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Integrated Pest Management for Florida Snap Beans[1]

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Integrated pest management (IPM) is a pest control strategy that uses a multitude of techniques to bring about effective, economic control of diseases, insects nematodes, and weeds in Florida snap bean fields. These techniques incude cultural methods, resistant varieties, biological control, and use of chemicals.

The development of the IPM recommendations presented here began in the fall of 1978 in response to the needs of the south Florida snap bean industry and to improve reliability of the tomato IPM program by conserving beneficial organisms in adjoining vegetable fields. So far, recommendations have been made primarily for bush-type snap beans; however, research at the Homestead TREC suggests that the same principles apply to pole-type beans.

Damage Threshold (Action Threshold, Economic Threshold)

Damage threshold, an important concept in IPM, refers to a level of damage (in this case, defoliation) which a snap bean plant can tolerate without loss in yield or pod quality. Chemical treatments for specific pests are recommended only when this experimentally determined level is reached. Specific chemical treatments are dictated by a combination of plant damage and pest density estimates obtained by the field scouting methods outlined below.

Field Scouting Procedures

Proper pest identification is obviously the key to accurate field scouting. See Table 1 for the field keys for some common pests. To assess pest levels properly, snap bean fields must be scouted twice a week. One visit a week is not sufficient for this high value, rapidly growing crop. One site for every 2-2.5 acres is sampled to determine the pest status in fields of 20 or more acres. If fields are smaller than 20 acres, the sampling intesity should be increased. Small fields, say five acres or less, may require such intense sampling that scouting may be uneconomical.

Selection of individual samples is done "at random" each time the field is visited. Samples are always selected radomly with each section of field, usually allowing 4-8 sections from throughout the bean field, so that all areas are represented in the composite data. It is a good idea to prepare a grid map the first time a field is visited with specific areas of the field labeled with a number. Then, in subsequent

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visits, pest counts can be obtained in each identified area on the map. Each sample consists of three ft (0.84 m) of a single bean row. Measurements of three ft can readily be made by placing a three-ft-square ground-cloth (which is essential to certain scouting procedures) alongside the bean plants to be sampled. Record plant growth stage (e.g., primary leaves, third true leaf, pinpod, etc.). Record an estimate of the total defoliation of the plants, including abiotic factors, in the sample, using the Horsfall-Barratt rating system. Follow this with individual Horsfall-Barratt ratings for total insect, and vegetable leafminer defoliation.

Since diseases must be controlled by preventative sprays and little can be done about abiotic defoliation (such as cold damage), current Institute of Food and Agricultural Sciences (IFAS) extension service recommendations concentrate on treatment of bean fields for the predominant defoliating insect pests. When defoliation levels from all sources reach 20 % prebloom and 10 % postbloom, chemicals can be applied to minimize the contribution of insects to this total defoliation. Therefore, scouts must accurately assess the total defoliation of the crop to determine if the damage threshold has been reached; estimates of individual contributions to the total defoliation enable the grower to tailor controls to the most serious pest problems.

More information on the relative abundance of specific pests can then be gathered in order to make the best specific pesticide choices. Very mobile insects (such as stink bugs, banded cucumber beetles, and beneficial ladybird beetles) are counted as the scout approaches the sample. When plant growth stage is from primary to two trifoliate leaves, specific counts are made of live vegetable leafminer larvae, aphids, and bean leaf rollers on three whole plants selected at random within the sample. When crop growth stage is three trifoliolate leaves, count those insects on three trifoliolate leaves about midway between the ground and the top of the plants.

Other insects are counted by using the ground cloth. To make these counts, simply unroll the ground cloth on the ground adjacent to the sample, bend the plants over the cloth, and shake vigorously. Identify and count the insects that fall onto the cloth. Record whole plant damage and loss due to diseases and insects as a percentage of the stand. Pests counted by this method include *Sclerotinia* (white mold) *Rhizoctonia*, *Pythium*, crickets, snails and slugs, and cutworms.

Growers should apply an insecticide at pinpod, based on the evaluation of crop growth stage, and will likely need at least one more insecticide application before harvest. However, pods should still be checked carefully for pest damage so that adjustments in the number and type of pesticide sprays can be made if needed. Since the bean pod is the part of the plant that is ultimately sent to market, the pests affecting the pods are usually the ones of most concern to the farmer. These incude stink bug, corn earworm, cabbage looper, *Sclerotinia* (white mold), Alternaria leaf and pod spot, Rhizoctonia pod rot, and common bacterial blight.

Pest Treatment Rationale

I. Diseases

The nature of plant diseases and the chemicals currently registered for use on snap beans dictate that fungicides be applied preventatively, before the arrival of disease propagules (fungus spores, bacterial cells). If fungicide sprays are initiated after the disease is discovered, it may be impossible to curb epidemics, particularly of bean rust and Sclerotinia rot. Chlorothalonil offers the most broad-spectrum activity against the important foliar and pod diseases. Rovral® and Topsin M® are important fungicides for white mold control and sulfur may enhance rust control. In recent years, Alternaria leaf and pod spot has been an increasingly serious problem on bean pods. It is important to apply chlorothalonil at pinpod to manage this disease.

II. Insects

Research in Florida has shown that snap beans can tolerate a considerable amount of defoliation before there is any loss in crop yield or quality. Using this research base, the IFAS extension and research personnel at the Homestead TREC set damage thresholds at 20 % defoliation prebloom and 10 % defoliaton postbloom. Quality crops were consistently produced using this approach with substantial savings in pesticide costs.

Melon thrips (*Thrips palmi*) feeding on leaves can significantly reduce the photosynthetic capacity and affect yield. Direct damage to flowers and pods further reduces the crops marketable capacity. Their short life cycle (i.e., 2 to 3 wk) and potential for rapid colonization of new crops from nearby reservoirs require grower vigilance to be ready to initiate chemical controls if significant populations of natural enemies (e.g., predacious mites and minute pirate bugs) are not present to quickly reduce their damage potential. Search along veins beneath leaves and along grooves in young stems for melon thrips. Flower thrips (*Frankliniella)* species target flowers and pinpods. *F. bispinosa* feeding can result in yield loss beginning at average densities of 8-10 per flower.

Silverleaf whitefly adults and nymphs feed beneath leaves and produce lots of honeydew that can be further colonized by sooty mold fungi. These whiteflies can transmit bean golden mosaic virus to snap beans. While chemical control may slow secondary virus transmission through fields, planting cultivars resistant to the virus is the more effective alternative in areas with previous virus history.

Before pinpods (young pods) appear on the plants, most insects can be controlled by applications of insecticides "on-demand"; that is, only when damage thresholds exceed 20 % total defoliation. Indeed, increases in some pests, in particular vegetable leafminer, are directly linked to overuse of broad-spectrum insecticides. To illustrate, if scouts record 20 % defoliation, with about 10 % each due to bean leafroller and rust, supplemental insecticide can be applied for the bean leafroller problem. Since fungicide should be applied on a regular basis, fungicide intervals may be shortened also to enhance rust control. However, it is important to note that additional supplemental chemical control should be aimed primarily at insects; disease will have to be controlled with routine preventative sprays.

When plants reach pinpod stage, the crop should be sprayed for pod-feeding insects. Usually an additional insecticide application is needed to produce a qualtiy crop. Waiting until pod damage is evident using random sampling methods can lead to substanitial dollar losses. The time and expense for the intensive sampling needed after pods appear to detect damaging levels of stink bug, corn earworm, and other podfeeders are too high to be of practical use on the farm. Hence, we recommend the "blanket" pod stage insecticide treatments.

Application of systemic insecticides at planting for whitefly control is recommended.

III. Nematodes

Treatment decisions for nematodes must be based on counts taken before planting. Standard laboratory assay of soil samples, taken as recommended by IFAS Extension Service, can be useful in determining potential nematode problems, particularly sting (*Belonolaimus* spp.), and stubby-root (*Trichodorus* spp.). Root knot larvae may also show up in the samples. However, if the soil sample is negative for root knot, it doesn't necessarily mean there is no serious potential for damage, since the root knot nematode may be present in the egg stage, which is not detected in routine soil samples. An additional bioassay, as described below, is required. Action thresholds have been worked out for some nematode species on the Rockdale soils of Dade County. Standard laboratory assay of soil samples, taken as recommended, can determine reniform nematode (*Rotylenchulus reniformis*) populations just prior to planting. Average reniform nematode counts of 200/100 cc of soil or greater will result in yield loss, dictating supplemental chemical treatment.

Decisions about the potential danger from root knot nematodes (*Meloidogyne* spp.) should be made at the end of the previous crop. Roots of a large number of plants of the previous crop should be examined for galls (or knots) typical of the damage caused by this nematode. More-or-less circular areas of unthrifty, off-color plants should be especially surveyed for root knot damage. If the inspected previous crop happens to be beans, care must be taken not to confuse root knot galls with the normal nitrogen-fixing nodules associated with the roots.

If a decision must be made after the previous crop has been destroyed, then a bioassay method using indicator plants must be used to determine the root knot infestation of the field to be cropped to beans. The bioassay is based on the extreme susceptibility of 'Clemson Spineless' okra to root knot nematodes. Composite soil samples are prepared and used to grow transplanted okra seedlings. After six weeks, the okra plants are uprooted and checked for galls.

One soil sample taken from every five acres is needed. Each sample consists of soil collected with a hand trowel from 20 locations within the 5 acre area. The soil for each sample is mixed thoroughly and divided into three or four equal parts, each portion of which is used to fill a one quart plastic pot. The pots are then planted to two-week-old orka seedlings (three or four/pot). Pots can then be placed outdoors and watered as needed. After six weeks the okra roots can be lifted and examined for galls.

The damage threshold for root knot is so low that any occurrence of knots on the previous crop or on the indicator plants should lead to a prompt decision to treat for nematodes.

Whatever the nematode problem, controls include primarily cultural methods (such as summer fallowing, cover crops, and crop rotation) and application of chemicals. See the IFAS Extension Service Nematode Control Guide or consult your county agent for current, specific nematicide recommendations.

IV. Weeds

Weeds can reduce yields of beans through direct competition for light, moisture, and nutrients. Early season competition is most critical and the major emphasis on control should be made during this period. Late season weeds can result in inefficient equipment operation and excessive harvest losses. Weeds can be controlled in snap beans; however, this requires good management practices in all phases of production. Because there are many kinds of weeds, with much variation in growth habit, they obviously cannot be managed by a single method.

Know Your Weeds. Specific weed problems may differ in the same field depending on the time of year the crop is grown. Annual weeds, as the name implies, complete their life cycles within a year. They are usually classified in two large groups: grasses and broadleaf weeds. In addition, their life cycles may begin at different seasons of the year. Summer annuals emerge during the days of spring, mature, produce seed, and die before winter.

Winter annuals, on the other hand, sprout from seed during the fall or early winter in South Flordia and complete their life cycle before the next summer. Annual weed problems then, must be anticipated, rather than scouted for just prior to planting. Perennial weeds, such as nutsedge, johnsongrass, and bermudagrass, on the other hand, can be scouted for prior to field preparation.

Weed "maps" should be made of weed species and their location in the field over several years and several times during the year. These "maps" can be useful in refreshing your memory on the weed complex you can expect and in the selection of herbicides that will be most appropriate for that particular field.

Crop Competition. An often overlooked tool in reducing weed competition is to establish a good snap bean stand in which plants emerge and grow rapidly and shade the row middles. The plant that emerges first and grows the most rapidly, is the plant that will have the competitive advantage. Utilization of good production management practices such as fertility, well-adapted varieties, proper water control (irrigation, drainage), and establishment of adequate plant populations is very helpful in reducing weed competition. Everything possible should be done to insure that the beans, not the weeds, have the competitive advantage.

Mechanical Control. Mechanical control includes field preparation by plowing or disking, cultivation, mowing, hoeing, and hand pulling of weeds. Mechanical control practices are among the oldest of weed management techniques.

Weed control is a primary reason for preparing land for crops planted in rows. Seedbed preparation by plowing or disking exposes many weed seeds to variations in light, temperature, and moisture. For some weeds this process breaks seed dormancy, leading to early season control with herbicides or additional cultivation.

Cultivate only deep enough in the row to achieve weed control; deep cultivation may prune the bean roots, bring weed seeds to the surface, and disturb the soil previously treated with a herbicide. If herbicides have been used, and good weed control has been achieved, delay cultivation until weeds are present.

Although a high level of control may result from the use of mechanical control, more consistent suppression of weeds can be achieved by the use of all previously mentioned practices in combination with the use of selected herbicides. Properly selected herbicides are very effective tools for weed control in snap beans. Most of the labeled herbicides for bush beans are for preplant or preemergence applications to the crop and weeds. Three herbicides are labeled at the present time for postemergent crop applications. Care must be exercised in using these materials at the proper rate and correct time to avoid crop damage.

Soil-applied herbicides are either applied to the surface or incorporated. Surface-applied herbicides require rainfall or irrigation shortly after application for best results. Lack of moisture often results in poor weed control. However, they are relatively easy to apply. Incorporated herbicides are not dependent on rainfall or irrigation and have generally given more consistent and wider-spectrum control. They do, however, require more time and equipment for incorporation.

Useful Literature

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Table 1. Field keys for some common pests.

Diseases	Pathogen	Field Key Symptoms
Rust	*Uromyces phaseoli*	Very early-chlorotic spots; reddish-brown (rusty-looking) pustules (uredia) on both surfaces. Pustules are usually surrounded by a chlorotic halo.
White mold (bean mold)	*Sclerotinia sclerotiorum*	White, thick, moldy growth on stems, pods, etc. Black sclerotia (resting structures) both outside and inside tissue.
Powdery Mildew	*Erysiphe polygoni*	A talcum powder-like series of spots, mainly on leaves. Pods may appear malformed and have purple and brown discoloration.
Rhizoctonia root & crown rot	*Rhizoctonia solani*	Brown or reddish-brown lesions, sometimes in the form of cankers, on lower stems.
Pythium root & crown rot	*Pythium* spp.	Plants are often noticeably wilted. Light brown lesions on stems and hypocotyl. Damping off can occur. Examine for oospores in the tissue in the laboratory for definitive diagnosis.
Angular leafspot	*Isariopsis griseola*	Gray spots on undersides of leaves. Brown angular spots (delimited by veins) later. Fungus growth sometimes seen on underside of spots.
Common bacterial blight	*Xanthomonas campestris pv. phaseoli*	First symptoms are water-soaked spots on undersides of leaves. Lesions then become necrotic with a chlorotic halo. Pods may be marked with circular, water-soaked spots. Seek laboratory assistance with "ooze test" for positive identification.
Alternaria leaf & pod spot	Alternaria spp.	Spots on leaves start as small, reddish-brown lesions surrounded by a darker brown border. Lesions can coalesce, covering large portions of leaves and leading to premature leaf drop. Spots on pods are very small, raised, brown pimples that very often throw fruit out of grade.
Insect (Arthropod)	**Scientific Name**	**Brief Description***
Bean leafroller	*Urbanus proteus*	Caterpillars with a green body and a large red head. Feed by rolling and tying leaf margins. L.
Cabbage looper	*Tricholplusia ni*	Green caterpillars usually with a narrow white line along each side. Only 2 pairs of abdominal prolegs. L, P.
Corn earworm	*Helicoverpa zea*	Caterpillars which can cause severe damage by podfeeding. Larvae vary considerably in color, from pink to light green to dark green. The distinctive feature is the presence of short sharp "micro-spines" all over the body, evident when specimens are examined at 10X or greater magnification. L, P.

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Velvetbean caterpillar	*Anticarsia gemmatalis*	This "worm" is greenish in color and generally striped, though highly variable. Larvae are very active when disturbed and thrash around. They have four pairs of abdominal prolegs. Sometimes confused with cabbage looper. L, P.
Leafminers	*Liriomyza* spp.	Serpentine (snake-like) mines on leaves; larvae are yellow maggots inside mines. L.
Aphids		Small, usually lemon-shaped with cornicles on posterior end. Winged forms seen on stalks. L, S, P, F.
Thrips	Several species	Tiny, narrow, pale yellow to brownish black, and approx. 1/32 to 1/16 in. long.
	Melon thrips - *Thrips palmi*	Pale yellow to orange thrips causes severe damage. Requires early and at least weekly sampling to initiate controls. L, F, P.
	Flower thrips - *Frankliniella* spp.	Pale yellow to tan thrips can cause flower damage leading to poor pod set and fill. F, P.
Silverleaf whitefly	*Bemesia argentifolia*	Tiny, moth-like, white adults and and translucent, scale-like nymphs are sap-feeders, 1/32 to 1/16 in. long. Feed beneath leaves. Adults vector bean golden mosaic virus. L.
Stink bugs		Relatively large, shield-shaped true bugs with prominent scutellum (triangular-shaped plate between the wing bases). P.
	Green stink bug - *Acrosternum hilare*	Sharply pointed spine between hind pair of legs.
	Southern green stink bug - *Nezara viridula*	More common in Miami-Dade County. Rounded spine between hind pair of legs.
		Nymphs similar to adults in outline but may be mottled with red, white, and green.
Cowpea curculio	*Chalcodermus aeneus*	Iridescent black, humpbacked beetle, with a long, slender, curved snout. Adult beetles make punctures in pods and lay eggs in seeds. Larvae are grubs which feed on seeds. The adults are easily disturbed and drop from plant. This habit often results in failure to detect the insect. A key to diagnosis of infestation is the regular (one-seed) puncture marks on the pod. P.
Banded cucumber beetle	*Diabrotica balteata*	Yellowish-green, with three transverse bands across wings. L.
Mites	*Tetranychus* spp. and others	Cause pinpoint white dots on upper leaf surfaces and sometimes webbing is found on underside; very small arthropods. L.

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Parasitic wasps	*Opius* spp.	Beneficial wasp; parasite of vegetable leafminer. Very small. Has antlike head and large antennae. Sensitive to broad-spectrum insecticides.
	Diglyphus spp.	Beneficial wasp; parasite of vegetable leafminer. Exceedingly small; appears "swayback" in side view. Sensitive to broad-spectrum insecticides.
Green lacewing	*Chrysopa* spp.	Beneficial. Adults have large, netted wings and golden eyes. Larvae are "aphis lions"; elongate, spindle-shaped, with sickle-like mandibles.
Ladybird beetles	Several genera	Beneficial. Adults-semihemispherical beetles, with appearance of split peas. Many are red with black spots on wings. Larvae taper posteriorly, generally dark with bright markings (many times orange) and covered with spines.
*Plant part affected: L=leaves, S=stems, F=flowers, P=pod.		