Crop Profile for Beans (Snap) in Michigan

Prepared: August, 1999

General Production Information

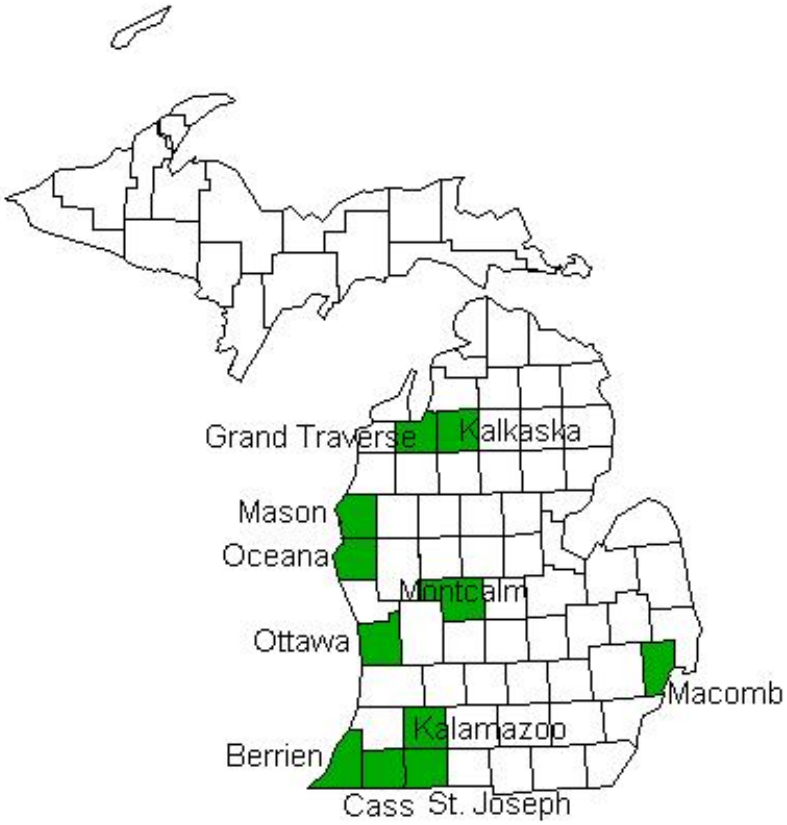
- Snap Bean is produced in Michigan for fresh market and processing.

	Snap bean (processed)	Snap bean (fresh)
Michigan Ranking	10	3
Percent of U.S. Production	9.1	
Area Planted (5 year average)	22,840	1,880
Area Harvested (5 year avg.)	21,860	1,760
Value of Production (thousands) (5 year average)	11,753.60	2,244.40
Production (thousands)	69	69

(13)

Production Regions

- Northwest District: Grand Traverse and Kalkaska counties
- Southeast District: Macomb county
- West Centeral District: Ottawa, Mason, Oceana and Montcalm counties
- Southwest District: Berrien, Cass, Kalamazoo and St. Joseph counties



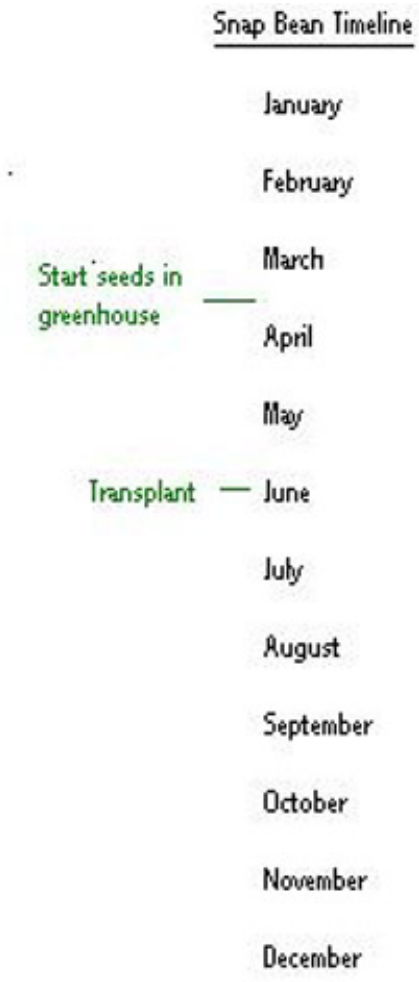
	Counties	District	Acres Planted	Yield (lb/acre)	Production in District
Snap beans for Processing (from 1995-96 MASS, MRS statistics)	**Kalkaska**	**Northwest**	3300	5,000	15,500
	Mason	West Central	4,000	5,500	20,900
	Montcalm	**Central**	2800	6,400	14,100
	Cass	**Southwest**	4200	6,200	24,800
	St. Joseph	S.west,S.central	7,700	7,000	51,800
Fresh Market Snap beans ('95-96)			1800	4,500	7,650

(5)

Top states in snap beans production are Wisconsin, New York, Florida, Oregon and Michigan. (15)

Cultural Practices

Spring crop snap beans are planted ¾ to 1 inch deep either just before or at the beginning of the frost-free period. Fall crop snap beans are planted early enough in the summer for harvest to be completed before the first killing frost. Row spacing for bush beans are 2 inches in the row and 18 to 36 inches between rows. The optimum temperature for plant growth is 60 to 70° F with some growth occurring between 50° and 80° F. Snap beans require 1,050 to 1150 degree days of heat with a base of 50° F.(17)



Snap beans require moist soil for germination. Water availability at pod fill is also critical to ensure high yields. Because of the relatively shallow root system of the snap bean the water requirement is high.

Snap beans are adaptable to a wide variety of soil types but will have difficulty emerging in crusted soils. Cover crops or other types of mulch or use of a rotary hoe may be necessary on heavy soils to break the crust. Uniform emergence is particularly important for bush type beans which will be once over mechanically harvested. For this, all areas of the field must be well drained and prepared with no crusted, cold or wet areas. Snap beans prefer a well drained soil with a pH of 5.5 to 6.0 but the pH can be as low as 5.0 if Mn or Al are not present in toxic concentrations. Liming to a pH of 6.0 makes fertilizer usage more efficient. Beans are particularly sensitive to Boron and may experience toxicity problems in fields where boron is naturally high or where it has been added to meet the requirements of cole crops such as broccoli or cabbage.(17)

Snap beans will nodulate and form symbiotic associations with N-fixing bacteria in the soil even without artificial inoculation. Modern cultivars require fertilizer nitrogen for best performance, however. Plants fixing their own N often get off to a slower start in the cool spring weather and are less uniform in bloom time and subsequent number of days to harvest. Inoculating bean seed with N-fixing bacteria has not been shown to increase yield or even provide nitrogen to snap beans. If not the proper strain, the N-fixing bacterium will be ineffective and possibly parasitic.

Fertilization is particularly difficult in sandy soils because of risk of salt injury to snap beans. High levels of salt cause shriveled or desiccated areas on foliage which often resemble cold injury. Initially fertilizer applications are sometimes broadcast rather than banded to reduce salt injury but sidedressings of N at vining and/or bloom are recommended in sandy soils or where there have been leaching rains.(17)

In soils where zinc is tied up by high pH and phosphate levels, zinc sulfate may be required. Harvesting one ton of snap beans removes 30 to 74 pounds N, 2 to 6 pounds P_2O_5, and 5 to 6 pounds K_2O from the soil.

Critical Use Issues

No information available

Insect Pests

Seed corn maggot (*Delia platura*)

Biology
Seed corn maggots injure seeds of a variety of crops, including snap beans. They overwinter as small, brown pupae in the soil. Adult flies emerge late in April to May. They are attracted for egg laying to soils that high in decomposing organic matter, including plowed-down cover crops and animal manure. Eggs are laid on or beneath the soil surface. Larvae feed on decomposing plant material in the soil and especially on seeds of corn, beans and cucurbits. Seeds may be attacked before or shortly after germination. Injury may kill seeds. If sprouting seeds are attacked, cotyledons and new leaves may show injury above ground. Damage is especially common in cool weather because the seed corn maggot is well adapted to cool temperatures and seeds germinate slowly and are exposed longer to injury. There may be three or more generations per year.

Cultural Controls
Monitoring for this insect is not practical, so **seed treatment is generally recommended.**
Limit the amount of organic matter available (10)
Delay in planting(10)

ChemicalControls
Treatments are applied to seeds before planting. Insecticide and fungicide treatments can be combined according to directions**. Handle seed carefully to prevent cracking.**
Lindane(Isotox Seed Treater F), 2oz/100 lb seed as planter box treatment.
Lorsban 50 SL, 2oz/100lb seed as slurry treatment only.
Lindane/diazinon/captan (Triple Seed Protectant) 3oz/bushel as planter box treatment.

Alternative Controls
No information available

Mexican bean beetle (*Epilachna varivestis*)

Biology
The adult is oval in outline and about 6-7mm in length. Adults overwinter in leaf litter and debris in a variety of habitats, with its native habitat being a very wet climate At emergence it is cream or straw colored , and eight black spots of variable size appear on each wing cover. The adults darken with age until they become an orange brown with a bronze tinge. The eggs of the Mexican bean beetle are approximately 1.3 mm in length and 0.6 mm in width and are pale yellow to orange yellow in color. They are found in clusters of 40-75 on the undersides of bean leaves. The larvae is light yellow when newly hatched and not over 1.6 mm in length. The body is covered with rows of stout branched spines, arranged in

six longitudinal rows on their back. The body is soft and tapers posteriorly and has an anal segment having a sucker-like apparatus for attachment to feeding surfaces. The mature larvae is from 6.0-9.5 mm in length and of greenish yellow color. It molts four times during the time of development. The larvae tend to congregate in considerable numbers for pupation.(18)

Both larvae and adults will feed upon the leaves, flowers and growing pods of the bean plant but the greatest injury is done to the leaves. The larvae cause a greater level of damage than the adult. They emerge in May and begin feeding on young bean plants and laying yellow eggs on the underside of leaves. There may be up to three generations per year. Both cause a typical skeletonizing of the leaves, with a lace-like appearance. Occasionally blossoms, and in many cases small pods, will be entirely destroyed or so badly eaten that they drop from the plant.(18)

CulturalControls
Destruction of overwintering locations and late planting of crop. The destruction of overwintering locations increases exposure to inclement weather conditions and can greatly reduce adult numbers the following spring. Since overwintering beetles actively forage upon emergence in the spring, beans planted early will attract a disproportionate number of beetles feeding during their preoviposition period.(18)

ChemicalControls
For curative control in outbreak situations, several insecticides are currently available.

Carbaryl (Sevin) 80 S, 1 ¼lb or XLR, 1pt (3days). Also registered for bean leaf beetle.
Endosulfan (Thiodan) 3 EC, 2 pt or 50 WP, 1 ½lb (3days). 3 times per season. Do not feed threshings to livestock or allow them to graze.
Diazinon 500-AG 1 pt (7 days)
Pencap-M, 2 pt(3days)(RUP). Do not apply during bloom.
Lannate SP, ¼to 1 lb (3days) or LV, ¾to 3 pt (RUP). Do not graze of feed treated vines to livestock within 3 days nor bean hay within 7 days of last application.
Orthene 75 S, 2/3 to 1 1/3 lb (14 days). Do not feed treaed vines to livestock. Also registered for bean leaf beetle.
Malathion 57 EC, 1 ½pt (1 day). Also registered for bean leaf beetles.

Alternative Controls
At least 17 species of predators exist for the Mexican bean beetle.
Bean leaf beetles can also cause serious injury to foliage of snap beans and are especially damaging to young seedlings. This beetle is restricted to the southern counties of Michigan.(18)

Potato Leafhoppers (*Empoasca fabae*)

Biology
The potato leafhopper is a serious pest of snap beans in Michigan. Adults cause "hopper burn" in the process of feeding. Foliage turns yellow, then brown, and plants may be stunted and the yield reduced. They migrate into Michigan from overwintering sites in the south, usually arriving in May. The potato leaf hopper feeds by sucking plant sap of a wide range of plants, including alfalfa and potatoes. They migrate into beans from these hosts, especially after cutting nearby alfalfa hay. There may be 4-6 generations per year.(20)

CulturalControls
resistant cultivars

ChemicalControls

Asana XL, 5.8 to 9.6 oz (3days). Do not harvest treated vine leaves for livestock forage, fodder or hay. (RUP).
Carbaryl (Sevin) 80 S, 1 1/4 lb or XLR Plus, 1 qt (3 days)
Dibrom 8 EC, 1 pt (1 day)
Dimethoate 4EC, 1pt (7days). Do not feed treated forage to livestock.

Lannate SP, ¼ to 1lb or LV, 3/4 to 3 pt(3 day) (RUP)
Orthene 75 S,2/3 to 1 1/3 lb(14 days)
Pencap-M, 2 pt (3days) (RUP).

Alternative Controls
They can be monitored visually or by using a sweep net.

European Corn Borers (*Ostrinia nubilalis*)

Biology
European corn borers may attack snap beans, boring into the pod and contaminating the product. They overwinter as larvae primarily in field corn crop residue. Mating occurs in grassy and weedy areas and the females move into snap beans, sweet corn and other crops to lay eggs. Eggs are usually laid on the underside of the leaves. Larvae may attack the stalk or bore into the pod and feed on the bean. They most often attack field corn during the first generation. Second generation egg laying usually occurs in late July and August. **A third generation of corn borers may occur in southern Michigan or during years in unusually warm spring and summer weather.**(20)

Damage in snap beans is usually most severe during late August and early September when other hosts for the corn borer mature and become less active.(2)

CulturalControls
Adult moth activity can be monitored using pheromone (sex attractant) lures and traps placed in grassy areas. European corn borer eggs and larvae can be monitored visually, **but preventative treatment is usually required as soon as fruit begins to form**.

Chemical Controls

Asana XL, 5.8 to 9.6 oz (3days). Do not harvest treated vine leaves for livestock forage, fodder or hay. (RUP).
Carbaryl (Sevin) 80 S, 1 ½ lb or XLR Plus, 1 to 1 ½ qt (3 days)
Lannate SP, ½ to 1lb or LV, 1 ½ to 3 pt(3 day) (RUP)
Orthene 75 S,1 to 1 1/3 lb(14 days)
Pencap-M, 2 to 4 pt (3days) (RUP).

Alternative Controls
No information available

Bean Aphids(*Aphis fabae*)

Biology
Bean aphids are small soft bodied insects that suck sap from the stem or leaves of plants. Aphids have a characteristically pear like shape, a pair of cornicles at the posterior end of the abdomen, and fairly long antennae. They cause a curling or wilting of the food plant by their feeding and they serve as vectors of a number of important plant diseases including mosaics of beans. Aphids can be controlled relatively easily with insecticides.(20)

Cultural Controls
No information available

Chemical Controls
Planting treatment:

Diazinon 500-AG 1 pt (7 days)
Dibrom 8 EC, 1 pt (1 day)
Dimethoate 4 EC, 1 pt (7 days)
Pencap-M, 2pt (3days) (RUP).
Malathion 57 EC, 2 pt (1 day)
Orthene 75 S, 2/3 to 1 1/3 lb(14 days)

Alternative Controls
No information available

Green cloverworm (*Plathypena scabra*)

Biology
The green cloverworm moth is very dark brown and about one inch long. The head is elongated slightly into a pointed snout caused by protuding palps that are associated with the mouthparts. When sitting the moths form a triangular or inverted V shape. The green cloverworm feeds primarily on legumes. The caterpillar is slender and green with two thin white stripes on each side. The full caterpillar is about one inch long. They feed on foliage and also cause damage to the pods. Most years the caterpillars are decimated by fungal disease that keeps their numbers low. The green cloverworm overwinters as pupae in Michigan and go through 2-3 generations per year.(20)

Cultural Controls
Fields should be inspected regularly for larvae or signs of foliar injury or injury to the bean pods.

Chemical Controls
Asana XL, 5.8 to 9.6 oz (3days). Do not harvest treated vine leaves for livestock forage, fodder or hay. (RUP).
Pencap-M, 2pt (3days) (RUP).(20)

Alternative Controls
No information available

Insecticide Profiles

Carbaryl (carbamate)

Formulations: Sevin
Pests Controlled: Potato Leafhopper
Percent of Crop Treated: no information available
Types of Applications: Ground spray/boom
Timing: Depends on appearance of the pest
Pre-Harvest interval: 3 days (2)
REI: 12 hours (2)
Use in IPM programs: None
Use in Resistance Management Programs: None
Efficacy Issues: good (2)
Advantages: Registered on many crops, low mammalian toxicity.
Disadvantages: Non-specific, may cause aphid build-up.
(9)(14)(18)(19)(20)

Acephate (Organophosphate) (Alternative to Carbaryl)

Formulations: Orthene 75 S

Pests Controlled: Non-specific leaf hopper
Percent of Crop Treated: no information available
Types of Applications: foliar spray
Timing: no information available
Pre-Harvest interval: 14 days (2)
REI: 24 hours (2)
Use in IPM programs: None reported
Use in Resistance Management Programs: none reported
Efficacy Issues: high
Advantages: may be combined with other pesticides (23)
Disadvantages: Generally use 1-2 applications per crop cycle, need more if weather is hot and dry.Kills predators of mites, which could lead to a mite outbreak.
(9)(14)(18)(19)(20)

Methomyl (carbamate) (Alternative to Carbaryl)

Formulations: Lannate SP and Lannate LV
Pests Controlled: Non-specific leaf hopper
Percent of Crop Treated: no information available
Types of Applications: foliar treatment
Timing: no information available
Pre-Harvest interval: 3 days (2)
REI: 48 hours (2)
Use in IPM programs: None reported
Use in Resistance Management Programs: no information available
Efficacy Issues: High
Advantages: compatible with other pesticides, rapid knockdown (23)
Disadvantages: Lannate is the least safe but growers may use if they already have the chemical for corn.
Other comments: Growers often use Carbaryl, Methomyl and Acephate depending on what they have available.
(9)(14)(18)(19)(20)(23)

Diazinon (organic phosphate)

Formulations: Lindane/diazinon/captan (Triple Seed Protectant)
Pests Controlled: Mexican bean beetle, aphids
Percent of Crop Treated: no information available
Types of Applications: foliar treatment
Timing: no information available
Pre-Harvest interval: 7 days (2)
REI: 12-24 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: good (2)
Advantages: compatible with other pesticides (23)
Disadvantages: bird and bee toxicity (23)
Comments: Long residual time (23)
(9)(14)(18)(19)(20)

Lindane (chlorinated-hydrocarbon)

Formulations: Isotox Seed Treater F
Pests Controlled: seed corn maggot
Percent of Crop Treated: no information available
Types of Applications: Planter box treatment, seed treatment
Timing: no information available
Pre-Harvest interval: no information available

Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: 5-10 times as effective as DDT (23)
Advantages: no information available
Disadvantages: persists in soil, toxic to fish and bees (23)
(9)(14)(18)(19)(20)

Methyl parathion (organic phosphate)

Formulations: Penncap-M
Pests Controlled: leafhoppers, green cloverworm, aphids, Mexican bean beetles
Percent of Crop Treated: no information available
Types of Applications: foliar treatment
Timing: no information available
Pre-Harvest interval: 3 days(2)
REI: 48 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: good (2)
Advantages: inexpensive
Disadvantages: Toxic to applicator. Risk of honeybee and other non-target loss.
(9)(14)(18)(19)(20)

Chlorpyrifos (organic phosphate)

Formulations: Lorsban 50 SL
Pests Controlled: seed corn maggot
Percent of Crop Treated: no information available
Types of Applications: Slurry treatment
Timing: no information available
Pre-Harvest interval: not applicable
REI: 24 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: effective
Advantages: resistant to leaching (23)
Disadvantages: no systematic activity, toxic to bees and fish (23)
(9)(14)(18)(19)(20)

Endosulfan

Formulations: Thiodan 3 EC, Phaser
Pests Controlled: Mexican bean beetles
Percent of Crop Treated: no information available
Types of Application: foliar spray
Number of Applications: maximum 3 applications per year (2)
Timing: no information available
Pre-Harvest interval: 3 days (2)
REI: 24 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: good (2)
Advantages: compatible with most pesticides, relatively non-toxic to bees (23)
Disadvantages: highly toxic to fish, corrosive to iron (23)
(9)(14)(18)(19)(20)

Diseases

Damping off

Biology
Damping-off disease of seedlings is widely distributed all over the world. It affects seeds, seedlings, and older plants of almost all kinds of vegetables, flowers, cereals, and fruit and forest trees. The greatest damage is done to the seed and seedling roots during germination either before or after emergence. Damping off is caused primarily by soilborne fungi. Significant losses may occur to susceptible varieties, especially if cool, wet weather conditions prevail for the first few weeks after seedling and then are followed by hot, dry weather.(21)

Damping off before emergence results from fungal attack of germinating seed and/or young seedlings while they are still in the ground. Infected seeds may fail to germinate, become soft and mushy and finally disintegrate. Slightly water-soaked lesions may be visible on stems of young seedlings. Infected areas enlarge quite rapidly, and seedlings may die shortly after infection, prior to emergence from soil. Roots or stems of seedlings that have already emerged also can be attacked at or below the soil line resulting in damping-off.

Infected roots are usually discolored or rotted and sometimes reddish brown lesions develop on the tap root. Infected stem tissues are soft and colorless to dark-brown. Basal portions of invaded stems may be much thinner than the areas above the lesion, a condition called "wire-stem", resulting in the seedling falling over and dying.(21)

Damping-off is a major cause of poor stand establishments in bean plantings. Older plants may also be attacked by these fungi. Later infections are usually confined to roots, which may result in stunting, wilting, or plant death.

Cultural Controls:
Do not grow beans continually in the same location. A 4-5 year rotation is desirable, avoiding fields known to be heavily infested with root-rot fungi. Plant beans only on well drained soils. Delay planting until the soil is warm(above 65 F) and seed shallow to insure rapid emergence. Avoid planting seeds to close together. Do not overfertilize, especially with nitrogen.
To diagnose bean root rots, suspected plants should be carefully dug up and washed.

Chemical Controls:

Benomyl
Metalaxyl
Captan
Quintozene
Thiram
Metalaxyl and Mancozeb
(21)

Alternative Controls:
No information available

Root and Stem Rot

Biology

In root rot of beans the tap roots of the young plants at first show a slightly reddish discoloration. This later becomes darker red to brown and larger, more or less covering the taproot and the stem below the soil line without a definite margin, or appearing as streaks extending up to the soil line. Longitudinal fissures appear along the main root, while the small lateral roots are killed. Plant growth is generally retarded and in dry weather the leaves may turn yellow and even fall off. Sometimes infected plants develop secondary roots and a large number of rootlets just below the soil line. These roots, under favorable conditions, may be sufficient to carry the plant to maturity and to production of a fairly good crop. In many cases the infected plants decline and die with or without wilt symptoms.(21)(22)

Cultural Controls:
See cultural control of Damping-off above.

Chemical Controls:
Quintozene

Alternative Controls:
No information available

Anthracnose *(Colletotrichum lindemuthianum)*

Biology
Glomerella Anthracnose disease is present wherever their hosts are grown and are more severe in warm to cool, humid areas and are generally not a problem under dry conditions. Bean plants in all stages of growth are subject to anthracnose. The fungus is often present in or on the seed produced in infected pods. Infected seed may show yellowish to brown sunken lesions of various sizes. When infected seeds are planted, many of the germinating seedlings are killed before emergence. Dark brown, sunken lesions with pink mass of spores in the center are often present on the cotyledons of young seedlings. The fungus may kill one or both of the cotyledons, while its spores spread onto the hypocotyl and the mycelium moves into the stem. On the stem the fungus produces numerous small, shallow, reddish-brown specks that subsequently enlarge, become elongated and finally sunken. The lesions are covered with myriads of pink- to rust-colored spores. If conditions are humid, the lesions may be so numerous that they girdle and weaken the stem to the point where it cannot support the top of the plant. The fungus also attacks the petioles and the veins of the underside of the leaves, on which it causes long, dark, brick-red to purplish colored lesions that later turn dark brown to almost black.(22)

On pods , small, flesh- to rust- colored elongated lesions appear, which later become sunken, circular, and about 5-8 mm in diameter. Lesions developing on young pods may extend through the pod and even to the seed, while in older pods the lesions do not extend beyond the pod. As the pod matures, the margin of the lesions is generally slightly raised, while the pink spore masses of the lesions dry down to gray, brown, or black granulations or to small pimplelike protusions.(22)

Cultural Controls:
Control damping off and wirestem in the greenhouse and field seedbeds by using sanitized media and containers and avoiding overwatering. Whenever possible use disease free seeds, although infected seeds can be treated by hot water. Planting seeds on raised beds with good aeration between plants can decrease occurrence. A three year crop rotation will reduce infect rates. Cole crops should not be grown in low-lying fields with heavy soils, and diseased transplants should not be used.(22)

Chemical Controls:
Foliar Treatment
Benomyl Benlate 50 WP, 8 to 24 oz. (14 days)
Copper Sulfate Basicop 53WP , 2 lb. Apply at 7- to 10- day intervals.
Thiophanate-Methyl Topsin M WSB, 1 to 1 ½ lb (14 day)
Thiram (42-S or 50 WP Dyed) is used as a seed treatment at a rate of 8 oz/100 lb seed. (REI 24 hours)

Alternatives Controls:
No information available

Gray Mold (*Botrytis cinerea*)

Biology
Gray mold is a disease caused by the fungus *Botrytis cinerea* and can infect all vegetable transplants at any stage of growth resulting in irregular brown spotting or blight of leaves and stem cankers. Under humid conditions, *Botrytis* produces gray and powdery propagules(conidia) on diseased plant parts that can be transported on air currents to cause disease on nearby healthy plants.(22)

Gray Mold can be prevalent during cloudy periods in the spring when conditions in the greenhouse are humid and foliage remains wet for an extended period of time. The fungus that cause gray mold requires a film of water to penetrate the plant..(22)

Cultural Controls:
No information available

Chemical Controls:
Benomyl Benlate 50 WP or Sp, 24 to 32 oz. (14 days)
Thiophanate-Methyl Topsin M WSB or 70 W, 1 ½ to 2 lb (14 day)
Chlorothalonil Bravo Weather Stik 3pt or Bravo 720, or Bravo 500, 2 ½ pt or Bravo Ultrex 82.5 WDG, 1.25 to 2.7lb (7day)
Supanil 720 or Terranil 6L, 3 pt (7 day)
Vinclozolin Ronilan EG, 1 lb (10 days)
Iprodione Rovral 50W or WG, (1 ½ to 2 pt) (14 days)

Alternatives Controls:
No information available

White mold (*Sclerotinia sclerotiorum*)

Biology
White mold has been found in numerous Michigan bean fields. Losses occur under conditions of high humidity and abundant rainfall in fields with heavy vine growth. Less damage is seen in the varieties with an upright bush habit than in older vine-type varieties. The more open growth habit of bush-type varieties reduces the time that soils are excessively wet and leaves and flowers are covered with free water.(22)

White mold is caused by the fungus *Sclerotinia sclerotiorum.* It is a fungus that is highly distributed throughout the U.S. and attacks many vegetable and field crops. Small black, hard bodies called sclerotia are produced on and in the stems and pods of infected plants. At harvest the sclerotia are scattered over the soil surface, but below the surface they can lie dormant for up to five years. Sclerotia serve as sources in the year following the one in which they were produced. They germinate to form stems which can be up to 3cm long. After the stems reach the soil surface they are stimulated by light to form another structure, the apothecium, at their tips. These produce ascospores which are discharged into the air and can travel as far as one-half of a mile before landing on plant parts such as leaves or flowers. **Ascospores are the source of nearly all the infections seen in beans.** They normally only infect dead or dying plant material, especially aging flowers. Wounds by hail or cultivation are sites of infection. Infection of healthy pods, leaves and stems generally results from an infected flower that has fallen onto or come in contact with other plant tissues.

Shortly after infection white masses of mold appear on infected tissues and black sclerotia begin to form in these areas within the stems, thus completing the life cycle. Secondary spread down rows occurs when infected plant tissues come into contact with health tissues.

The fungus will often girdle the main stem or its branches causing the plant or plant parts to wilt and die. The leaves turn

bright yellow and then brown. Infected pods become soft and mushy, but later dry out and are light colored and shrivelled.

Cultural Controls:
All bean varieties are susceptible to white mold. **Varieties** with a shorter flowering period and an upright-bush habit may be less likely to be severely affected under heavy disease pressure. These varieties also respond better to chemical control because of shorter times needed for protection and because of a less extensive canopy. Using cultural practices that allow for the plants to dry out rapidly. Maintaining proper **spacing** between rows and avoiding crowding of plants within the row increases air circulation and promotes drying of soil and foliage. Attempts to control white mold with deep plowing have been unsuccessful. Once high populations of sclerotia have built up in the soil rotation has little effect on reducing the white mold pathogen because of the longevity of sclerotia in the soil. Other numerous crops and weeds are host to white mold also.

Chemical Controls:
White mold is not a problem every year, but only in years of abundant rainfall and extensive canopy cover chemical control may not be advisable as a normal management practice. Chemical control can be effective when:
The chemical is applied before infection has occurred.
The chemical adheres to the plant for a considerable length of time.
The chemical penetrates the canopy and reaches the flowers which are the most important sites of initial infection.
These conditions require that timing of sprays be adjusted so that a maximum number of flowers are protected by a chemical that moves into the canopy before the canopy closes. Growers should look for 10 days of continuously wet soils between emergence and flowering. Plan on spraying at peak bloom. This occurs between 10 and 14 days after the appearance of the first flower in a field, or about 6 to 8 days after a single flower has been observed on 50% of the plants in the field.
Timing of chemical application is critical. Spraying after peak bloom will be considerably less effective because a large percentage of the flowers may already be infected, and later sprays may not reach the flowers because of the canopy cover. Spraying earlier than peak bloom will result in too many of the flowers being protected.
In normal years, one spray should be adequate**. In very wet years two sprays may be needed**. This question has not yet been settled in Michigan. The second spray, if needed, should be applied 7 to 10 days after the first spray. Using wet flowers to determine disease does not leave enough lead time to apply chemical for effective control.
Application of chemical can be made by airplane or ground spray equipment. Ground equipment may be more effective if field conditions permit and if the plants are not severely damaged.Ground equipment should be equipped with a single over-the-row nozzle and drop nozzles between the rows about 5 inches above the ground. Use 25 to 50 gallons of water per acre for ground application at 60 to 100 psi. Use 5 gallons of water per acre for air applications.
Benomyl (50% wet-table powder) has been superior to other registered fumicides in reducing the white mold disease. Apply at a rate of 1.5lbs/acre for a single spray and 1lb/acre if two sprays are to be made.
Chemical control of white mold is a preventative measure and should be started when a disease problem is predicted and **not after the disease has started and is easily observed in the field.**
Benomyl Benlate 50 WP or Sp, 24 to 32 oz. (14 days)
Thiophanate-Methyl Topsin M WSB or 70 W, 1 ½ to 2 lb (14 day)
DCNA Botran 75-W, 2 ¼ lb(bush beans) or 4lb (pole beans), (2days)
Vinclozolin Ronilan EG, 1 lb (10 days).
Iprodione Rovral 50W or WG, (1 ½ to 2 pt) (14 days)
PCNB Terraclor 75 W, 2 ¾ lb or Terraclor 2 E, 4 qt as a band spray per 14500 ft row.
(20)(21)(22)

Alternative Controls
No information available

Fungicide Profiles

Benomyl (carbamate) **(**Moderate disease severity)

Formulations: Benlate 50 WP or SP

Disease Controlled: Damping Off
Percent of Crop Treated: no information available
Application rate: 12 to 16 oz. in furrow at planting(2)
Types of Applications: Seed treatment, planting treatment
Timing: at planting, at 50% bloom (2)
Pre-Harvest interval: 14 days (2)
REI: 24 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: preventative and eradicating fungicide, excellent residual activity (24)
Disadvantages: no information available
(1)(2)(9)(10)(14)(24)

Metalaxyl (acylalanine, phenylamides)

Formulations: Apron 50 W, Apron FL or FS
Disease Controlled: Damping-off
Percent of Crop Treated: no information available
Types of Applications: seed treatment, preplant incorporated
Application rate: Apron 50 W 1/2 to 1 oz / 100 lb seed, Apron FL or FS 0.75 to 1.5 oz / 100 lb seed
Timing: seed treatment, at planting, 14 day intervals (2)
Pre-Harvest interval: not applicable
REI: 48 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: long lasting activity (24)
Disadvantages: B2 carcinogen, resistance concerns, corrosive (24)
(1)(2)(9)(10)(14)(24)

Captan (carboximide, sulfenimide)

Formulations: Captan 50 WP, Captan 30-DD or 300, Captan 400 or 400-DD
Disease Controlled: Damping-off
Percent of Crop Treated: no information available
Types of Applications: seed treatment
Application Rates: Captan 30-DD or 300, 2 1/4 oz per 100 lb seed, Captan 400 or 400-DD, 2 to 3 oz per 100 lb seed (2)
Timing: Planting
Pre-Harvest interval: not applicable
REI: no information available
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: no information available
Disadvantages: Resistance concerns, Captan is a B2 carcinogen
(1)(2)(9)(10)(14)(24)

Quintozene (chlorinated hydrocarbon) (Moderate disease severity)

Formulations: PCNB, Terraclor 75 W or Terraclor 2 E
Disease Controlled: Damping-off
Percent of Crop Treated: no information available
Types of Applications: Seed treatment, soil treatment, foliar treatment
Application rate: Terraclor 75 W, 2 ¾lb or Terraclor 2 E, 4 qt as a band spray per 14500 ft row. (2)
Timing: 2 to 3 week intervals, not after bloom (2)

Pre-Harvest interval: no information available
REI: 12 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: no information available
Disadvantages: no information available
(1)(2)(9)(10)(14)(24)

Thiram (organic compound)

Formulations: 42-S Thiram or Thiram 50 WP Dyed
Pests Controlled: Damping-off
Percent of Crop Treated: no information available
Types of Applications: Seed treatment
Application Rates: 2 oz per 100 lb seed (2)
Timing: not applicable
Pre-Harvest Interval: not applicable
REI: not applicable
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: compatible with common pesticides (24)
Disadvantages: no information available
(1)(2)(9)(10)(14)(24)

Copper and Copper + Sulphur

Formulations: Copper Hydroxide (Champ F or Kocide LF, Champ Formula 2F or Kocide 4.5 LF, Champion WP or Kocide 101 or Kocide DF, Kocide 2000, Nu-Cop 3L), Copper Sulfate (Basicop 53 WP), Copper Ammonium carbonate (Copper Count N 8L)
Disease Controlled: Anthracnose, bacterial blight
Percent of Crop Treated: no information available
Types of Applications: foliar treatment
Application rates:

Champ F or Kocide LF, 1 1/3 to 4 pt
Champ Formula 2F or Kocide 4.5 LF, 2/3 to 2 pt
Champion WP or Kocide 101 or Kocide DF, 1 to 3 lb
Kocide 2000, 3/4 to 2 1/4 lb
Nu-Cop 3L, 2/3 to 4 pt
Basicop 53 WP 4 lb
Copper Count N 8L, 1 to 3 qt (2)

Timing: 7-14 day intervals (2)
Pre-Harvest interval: 0 days (2)
REI: 24-48 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: compatible with most other pesticides (27)
Disadvantages: toxic to fish (27)
(1)(2)(9)(10)(14)

Thiophanate-Methyl (organic compound)

Formulations: Topsin M 70 W or WSB
Disease Controlled: Gray mold
Percent of Crop Treated: no information available
Types of Applications: foliar treatment
Application rate: 1 to 2 lb (2)
Timing: after bloom
Pre-Harvest interval: 14 days (2)
REI: 12 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: curative, preventative and systemic fungicide (24)
Disadvantages: resistant fungi have been reported, resistance is a concern (24)
(1)(2)(9)(10)(14)

Chlorothalonil (Nitrile Compound)

Formulations: Bravo 500, Bravo 720, Bravo Ultrex, Bravo Weather Stik, Echo, Daconil
Disease Controlled: Gray mold
Percent of Crop Treated: 7%
Types of Applications: foliar
Timing:suggested 7-14 day intervals (24)
Pre-Harvest interval: no information available
REI: 48 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: broad-spectrum foliage protectant fungicide
Disadvantages: B2 carcinogen
(1)(2)(9)(10)(14)

Vinclozolin (analide)

Formulations: Ronilan EG
Disease Controlled: Gray mold
Percent of Crop Treated: no information available
Types of Applications: foliar
Application rate: 1 lb (2)
Timing: 10% bloom, repeat 7 to 21 days (2)
Pre-Harvest interval:10 days(2)
REI: 12 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: contact and protective fungicide, compatible with other fungicides, not toxic to bees (24)
Disadvantages: toxic to fish (24)
(1)(2)(9)(10)(14)

Iprodione (dicarboximide)

Formulations: Rovral 4 F, 50 W or WG
Disease Controlled: Gray mold
Percent of Crop Treated: no information available
Types of Applications: foliar
Application rate: Rovral 4 F 1 1/2 to 2 pt, Rovral 50 W or WG 1 1/2 to 2 lb
Timing:early and peak bloom (2)

Pre-Harvest interval: 14 days (2)
REI: 12 hours (2)
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: no information available
Disadvantages: B2 carcinogen, resistance concerns
(1)(2)(9)(10)(14)

DCNA (chloronitrobenzene)

Formulations: Botran 75-W
Disease Controlled: White mold
Percent of Crop Treated: no information available
Types of Applications: foliar
Application rate: 2 ¼lb(bush beans) or 4 lb (pole beans) (2)
Timing: begin when disease is anticipated, 7 day intervals (2)
Pre-Harvest interval: 2 days (2)
REI: 12 hours (2)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: compatible with most fungicides and insecticides (24)
Disadvantages: no information available
(1)(2)(9)(10)(14)

Nematodes

Biology
Soybean cyst nematode can cause varying degrees of losses from slight to complete destruction. In fields with heavy infestation, the loss is between 30 and 75 per cent. Infected plants appear stunted and have an unthrifty appearance. The foliage turns yellow prematurely and falls off early. The plants only produce a few flowers and a few small seeds. Infected plants growing on sandy soils usually die. Infected plants growing on fertile soil can maintain normal yields and little chlorosis, it is in the subsequent years, due to the tremendous buildup of nematodes in the soil, that these areas also become severely chlorotic and dwarfed.

The soybean cyst nematode overwinters as a brown cyst in the upper 90-100 cm of the soil. When temperature and moisture become favorable in the spring, larvae emerge from the cysts and infect roots of host plants.

Cultural Controls:
Use of resistant varieties and a 1-2 year crop rotation with non-host crops, since some legumes are the only other cultivated crops that are hosts of this nematode. More resistant varieties are recommended , allowing for less build up of nematode populations.

Chemical Controls:
Nematodes can be controlled chemically through nematicide fumigations in the fall, preplanting soil treatment and soil treatment at planting. However, **nematode cysts and larvae are almost never completely eradicated from the field by fumigation and a small nematode population can build up rapidly.**(2)
Fall soil fumigation (Broadcast)
Mocap 10 G , 60-80 lbs from 3 days prior to planting to at-planting time and incorporate to a depth of 4 inches.
Mocap 6 EC 1-1 1/3 from 3 days prior to planting to at-planting time. Immediately incorporate to a depth off 4 inches.

Alternative Controls:
No information available

Nematicide Profiles

Ethoprophos (organic phosphate)

Formulations: Mocap 6 EC, Mocap 10G
Pests Controlled: nematodes
Percent of Crop Treated: no information available
Types of Applications: soil treatment
Application Rates: Mocap 6 EC 1 1/3 qt /A; Mocap 10G at 60 to 80 lbs/A (2)
Number of Applications: 1
Timing: preplant or at planting
Pre-Harvest Interval: no information available
REI: 48 hours
Use in IPM Programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: no information available
Advantages: contact nematicide and insecticide
Disadvantages: no information available

Weeds

Weed control is important for the control of diseases and pests. Crop rotation, cultivation and herbicide applications help to control weeds. Herbicide can be applied either before planting and incorporate into the soil or after seeding. Other herbicides can be applied after crop emergence.

Cultural Controls:
Crop Rotation
Cultivation

Chemical Controls:
Paraquat (Gramoxone extra)
EPTC (Eptam 7E)
Pendimethalin (Prowl 3.3E)
Metholachlor (Dual 8E)
Trifluralin
Glyphosate (Roundup)
Quizalofop (Assure II)
Sethoxydim (Poast 1.5E)
Bentazon (Basagran)
Paraquat is used to control emerged weeds before crop emergence or before transplanting at a rate of 1 pt per 100 gal. Apply to emerged weeds before crop emergence.(15)

EPTC is used under dry conditions. Apply before planting and incorporate 2-4 inches immediately. Used on germinating grasses and some broadleaves.(15)

Pendimethalin Apply before planting and incorporate 1-2 inches deep. Use high rate on soils with 3% or more organic matter. Used on germinating grasses and some broadleaves.(15)

Metholachlor can be applied at preplanting or at emergence. Needs to be incorporated 1-2 inches if preplant. Use lower rates on sandy soils with less than 3% organic matter. Used on germinating grasses and some broadleaves.

Trifluralin (Treflan) can be incorporated into soils for pre-planting weed control, using lowest rate on sandy soils. It is used to control broadleaves and annual grasses. Does not control ragweed. Used on germinating grasses and some broadleaves.

Roundup is used to control quackgrass in snap beans. Applt to 8-10 inch quackgrass in the fall or spring prior to planting. Allow at least five days before plowing.

Quizalofop is applied actively to growing grasses in 10-20 gpa. Apply to postemergence grasses.

Emerged grasses are controlled by sethoxydim. It is applied to actively growing grasses.

Bentazon is applied after beans have more than one expanded trifoliate leaf to prevent crop injury. Two applications are needed for nutsedge and Canada thistle control. Do not apply more than 2qt/acre/year. This is used on emerged annuals and yellow nutsedge.(15)

Herbicide Profiles

Paraquat (bipyridylium)

Formulations:Gramoxone Extra2.52
Weeds Controlled: emerged annual weeds
Percent of Crop Treated: No information available
Types of Applications: spray
Application Rates: 0.7-1.0 ai/acre (15)
Timing:before or after seeding but before emergence
Pre-Harvest interval: Not applicable
Use in IPM programs: No information available
Use in Resistance Management Programs: No information available
Efficacy Issues: no control of perennials
Advantages: kills all emerged green foliage
Disadvantages: non-selective herbicide, no residual control
(6)(9)(14)(15)

Pendimethalin (dinitroanaline)

Formulations: Prowl 3.3E
Weeds controlled: germinating grasses and some broadleaves
Percent of Crop Treated: no information available
Types of Applications: preplant incorporation
Application Rates: 1.0-1.5 lb AI/ac (15)
Timing: before planting
Pre-Harvest interval: not applicable
REI: 12 hours (15)
Use in IPM programs: No information available
Use in Resistance Management Programs: No information available
Efficacy Issues: No information available
Advantages: resists leaching (25)

Disadvantages:toxic to fish (25)
(6)(9)(14)(15)

EPTC (thiocarbamate)

Formulations: Eptam 7E
Weeds controlled: germinating grasses and some broadleaves
Percent of Crop Treated: no information available
Types of Applications: preplant incorporation
Application Rates: 3 lb AI/ac (15)
Timing: before planting
Pre-Harvest Interval: not applicable
REI: 12 hours (15)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: more effective on grasses than broadleaves (25)
Advantages: established plants tolerate over the top sprays (25)
Disadvantages: readily volatilizes (25)
(6)(9)(14)(15)

Metolachlor (acetamide)

Formulations: Dual 8E
Weed controlled: germinating grasses, yellow nutsedge
Percent of Crop Treated: No information available
Types of Applications: No information available
Application Rates: 1.5-3 lb AI/ac (15)
Number of Applications: No information available
Timing: Apply before or immediately after transplanting
Pre-Harvest Interval: No information available
REI: 12 hours (15)
Use in IPM Programs: No information available
Use in Resistance Management Programs: No information available
Efficacy Issues: No information available
Advantages: No information available
Disadvantages: need to use high rate on muck soils
(6)(9)(14)(15)

Trifluralin (dinitroanaline)

Formulations: Treflan 4E, Trilin 4E
Weeds Controlled: to control broadleaves and annual grasses
Percent of Crop Treated: no informtion available
Types of Applications: incorporated into soils for pre-planting weed control
Timing: before planting
Pre-Harvest interval: not applicable
REI: 12 hours (15)
Use in IPM Programs: No information available
Use in Resistance Management Programs: No information available
Efficacy Issues: soil incorporation within 24 hours gives greatest effectiveness, good grass control (15)
Advantages: kills weed seeds as they germinate, rainfall is not required (25)
Disadvantages: not very effective on muck soils
(6)(9)(14)(15)

Glyphosate (Phosphono Amino Acid)

Formulations: Roundup Ultra
Weed controlled: wide spectrum weed control
Percent of Crop Treated: No information available
Types of Applications: No information available
Application Rates: 2 lb. AI/acre (15)
Timing: It is applied to emerged perennials before planting in the spring or after harvest in the fall
Pre-Harvest Interval: not applicable
REI: 12 hours (15)
Use in IPM Programs: No information available
Use in Resistance Management Programs: No information available
Efficacy Issues: Excellent
Advantages: non-residual, used to control dense stands of perennials which can not be controlled by other herbicides (15)
Disadvantages: No information available
(6)(9)(14)(15)

Quizalofop (organic compound)

Formulations: Assure II
Weeds controlled: post emergence grasses
Percent of Crop Treated: no information available
Types of Applications: may be applied by air
Application Rates: 0.04-0.08 lb AI/ac (13)
Timing: apply to actively growing grasses
Pre-Harvest interval: 30 days (15)
REI: 12 hours (15)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: does not control sedges and broadleaves (25)
Advantages: may be mixed with other herbicides (25)
Disadvantages: a second application may be necessary on perennial grasses (25)
(6)(9)(14)(15)

Sethoxydim (cyclohexenone)

Formulations: Poast 1.5E
Weed controlled: post-emergence control of grasses
Percent of Crop Treated: No information available
Types of Applications: foliar spray to actively growing grasses
Application Rates: 0.19 to 0.28 lb AI/ac, 5 pt
Timing: Apply to actively growing grasses
Pre-Harvest interval: 15 days
REI: 12 hours (15)
Use in IPM programs: No information available
Use in Resistance Management Programs: No information available
Efficacy Issues: not effective at temperatures below 60° F(25)
Advantages: selective for emerged grasses (25)
Disadvantages: established grasses may require two applications (25)
(6)(9)(14)(15)

Bentazon (benzothiadiazole)

Formulations: Basagran 4SL
Weeds controlled: emerged annuals, yellow nutsedge
Percent of Crop Treated: no information available
Types of Applications: no information available

Application Rates: 0.75-1.0 lb AI/ac, not more than 2 qt / ac / year (15)
Timing: apply after beans have more than 1 expanced trifoliate leaf to prevent crop injury(15)
Pre-Harvest interval: not applicable
REI: 12 hours (15)
Use in IPM programs: no information available
Use in Resistance Management Programs: no information available
Efficacy Issues: rain within 8 hours will reduce effectiveness (25)
Advantages: may be combined with other herbicides (25)
Disadvantages: 2 applications are needed for nutsedge and Canada thistle control(15)
(6)(9)(14)(15)

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