pods set, they are usually rough and fibrous during periods of moisture stress.



For each row, the following extra equipment is needed:

Three - 1/4 TT Nozzle Bodies with 1325 Nozzle Caps
Three - D6-45 Disc and Core Nozzle Tips with 5414-32 slotted strainers
One - standard NPT -inch T-pipe fitting
-One - 18-inch 1/2 TD high pressure hose
Two - 4251 - 500 Hose Shanks with Hose Clamps

The pump should have a 0.3-0.4 gallon per-minute, per-row capacity when applying 50 gallons per acre at 100 PSI. After establishing the pump requirement for the number of rows your unit covers, then add three gallons per minute required for pressure regulation and agitation. This is very important in good sprayer operation and maintenance.

Yields can be greatly reduced during the various stages of snapbean growth. If a moisture stress occurs during these stages, losses may occur as follows:

Plant Stage	Potential Percent Yield Reduction
Emergence to bloom	12
Flowering and pod set	52
Pod enlargement	44
Pod maturity	12

The degree of moisture stress may depend upon the moisture-holding capacity of the soil, which in turn is influenced by its moisture, texture and organic matter content. Medium- textured or loamy soils have a high moisture-holding capacity and normal rainfall usually provides adequate moisture for snapbean production on these soils. Coarse-textured or sandy loam soils have a low moisture-holding capacity and they can provide adequate moisture for only three or four days without additional rainfall.

An effective irrigation program promotes uniform germination, plant development and harvest maturity, high yields and pod quality. The following irrigation practices are designed basically for coarse-textured (sandy) soils and assume no rain during a given four-day period. They are guides and should be adjusted to the soil type and rainfall distribution.

Planting: Apply 0.2 to 0.3 inches after planting if the soil is dry.

Planting to Bud Formation: Apply 0.6 to 0.8 inches every four days.

Bud Formation to Harvest: Apply 0.8 to 1 inch every four days.

Harvesting

Almost all of the bush snapbeans grown in Tennessee are harvested mechanically. When they are in full bloom, it will be 14 to 18 days until harvest.

Harvester Speed

The ground speed and reel speed of the harvester are important aspects of harvesting and influence of quality. Research has shown that less pod breakage occurs when the ground speed is 1 to 1.5 miles per hour and the reel speed is from 120 to 140 revolutions per minute (rpm). These speeds increase harvester efficiency, reduce pod breakage and harvest the maximum number of pounds per acre. At 1 mph, a two-row harvester would harvest 1-1.3 acres per hour. The blower should be adjusted to remove all foliage and other plant debris from the harvested product.

Sieve Size

The correct stage of the pod for harvesting processor beans depends upon the sieve size, the cultivar and the environmental conditions under which the crop is being grown. Most processor lines are set up to handle more pods of sieve size 4 (U.S. No. 1) or smaller than they are of sieve size 5 (U.S. No. 2) or larger.

The most common ratio used for determining the stage of maturity for harvest are 70:30, 65:35 and 60:40. The larger figure in each ratio is the percentage of sieve size No. 4 and under (small pods) and the smaller figure is the percentage of sieve size No. 5 and 6 (large pods). The most common harvesting ratio for processors in Tennessee is 70:30.

Sieve size is determined by passing pods through sieve perforations according to those described in Table 7.

Table 7. Approximate Sieve Size of Whole, Raw Product Snapbeans for Processor Beans

Sieve Size	Pod Thickness in 64ths of an inch
1	12.0 to 14.4
2	14.5 to 18.4
3	18.5 to 20.9
4	21.0 to 23.9
5	24.0 to 26.9
6	27.0 plus

During periods of cool weather, pod size will increase slowly and several days may elapse before the ratio of small to large pods will change appreciably. With high temperatures, the percentage of large pods will increase rapidly and a substantial change can occur in 24 to 48 hours. When high temperatures are prevalent, fields must be closely checked and harvested before the percentage of large pods becomes excessive.

Storage and Transport

Freshly harvested snapbeans should be cooled down as rapidly as possible in order to prevent pod deterioration. Refrigeration is the best method of cooling snapbeans, but forced air ventilation is effective if refrigeration is not available. Forced air ventilation can be used for "in-transit" cooling of bulk-hauled snapbeans for processing purposes.

Flume-type hydracoolers are now being used to cool snapbeans planned for the fresh market. This removes field heat rapidly and greatly increases storage life.

If necessary, snapbeans can be kept in storage up to one week if they are cooled down to 45 to 50 degrees Fahrenheit and kept at a relative humidity of 85 to 90 percent. Refrigeration is recommended to prolong the usable life of beans.

After-harvest Operations

As soon as possible after harvest, disk the fields to keep weeds from going to seed and hasten the decomposition of plant residue. This reduces the potential for winter carryover of weeds and diseases. If possible, seed the fields to an oat cover crop to reduce soil erosion and maintain the organic matter content. Maintaining good organic matter content aids in reducing soil crust formation when rains occur immediately after seeding. This serves to increase both the percentage and uniformity of snapbean emergence.

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