

## TOBACCO INSECT MANAGEMENT

**Paul J. Semtner, Retired Extension Entomologist**

Several species of insects cause serious damage to tobacco in the field, the greenhouse, and the curing barn. Insects damage the roots, destroy the leaves and buds, and reduce leaf quality. Some also transmit several important tobacco diseases.

Integrated pest management (IPM) combines cultural, natural, and chemical controls to maintain insect pest populations below levels that cause economic damage to the crop. IPM promotes the use of insecticides only when needed. A certain amount of insect damage does not reduce crop value enough to pay for the cost of treatment. In addition, tobacco plants often compensate for insect damage. IPM helps to maximize profits, reduce pesticide residue levels, environmental contamination, and human exposure to pesticides. It also optimizes natural control provided by beneficial organisms.

### Cultural controls

Several cultural practices help reduce insect infestations and decrease the need for insecticide applications. The following cultural practices aid in the management of insect pests on tobacco.

1. **Early land preparation.** Plowing at least 4 weeks before transplanting reduces cutworm infestations and may aid in wireworm control.
2. **Use of recommended nitrogen rates.** Excessive rates of nitrogen fertilizer may delay maturity and make tobacco a more favorable host for hornworms and aphids after topping.
3. **Adjustments in transplanting date.** This reduces tobacco susceptibility to insect pests. Early-planted tobacco is often less favorable for aphids and hornworms, and more favorable for budworms and flea beetles. Late-planted tobacco is highly susceptible to hornworm damage and may have reduced yield and quality. Aphid infestations are usually most serious on tobacco transplanted near the middle of the transplanting period.
4. **Destruction of greenhouse transplants as soon as practical after transplanting is completed.** This practice will keep aphids and other insects from developing high populations on the transplants and migrating to nearby tobacco fields.
5. **Management of field borders to reduce insect habitat.** Keep field margins clear of weeds and tall grass to reduce feeding, breeding, and overwintering sites for grasshoppers and other insects that move from

these sites into tobacco fields. After tobacco is established and growing, leave uncut barriers between tobacco fields and hay fields that are heavily infested with grasshoppers.

6. **Topping tobacco in the button or early flower stage.** This practice eliminates food sources for budworms and makes the crop a less desirable host for aphids and hornworms.
7. **Obtaining effective sucker control.** Sucker control reduces food sources for hornworms, budworms, and aphids.
8. **Destroying crop residues immediately after harvest is completed.** Stalk cutting and root destruction reduces feeding and overwintering sites for hornworms, budworms, and flea beetles. This practice is most effective when done on a community-wide basis.
9. **Use crop rotations that reduce infestations of soil-inhabiting insects.** Rotate tobacco with crops that are poor hosts of cutworms, white-fringed beetles, and wireworms. Beware of cutworm and wireworm infestations following established grass sods and soybeans.
10. **Conservation tillage.** Use conservation tillage practices to manage insect infestations. Conservation tillage strategies including no-till and strip-till reduces aphid and flea beetle populations, but may increase [problems with cutworm, vegetable weevil, and slug infestations.

### Natural Control

Beneficial organisms, including predators, parasites and pathogens, help control several insect pests. For example, parasites often kill more than 80 percent of the budworms in tobacco fields, control similar to that obtained with the most effective foliar insecticides.

Hornworms are parasitized by the larvae of *Cotesia congregata*, which feeds inside the caterpillars. When these larvae mature, they emerge through the backs of the hornworms and form egg-like cocoons. Tiny wasps emerge from these cocoons in a few days, mate, and lay eggs in other hornworms. Stilt bugs are long-legged, slender, brown bugs that feed on hornworm and budworm eggs, aphids, and even small amounts of tobacco sap.

Aphids are attacked by the adults and larvae of several species of lady beetles, lacewings, and syrphid fly larvae. Bright red midge larvae also feed on aphids after topping. The pathogenic fungus, *Pandora neoaphidis*, frequently controls aphids from July through September, especially in wet seasons. Although lady beetles, lacewings, and syrphid fly larvae are usually abundant on aphid-infested tobacco, they often have trouble keeping aphid populations below economic threshold levels.

To preserve beneficial insects, scout fields, and use economic thresholds to time insecticide applications. Select insecticides with low impact on beneficials. These insecticides include: *Bacillus thuringiensis* (*Bt*), chloranthraniliprole (Coragen) emamectin benzoate (Denim), flubendiamide (Belt), methomyl (Lannate), pymetrozine (Fulfill), and spinosad (Tracer). Transplant water and tray drench applications of imidacloprid (Admire Pro and various generics) and thiamethoxam (Platinum) have limited direct impact on beneficials.

### Chemical control

Economic thresholds and field scouting are important tools in IPM. The economic threshold is that pest population or injury level that requires treatment with an insecticide to prevent economic damage to the crop. Fields are scouted or sampled at regular intervals (once a week) to determine when insect pests reach their thresholds. Foliar insecticides are applied when scouting indicates that one or more pests have reached their economic thresholds. Insecticides applied as foliar, transplant water, tray drench and soil treatments are extremely important tools in an IPM program. Many cultural and natural controls help reduce insect outbreaks, but it is almost impossible to grow a top quality, high yielding tobacco crop without using some insecticides.

### **Insect Control on Transplants Produced in the Greenhouse**

Almost all of the tobacco transplants (>99%) used in Virginia is produced in greenhouses. So far, insects have caused minor problems in greenhouses. However, if recommended cultural practices are not carried out, several of the following pests could become serious problems.

- **Ants** can remove seeds from greenhouse trays and cause poor stands of seedlings.
- **Crickets and earwigs** often destroy newly emerged tobacco seedlings, reducing stands and initial growth.
- **Shoreflies**, tiny flies that look like small houseflies, are frequently numerous in greenhouses. Their larvae (tiny maggots) feed on young seedlings and may reduce stands during the first 2 weeks after germination.
- **Mice** remove the seeds from float trays seriously reducing plant stands. If stand loss is severe, the entire greenhouses may require reseeded.
- **Green June beetle grubs** uproot seedlings in the trays sitting on the soil surface in greenhouses with overhead watering systems.

- **Cutworms, crickets, vegetable weevils, and slugs** usually feed on stems and leaves at night. Cutworms also cut off and destroy plants.
- **Crickets, cutworms, slugs, and yellow-striped armyworms** may destroy individual leaves on larger seedlings; this damage appears to do little harm unless populations are very high.
- **Vegetable weevil** adults and larvae often feed on the leaves and stems destroying the buds of seedlings.
- **Aphids** often build up high populations on tobacco seedlings in the greenhouse reducing plant vigor, and they may be carried to the field on infested plants.

#### Cultural controls in the greenhouse

Sanitation is the most important practice for managing insect pests in tobacco greenhouses. The following practices reduce the potential for insect infestations in greenhouses.

- Discard all unused plants and clean out the greenhouse immediately after transplanting has been completed.
- Keep the area in and around the greenhouse clean and free of weeds, decaying plant material, plastic, rocks, wood, metal, and other items that provide food and shelter for insects and other pests.
- Do not plant fall and winter gardens near the greenhouse. Aphids can survive on various vegetables and related weeds during the winter and develop winged forms that fly into greenhouse and establish colonies on tobacco seedlings. Pests such as cutworms, armyworms, vegetable weevils, and slugs may hide in these sites, migrate into the greenhouse, and damage tobacco seedlings.
- If greenhouses are used to produce other crops, a fallow period should be followed to keep pests from moving from the other crops. Whiteflies or aphids may become problems moving from earlier crops to tobacco.
- Use extreme temperatures to kill insects hiding in the greenhouse. Close the greenhouse to increase the temperature in the summer and promote cold temperatures in the winter.
- Seed the entire greenhouse at the same time. Do not seed tobacco in greenhouses that are already infested with large numbers of shore flies. Shore flies lay eggs on the media and the larvae injure emerging seedlings reducing stand and seedling uniformity

- Clean the greenhouse thoroughly just before seeding in the spring.
- Produce a uniform crop.

Chemical control in the greenhouse

Acephate (Orthene or other generics) is the only effective insecticide labeled for use on tobacco transplants grown in greenhouses (Table 1). It should be applied as a foliar spray when insect infestations are observed. Acephate provides good to excellent control of aphids, yellow-striped armyworms, cutworms, flea beetles, and vegetable weevils. It should not be applied in the irrigation water or the float water. Acephate also gives effective control of ants when applied in the greenhouse before the float beds are set up. When spraying young plants, use the proper rate. Excessive rates of acephate can injure or kill young seedlings.

Metaldehyde (Deadline Bullets) bait controls slugs and snails in the greenhouse. In the early evening, apply methaldehyde along walkways and the outside margins of the float beds. Do not apply methaldehyde directly to seedlings or use it in float beds.

Mice should be controlled with baits labeled for their control.

**Table 1. Insecticides for use on Transplants Grown in Greenhouses**

Insect	Insecticide and formulation	Rate per 1,000 sq ft
<b>Aphids, cutworms, flea beetles</b>	Acephate (Acephate AG) 75SP	1 tbs/3 gal of water (1 lb/acre)
	(Acephate) 97UP	¾ tbs/3 gal of water (¾ lb/acre)
	(Orthene) 97PE	¾ tbs/3 gal of water (¾ lb/acre)
<b>Remarks and precautions:</b> Apply as a spray. <b>Excessive rates of acephate can injury tender young plants. Do not apply through an irrigation system or in the float water.</b>		
<b>Snails and slugs</b>	Metaldehyde (Deadline Bullets) 4% bait	¼ to ½ lb
<b>Remarks and precautions:</b> <b>Slug damage is usually associated with shiny slime trails.</b> Apply to alleys, walkways and vacant areas in late afternoon. <b>Do not apply to float water or directly on foliage.</b> It is deactivated by water.		
<b>Ants</b>	Acephate (Acephate AG) 75SP	1 oz/5 gal of water
	(Acephate) 97UP	¾ oz/5 gal of water
	(Orthene) 97PE	¾ oz/5 gal of water
<b>Remarks and precautions:</b> Apply 1 gal of mix to each mound area by sprinkling the mound until it is wet. Treat a 4 ft diameter circle around the mound. Treat only once during the season.		

## **Insect Control on Newly Transplanted Tobacco**

### **Wireworms**

Wireworms are hard, white to yellowish-brown, wire-like larvae of click beetles. These pests live in the soil, feed on the roots, and tunnel the piths of young tobacco plants. This injury stunts plant growth, causing irregular stands and lower yields. Although wireworms feed throughout the growing season, the most serious damage occurs when the plants are becoming established during the first month after transplanting. Wireworms take 1 to 5 years to complete their life cycle. Most of this time is spent in the larval stage. The larvae emerge from eggs in the summer and fall, feed on the roots of various host plants, and overwinter into the next year. Larvae then feed on the newly transplanted tobacco seedlings. Pupation and emergence as adult click beetles occurs in late spring and early summer.

Wireworms are most common in fields with a history of wireworm problems, or in those previously planted after grass sod, weeds, corn, or small grains. In these situations, apply an insecticide labeled as soil, tray drench or transplant water treatments for wireworm control (Table 2). Apply soil insecticides (Lorsban or Mocap) as broadcast treatments and incorporate them at least 2 weeks before transplanting. Another option is to use Admire Pro, Platinum, or their generics applied at the wireworm rates as transplant water or transplant drench treatments. The most effective cultural practice for wireworm control is to use sturdy, healthy transplants that are less susceptible to wireworm damage than tender, young transplants. After wireworm damage has occurred, it is too late to apply an insecticide. Where damage is light to moderate, cultivation and irrigation may help injured plants recover and produce near normal yields although crop maturity may be delayed. If wireworms seriously reduce the stand, replant after a recommended soil insecticide is applied.

### **Cutworms**

Cutworms are active at night, feeding on roots or leaves or cutting off entire plants. This injury can cause enough damage and stand loss to require replanting. However, since tobacco compensates well, less than five percent stand loss usually has no impact on yield but it may affect uniformity. Cutworm infestations are very sporadic and difficult to predict, but they are most likely to occur in low, wet areas, and weedy fields that are plowed less than a month before transplanting. Plowing fields in the early spring usually destroys the cover crop and weed hosts, and reduces cutworm populations. Scout fields for cutworm damage once or twice a week during the first month after transplanting to determine whether a remedial foliar treatment is needed (Table 10). For optimum control of this night-feeding pest, apply a foliar insecticide in late

afternoon or early evening when five percent or more of the plants in a field have recent cutworm damage.

### **Whitefringed beetles**

Whitefringed beetle grubs sometimes cause serious problems in flue-cured and burley tobacco fields. Outbreaks usually occur in tobacco field rotated with clover, soybeans, or alfalfa. Most legumes are excellent food plants for the grubs, while most grasses are unfavorable hosts. Grubs feed on the outer surface of the taproots and tunnel into the pith of newly transplanted tobacco killing or stunting the plants and causing serious yield reductions. Whitefringed beetles spread very slowly because all adult beetles are flightless female weevils. They can be transported to a new field, on farm equipment, water, hay, and other crops. No insecticides are currently registered for the control of whitefringed beetles on tobacco. The rotation of tobacco with good stands of grass containing few legumes or broadleaf weeds may help reduce grub damage. Imidacloprid (Admire and generics) and thiamethoxam (Platinum and TMOXX) provide some control of whitefringed beetles.

### **Soil-incorporated insecticides**

Pretransplant soil applications of insecticides can provide effective control of cutworms and wireworms on tobacco. Several factors should be considered before selecting a soil insecticide.

- If a tobacco field has been in sod, weeds, or small grains during the previous year or has a history of wireworm problems, apply an insecticide for wireworm control.
- Mocap, Brigade/Capture, and Lorsban are broadcast soil treatments for wireworm control (Tables 2 and 3).
- Admire Pro or Platinum applied as transplant water or transplant drench treatments may be better choices for wireworm control because they also control aphids and flea beetles (Tables 2, 4, and 5).
- Soil fumigants applied at the nematicide rate provide little control of insects in the soil or on the foliage because many insects are below the zone being fumigated.

**Table 2. Ratings of soil, greenhouse tray drench, and transplant water treatments for control of insects on flue-cured tobacco.**

Insecticide	Application method <sup>1</sup>	Leaf feeding insects			Soil insects		
		Aphids	Bud-worms	Flea beetles	Horn-worms	Cut-worms	Wire-worms
Acephate/Acephate AG/Acephate UP; Orthene 97	TW	2	0	3	0	3-4	0
Imidacloprid (Admire Pro and generics) <sup>2</sup>	TW	5	0	2	0	0	3
Imidacloprid (Admire Pro and generics) <sup>2</sup>	TD	5	0	4	0	0	3
Bifenthrin (Brigade/Capture and generics) <sup>2</sup>	TW	0	0	0	0	3	3
Chlorpyrifos (Lorsban) 4E	PPI	0	0	1	0	3	4
Chlorantraniliprole (Coragen)	TPW	0	2.-3	0	3	0	0
Lambda cyhalothrin (Karate, Warrior and others)	PPI	0	0	0	0	3	0
Ethoprop (Mocap) 6EC	PPI	0	0	1	0	3	4
Thiamethoxam (Platinum/TMOXX) 2F	TW	5	0	3	0	0	3
Thiamethoxam (Platinum/TMOXX) 2F	TD	5		4		0	3

Ratings are based on a scale of 0 to 5 where 0 = not labeled or no control, 1 = poor control, 2 = fair control, 3 = good control, 4 = very good control, and 5 = excellent control.

<sup>1</sup> TW = Transplant water, TD = Transplant drench, PPI=Preplant soil incorporated.

<sup>2</sup> There are many generic formulations of imidacloprid and bifenthrin.

**Table 3. Insects on Field Tobacco - Pretransplant Soil Treatments**

Insect	Insecticide and formulation	Rate per acre
<b>Wireworms, Cutworms</b>	Ethoprop (Mocap) 6EC	1 <sup>1</sup> / <sub>3</sub> to 4 qt
	(Mocap) 15G	13 lb
	Chlorpyrifos (Lorsban) 15G	13 <sup>1</sup> / <sub>2</sub> lb
	(Lorsban and generics) 4E	1 qt
	Lorsban Advance 3.755EW	1 qt
	Bifenthrin (Brigade/Capture and generics) 2EC	2.56 to 6.4 fl oz
	Lambda cyhalothrin (Karate with Zeon and generics)	1.92 fl oz

**Remarks and precautions:** Make broadcast applications at least 2 weeks before transplanting. Band applications are usually less effective than broadcast treatments. Use a suitable device to incorporate insecticides into the soil to a depth of at least 4 inches immediately after application. Chlorpyrifos and bifenthrin are also registered for cutworms and flea beetle larvae. **These chemicals are restricted use.**

**Table 4. Insects on Field Tobacco - Transplant Water Treatments**

Insect	Insecticide and formulation	Rate
<b>Flea beetles, cutworms, thrips, suppression of aphids</b>	Acephate (Acephate AG) 75SP	1 lb/acre
	(Acephate) 97UP	0.75 lb/acre
	(Orthene) 97PE	0.75 lb/acre
	Bifenthrin (Brigade/Capture) 2EC	2.56 to 6.4 fl oz/acre
<b>Aphids, flea beetles</b>	Imidacloprid (Admire Pro) 4.6SC	0.5 to 0.6 fl oz/1,000 plants
	(various generics) 2F	1.0 fl oz/1,000 plants
	Thiamethoxam (Platinum/TMOXX) 2SC	0.5 to 0.8 fl oz/1,000 plants or 3 to 5 fl oz/acre
<b>Budworms, hornworms</b>	Chlorantraniliprole (Coragen) 1.67SC	5.0 to 7.5 fl oz/acre
<b>Remarks and precautions:</b> Apply in at least 100 gallons of water per acre. Coragen must be applied uniformly in the root zone or poor performance will result.		
<b>Wireworms, thrips for suppression of tomato spotted wilt virus</b>	Imidacloprid (Admire Pro) 4.6SC	0.8 to 1.2 fl oz/1,000 plants
	(various generics) 2F	1.4 to 2.8 fl oz/1,000 plants
	Thiamethoxam (Platinum/TMOXX) 2SC	0.8 to 1.3 fl oz/1,000 plants or 5 to 8 fl oz/acre
<b>Remarks and precautions:</b> Acephate provides flea beetle control for 3 to 4 weeks after transplanting and suppresses aphid infestations for 4 to 6 weeks. Admire Pro and Platinum usually give excellent season-long control of aphids. Apply treatments in at least 100 gal of water/acre. <b>Calibrate transplanters and allow tanks to run low before refilling.</b>		

**Table 5. Insects on Field Tobacco-Drench Application to Greenhouse Transplants**

Insects	Insecticide and formulation	Rate per 1,000 plants
<b>Aphids, flea beetles</b>	Imidacloprid (Admire Pro) 4.6SC	0.5 to 0.6 fl oz
	(various generics) 2F	1.0 fl oz
	Thiamethoxam (Platinum) 2SC	0.5 to 0.8 fl oz
	(TMOXX) 2SC	0.5 to 0.8 fl oz
<b>Wireworm, Thrips for suppression of tomato spotted wilt virus</b>	Imidacloprid (Admire Pro) 4.6SC	0.6 to 1.2 fl oz
	(various generics) 2F	1.4 to 2.8 fl oz
	Thiamethoxam (Platinum) 2SC	0.6 to 1.3 fl oz
	(TMOXX) 2SC	0.6 to 1.3 fl oz

**Remarks and precautions:** Apply as a drench to plants in trays or flats prior to transplanting. Mix with water before application. Keep agitated or mix regularly to avoid settling in tank. Water the plants in the trays before treatment and again immediately after application using enough water to wash the residue from the foliage into the media. Transplant within 3 days.

### **Remedial Control of Insects on Larger Tobacco**

#### **Scouting for Insects**

Tobacco fields should be scouted at least once a week throughout the season to determine when insecticide applications are needed.

1. Take representative samples from the entire field except for the outside rows. Take samples in Z or N patterns across the field. Do not sample the same plants each week. Look for insect pests and their damage on at least 50 plants in a field (1 to 10 acres). Make counts and record the data for 5 consecutive plants at 10 locations throughout the field. Select the plants before you see them. If a field is planted on two different dates or if there are great differences in plant size within the field, divide the field into two or more sections and sample each section separately. Large fields (more than 10 acres) will require larger samples. Sample an additional 10 plants for every 2 additional acres.
2. During the first 4 weeks after transplanting, check tobacco for feeding holes or missing, stunted, or cut plants. Cutworms, flea beetles, wireworms, and other insects may have damaged these plants.
3. Beginning 3 to 4 weeks after transplanting, aphids, budworms, flea beetles, and hornworms are the primary targets of an insect scouting program.

4. When a field is being scouted for insects that feed on tobacco foliage, individual plants should be examined and the observations recorded in a notebook as follows:
  - a. Check the bud region for budworm damage. If damage is present, look carefully for budworms and the white cocoons of the budworm parasite, *Campoletis sonorensis*. If there is budworm damage, but no worm, do not count the plant as infested.
  - b. Examine the entire plant for hornworm damage, locate, count the hornworms that are at least 1 inch long, and determine whether they are parasitized by *Cotesia congregata* (white egg-like cocoons on hornworm's back).
  - c. Check the undersides of the upper leaves for aphids and the upper surfaces of the middle and lower leaves for honeydew, flea beetles, flea beetle feeding holes, and the mines of the tobacco splitworm.
  - d. If you find an unidentified insect that appears to be damaging the crop, collect the insect and samples of its damage, put them in a container, and take them to a local Extension agent for identification. This is important because beneficial insects are often mistaken for pests. In addition, the misidentification of a pest may lead to the selection of the wrong insecticide for its control.
5. Tobacco fields should be treated when one or more insect pests meet or exceed the threshold levels shown in Table 6.

**Table 6. Economic thresholds for various insects on tobacco.**

Insect	Economic threshold	Time when insect is a problem (weeks after transplanting)
Aphids	50 or more aphids on any upper leaf of 5 of 50 plants.	4 weeks after transplanting to final harvest
Budworms	10 plants with one or more budworm per 50 plants until 1 week before topping.	3 weeks after transplanting to 1 week before topping
Cutworms	5 of 100 plants with recent cutworm damage.	1 to 4 weeks after transplanting
Flea beetles	4 beetles per plant on tobacco less than 2 weeks old, 8 to 10 beetles per plant on 2 to 4 week-old plants, 60 beetles per plant on plants more than 4 weeks old.	Transplanting to 4 weeks after transplanting and from topping to final harvest
Grasshoppers	10 grasshoppers per 50 plants.	4 weeks after transplanting to final harvest
Hornworms	5 larvae (worms) at least 1 inch long per 50 plants. Do not count parasitized worms with the egg-like cocoons on their backs. For hornworms $\frac{1}{2}$ to $\frac{3}{4}$ inch long, treat when there is 1 hornworm per plant.	3 weeks after transplanting to final harvest. Can be a problem on air-cured tobacco in curing structures
Wireworms	Not determined	1 to 6 weeks after transplanting

### Tobacco Budworms

Tobacco budworms feed in the buds of young tobacco plants causing many holes in the tiny developing leaves. As the leaves grow, the feeding holes become larger and give the plants a ragged, distorted appearance. Tobacco plants usually compensate for this damage so yield and quality may not be affected. However, budworms sometimes top the plants prematurely causing early sucker growth that may stunt the plants and require extra labor to remove the suckers. After the button stage, budworms rarely cause economic damage although they may burrow into the stalk. Apply foliar sprays for budworm control with 1 or 3 solid-cone or hollow-cone nozzles over each row using 40 to 60 psi to deliver 10 to 25 gallons of spray mixture per acre. Control with foliar sprays rarely exceeds 80%. The tobacco rows must be planted evenly so that the nozzles can be oriented directly over the row. See insecticide performance ratings in Table 7 and insecticide options for budworm control in Table 10. When

checking tobacco for budworms, look on the leaves near the bud for the cocoons of the wasp (*Campoletis*) that parasitizes budworms. These cocoons are about ¼ inch long and white or grayish in color with two black bands or dots. *Campoletis* and other parasites provide good natural control of budworms on tobacco in Virginia.

### **Hornworms**

Tobacco and tomato hornworms are large caterpillars (up to 4 inches long) that eat considerable amounts of tobacco leaf. Infestations may develop anytime from transplanting until harvest, but damage is usually most severe during June, August, and September. Treat for hornworms when there are 5 or more hornworms 1 inch long or longer per 50 plants. Do not count parasitized hornworms that have the white egg-like cocoons of the parasitic wasp, *Cotesia congregata*, on their backs. Parasitized hornworms eat much less than healthy hornworms and they are a food source for parasites that help reduce the next generation of hornworms. Predators also kill large numbers of larvae that are less than 1 inch long. For this reason, hornworms less than 1 inch long are not considered when determining the economic threshold because they cause very little damage and have no effect on yield or quality. However, if a field has large numbers of hornworms less than 1 inch long, the field should be rechecked in 3 to 4 days. For optimum control of hornworms, direct insecticide sprays to the upper one-half of the plants. See the insecticide ratings in Table 7 and the labeled insecticides in Table 10. Several cultural practices help reduce the susceptibility of tobacco to hornworms. Early topping, early transplanting, effective sucker control, and fertilization with recommended rates of nitrogen help reduce late-season infestations. When used on an area-wide basis, stalk cutting and root destruction immediately after harvest reduces overwintering hornworm populations.

### **Aphids**

The green peach aphid is a severe pest of tobacco in Virginia. Aphid populations increase rapidly, doubling in size about every two days under favorable conditions. High populations of aphids can reduce tobacco yield by 5 to 25 % (100 to 500 lbs/acre) or more. As aphids feed, they excrete honeydew that contains the excess sugars obtained from the plant sap. This sticky, shiny honeydew and tiny white exoskeletons are deposited on the leaves below the feeding aphids. A dark, sooty mold often grows on the honeydew. The combination of sooty mold and honeydew interferes with curing, reduces leaf quality, and often remains on the leaves after aphids have been controlled. Aphids are most severe on field tobacco from late June to September. Tobacco plants become infested when winged aphids fly into fields and deposit young wingless nymphs on the upper leaves. It is important to watch for increases in aphid populations

from early June to the end of August. Examine the undersides of leaves from all portions of tobacco plants to assess the extent of aphid infestation.

The following practices can be used to manage aphids on tobacco.

## 1. Preventive Control

### a. **Apply systemic insecticides before or at transplanting.**

Admire Pro or Platinum applied as transplant drench or transplant water treatments usually provide excellent season-long control of aphids (Table 2).

## 2. Remedial Control of Aphids

a. **Make remedial applications of a foliar insecticide at the economic threshold level** before populations become too high (Table 3). This will make aphid control much easier for the rest of the season.

b. **Rotate insecticides for resistance management.** The continuous use of the same insecticide year after year increases the chances that aphids and other pests will develop resistance to it. Rotating insecticides with different modes of action reduces the chances that resistance will develop. The insecticides available for aphid control on tobacco are in several different groups based on their modes of action (the way they kill aphids) (Table 9). When applying several insecticides for aphid control over the growing season, change from one group to another. Do not apply a neonicotinoid (group 4) such as Provodo, Actara, or Assail to tobacco already treated with another neonicotinoid (group 4) such as Admire or Platinum. Instead, apply Orthene (group 1B) or Fulfill (group 9) because they are in different chemical groups.

c. **Assess control after 3 or 4 days.** It takes 1 to 3 days after application of most insecticides for the aphids to die. If control is not adequate, determine whether the weather conditions, spraying equipment, improper calibration, or other factors contributed to the poor control. If the aphids appear to be resistant, apply an insecticide in another group (Table 9).

d. **Higher gallonage, higher sprayer pressure, drop nozzles, and spreader-stickers can improve coverage.** For optimum aphid control with foliar insecticides, the sprays must come in contact with the aphids concentrated on the undersides of the leaves. Drop nozzles improve control if aphids are abundant on the undersides of the lower leaves.

e. **Continue to scout the crop** after satisfactory control is obtained. Aphid populations may return to damaging levels and require additional insecticide applications.

### 3. Cultural Control of Aphids

**Most cultural practices do not keep aphid populations below the economic threshold**, but they can improve the effectiveness of foliar insecticides and reduce the need for insecticide applications after topping. Useful cultural practices include:

a. **Avoid planting cole crops such as cabbage and turnips near greenhouses.** These plants are sources of aphids that can infest tobacco plants early in the growing season.

b. **Control aphids in greenhouses.** Make sure seedlings are aphid-free before they are transplanted. Destroy greenhouse transplants immediately after transplanting is completed.

c. **Transplant early.** Early planted tobacco may become infested with aphids earlier, but it matures earlier and the aphids have less impact on early-planted tobacco than they do on tobacco planted near the middle of the recommended planting period.

d. **Use recommended nitrogen rates on flue-cured tobacco.** Too much nitrogen fertilizer causes the leaves to remain green later in the year and it promotes excessive sucker growth that favors aphid infestations.

e. **Top early and control suckers.** Aphid populations often decline rapidly after topping, especially in hot, dry weather. However, aphids may still reach damaging levels that require insecticide treatment.

### Tobacco Flea Beetle

Adult tobacco flea beetles feed on the leaves and stalks of tobacco, while the grubs or larvae feed on the roots. Extensive feeding on newly set transplants by both beetle stages may cause stunting and uneven stands. When checking tobacco fields for flea beetles, look for the characteristic shot-hole feeding damage, and then count the beetles on 20 plants (2 per field-sample location). **Apply treatments for flea beetles on newly set tobacco when there are 4 or more beetles per plant.** Larger plants can tolerate very high flea beetle densities. Apply an insecticide when the base of the lower leaves have a netted appearance or densities exceed 60 beetles per plant. Flea beetle control ratings for systemic and foliar insecticides are listed in Tables 2 and 7, respectively. Insecticides for flea beetle control are listed in Tables 3, 4, 5, and 10. Harvesting at the normal time, and stalk cutting and root destruction immediately after the last harvest are the most effective cultural practices for reducing flea beetle populations

and the resulting damage the next year. Tobacco with nitrogen deficiency appears to be more susceptible to flea beetle damage after topping.

Flea beetles are difficult to control after topping because most insecticides that can be used at this time provide only short residual control while flea beetles are emerging from the soil over an extended period.

### **Managing thrips to control tomato spotted wilt virus**

The tobacco thrips, *Frankliniella fusca*, is the primary vector of the tobacco pathogen, tomato spotted wilt virus (TSWV). TSWV caused moderate stand reductions in tobacco fields in parts of Virginia in 2002 but it has occurred at very low rates since then. Foliar treatments for thrips control are not effective for managing TSWV after the disease is observed in the field. However, tray drench or transplant water applications of Admire Pro or generic forms of imidacloprid and Platinum suppress TSWV. Tray drenches are more effective than transplant water treatments.

### **Tobacco splitworm**

The tobacco splitworm or potato tuberworm, a leaf-mining caterpillar is sometimes a late season problem on tobacco. Splitworms live in tunnels or mines that appear as brown, tan, or grayish, translucent blotches on the leaves. Splitworms can also feed in the midvein and stalk. Old mines turn brown and brittle and may destroy over 50 percent of the leaf. Although the mines are most common on the lower leaves, they can occur on any leaf. Splitworm damage increases the amount of dead leaf tissue and may reduce crop yield and value. Since splitworms feed within the leaves, they are difficult to control with insecticides. Currently, only Coragen is registered for splitworm control on tobacco. However, Belt, Denim, Tracer, and acephate applied in high volumes of water provide fair to good control. Denim was the most effective treatment for splitworms in one trial. Early-season applications of Karate/Warrior appear to be effective but are rarely necessary and no early-season thresholds have been established.

It is important to avoid planting or storing Irish potatoes near tobacco fields because they are an important source of this pest in tobacco. If splitworm mines are observed on the lower leaves, the leaves should be harvested and cured as soon as possible. Since splitworms continue to develop inside the leaves after they are harvested, removing infested leaves and dropping them on the ground will not reduce the problem and may make it worse.

### **Insecticide Application Methods**

Apply insecticides properly for optimum insect control. On small tobacco, obtain effective control by directing one solid-cone or hollow-cone nozzle per row to the bud. Operate equipment at 40 to 60 psi, do not exceed 5 miles per hour, and use at least 6 to 8 gallons of finished spray per acre.

After tobacco is 2 ft. tall, use one or three nozzles per row. If three nozzles are used, orient the two side nozzles at 45 degree angles toward the upper  $\frac{1}{3}$  of the plant. Use 20 to 50 gallons of spray mixture per acre at 40 to 60 psi. Set the nozzles 8 to 12 inches above the tobacco. Drop nozzles oriented to the undersides of the leaves and used in combination with one or three nozzles over the row may improve aphid, splitworm, and flea beetle control. Plant tobacco uniformly so that the space between rows is constant. This makes it easier to orient the spray nozzles over the plants during the spraying operation.

**Table 7. Rating of foliar insecticides for control of insect pests on flue-cured tobacco.**

Insecticide	Aphid	BW <sup>1</sup>	CW <sup>1</sup>	FB <sup>1</sup>	G <sup>1</sup>	HW <sup>1</sup>
Actara/TMOXX	4	0	0	3	0	0
Assail	4	2	0	4	0	3*
<i>Bacillus thuringiensis</i>	0	2	0	0	0	5
Agree, Crymax/Dipel/Javelin/ Lepinox/XenTari						
Brigade/Capture	2	3	4	3	3	5
Belt	0	4	0	0	0	5
Coragen	0	4	0	0	0	5
Denim	0	4	0	0	0	4
Fulfill	3	0	0	0	0	0
Lannate	2	3	0	2	0	5
Orthene/Acephate/ Acephate 97UP	4	3	4	2	4	5
Provado/Nuprid	4	0	0	2	0	0
Sevin	0	2	3	2	3	4
Tracer	0	4	0	0	0	4
Karate/Warrior	1	3	3	3	3	5

<sup>1</sup> BW = Budworm; CW = Cutworm; FB = Flea Beetle; G = Grasshopper; HW = Hornworm. Rating is as follows 0 = not labeled, 1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent.

\*effective, but not labeled.

**Table 8. Restricted entry intervals and preharvest intervals for various insecticides used on flue-cured tobacco in Virginia.**

Insecticide	Restricted entry Intervals (REI) (hours)	Preharvest interval (PHI) (days)
<b><u>Foliar treatments</u></b>		
Acephate (Orthene/Acephate AG/Acephate UP)	24	3
Acetamiprid (Assail) 70WP, 30WG	12	7
<i>Bacillus thuringiensis</i> (Agree/Crymax/Dipel/ Javelin/XenTari)	4	0
<i>Bacillus thuringiensis</i> (Lepinox)	12	0
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Bifenthrin + imidacloprid (Brigadier)	12	Do not apply after layby
Carbaryl (Sevin)	12	0
Chlorantraniliprole (Coragen)	4	1
Flubendiamide (Belt)	14	14
Imidacloprid (Nuprid/Provado) 1.6F	12	14
Lambda-cyhalothrin (Karate/Warrior 1CS)	24	40
Methomyl (Lannate)	48	7
Pymethozine (Fulfill)	12	14
Spinosad (Tracer)	4	3
Thiamethoxam (Actara/TMOXX)	12	14
<b><u>Soil treatments</u></b>		
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Chlorpyrifos (Lorsban/Lorsban Advance)	24	“
Ethoprop (Mocap)	48	“
Metaldehyde (Deadline Bullets)	12	“
<b><u>Greenhouse seedling drench or transplant water treatments</u></b>		
Acephate (Orthene/Acephate)	24	3
Bifenthrin (Brigade/Capture)	12	Do not apply after layby
Chlorantraniliprole (Coragen)	4	1
Imidacloprid (Admire Pro and various generics)	12	14
Lambda-cyhalothrin (Warrior/Karate)	12	40
Thiamethoxam (Platinum/TMOXX) 2F	12	14

## Resistance Management

### Minimizing Insecticide Residues

Pesticide residues are an important factor in the quality of cured tobacco that can cause some contractors to reject a tobacco crop. The following points help to minimize pesticide residues on the marketed crop.

- **Do not use any insecticides not labeled for use on tobacco.**
- **Do not use endosulfan (Cekulfan, Ednosulfan, Emusifiable Concentrate, Thiodan, Thiokill, Golden Leaf Tobacco Spray).** There are several insecticides that give equal or superior control. Some companies specify in their contracts that this chemical must not be used on the tobacco.
- **Follow the preharvest intervals closely.** The pyrethroids, bifenthrin (Brigade) and lambda-cyhalothrin (Karate/Warrior) have very long preharvest intervals. Bifenthrin should not be applied after layby and lambda-cyhalothrin has a 40-day preharvest interval.
- **Use insecticides with short preharvest intervals during the harvest period.** *Bt* and Tracer are good options for hornworms, Orthene provides effective control of aphids and some control of flea beetles, but there is usually no need for late-season applications.

The Insecticide Resistance Action Committee (IRAC) has grouped insecticides into mode of action (MOA) groups that are listed on many of the insecticide labels (Table 9). Avoid using insecticides with the same mode of action group to control an insect more than once during the growing season. This reduces the chances that an insect will develop resistance to the insecticides registered for tobacco.

**Table 9. Tobacco insecticides by group and mode of action for resistance management.**

Goup #	Mode of action	Chemical sub-group or active ingredient	Product name
1A	Acetylcholine esterase inhibitors	Carbamates	Lannate, Sevin, Temik
1B	Acetylcholine esterase inhibitors	Organophosphates	Orthene
3A	Sodium channel modulators	Pyrethroids, Pyrethrins	Brigade/Capture Karate/Warrior
4A	Nicotinic Acetylcholine receptor agonists / antagonists	Neoicothinoids	Actara, Admire Pro, Assail, Platinum, Provado
5	Nicotinic Acetylcholine receptor agonists	Spinosyns	Traces
6	Chloride channel activators	Avermectins	Denim
9	Selective feeding blockers	Pymetrozine	Fulfill
11	Microbial disruptors of insect midgut membranes	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i> <i>Bacillus</i> <i>thuringiensis</i> var. <i>tenebrionenses</i>	Dipel, etc.
28	Ryanodine receptor inhibitor	Chlorantraniliprole Flubendiamide	Belt, Coragen

**Table 10. Insects on Field Tobacco - Foliar Treatments**

Insect	Insecticide and formulation	Rate per acre
<b>Aphids</b>	Acephate (Acephate AG) 75SP	$\frac{2}{3}$ to 1 lb
	(Acephate) 97UP	$\frac{1}{2}$ to $\frac{3}{4}$ lb
	(Orthene) 97PE	$\frac{1}{2}$ to $\frac{3}{4}$ lb
<b>Remarks and precautions:</b> MOA = 1B Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy infestations or if control was poor with previous application. If tobacco is large and aphids are established on the lower leaves, drop nozzles that orient spray to undersides of leaves improve control. Prime before treating.		
	Acetamiprid (Assail) 70WP	0.6 to 1.7 oz
	(Assail) 30WG	1.5 to 4.0 fl oz
<b>Remarks and precautions:</b> MOA = 4A Apply as a spray in at least 20 gal/acre. Do not apply to tobacco already treated with Admire Pro, Platinum, Provado, or Actara. Also provides fair control of hornworms.		
	Bifenthrin (Brigade/Capture) 2EC	2.56 to 6.4 fl oz
<b>Remarks and precautions:</b> MOA = 4A Do not apply after layby.		
<b>Restricted use.</b>		
	Bifenthrin + imidacloprid	3.8 to 6.4 fl oz
	(Brigadier) 1 + 1EC	2.56 to 6.4 fl oz
<b>Remarks and precautions:</b> MOA = 3A Do not apply after layby.		
<b>Restricted use.</b>		
	Imidacloprid (Provado) 1.6F	2 to 4 fl oz
	(Nuprid and other generics) 1.6F	2 to 4 fl oz
<b>Remarks and precautions:</b> MOA = 4A Apply as spray. <b>Do not apply to tobacco treated with Admire Pro, Assail, Platinum, Provado, or TMOXX.</b>		
	Methomyl (Lannate) 90SP	$\frac{1}{4}$ to $\frac{1}{2}$ lb
	(Lannate) 2.4LV	1 $\frac{1}{2}$ pt
<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. Several applications may be necessary to control aphids.		
<b>Restricted Use</b>		
	Pymetrozine (Fulfill) 50WG	2 $\frac{3}{4}$ oz
<b>Remarks and precautions:</b> MOA = 9 Do not apply more than twice or $5\frac{1}{2}$ oz/acre/year. Allow 7 days between applications.		
	Thiamethoxam (Actara) 25WDG	2 to 3 oz
<b>Remarks and precautions:</b> MOA = 4A Do not apply to tobacco already treated with Platinum, TMOXX, Admire Pro, Assail, or Provado. Apply only once during the growing season.		

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Armyworms</b> (beet, fall and yellowstripped)	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	<b>Remarks and precautions:</b> MOA = 3A Do not apply after layby. <b>Restricted use.</b>	
	Emamectin benzoate (Denim) 0.16EC	6 to 12 fl oz
	<b>Remarks and precautions:</b> MOA = 6 <b>Restricted Use.</b> Apply in sufficient water for through coverage.	
<b>Budworms</b>	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	<b>Remarks and precautions:</b> MOA = 3A <b>Restricted Use.</b> Apply as a spray. Observe the 40-day preharvest interval. Orthene is labeled for armyworms on other crops.	
	<b>Remarks and precautions:</b> MOA = 1B Apply as a spray. When using hand sprayer apply in 10 to 50 gal/acre.	
<i>Bacillus thuringiensis</i>		
<b>Budworms</b>	(Agree) WG	1 to 2 lb
	(Crymax) WG	½ to 2 lb
	(Dipel) DF	½ to 1 lb
	(Dipel) ES	1 to 2 pt
	(Javelin) WG	1 to 1 ¼ lb
	(XenTari) WDG	½ to 2 lb
	<b>Remarks and precautions:</b> MOA = 11 Apply as a spray. <b>Do not allow diluted sprays to stand in the sprayer more than 12 hours.</b>	
Bifenthrin ((Brigade/Capture) 2EC	4.0 to 6.4 fl oz	
<b>Remarks and precautions:</b> MOA = 3A <b>Restricted use.</b> Do not apply after layby.		
<b>Budworms</b>	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb
	(Sevin XLR Plus) 4F	1 to 2 qt
	<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. Do not apply until plants are established and growing. The tobacco aphid often becomes a problem on tobacco following two or more applications of Sevin.	

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Budworms</b> (cont'd)	Chlorantraniliprole (Coragen) 1.67SC	3.5 to 7.5 fl oz
	<b>Remarks and precautions:</b> MOA = 28 Make no more than 4 applications per acre per season. Do not use an adjuvant with applications.	
	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	<b>Remarks and precautions:</b> MOA = 6 <b>Restricted Use.</b> Apply in sufficient water for through coverage. Apply before damaging infestations occur.	
	Flubendiamide (Belt) 4SC	2 to 3 fl oz
	<b>Remarks and precautions:</b> MOA = 28 Apply in at least 10 gal/acre. Do not exceed four applications per year.	
	Lambda-cyhalothrin (Karate/Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	<b>Remarks and precautions:</b> MOA = 3A <b>Restricted Use.</b> Apply as a foliar spray after field scouting indicates the population has reached the economic threshold as indicated by field scouting. Observe the 40-day preharvest interval.	
	Methomyl (Lannate) 90SP	½ lb
(Lannate) 2.4LV	1 ½ pt	
<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. Make applications as needed. Direct the spray into the buds before buttoning. <b>Restricted Use.</b>		
Spinosad (Tracer) 4F	1½ to 2 fl oz	
<b>Remarks and precautions:</b> MOA = 5 Use higher rates for large larvae or high infestations. Use at least 20 gal of water per acre.		
<b>Cabbage loopers</b>	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	<b>Remarks and precautions:</b> MOA = 1B Apply as a spray in 10 to 50 gal of water	
	<i>Bacillus thuringiensis</i>	
<b>See rates and formulations under budworms</b>		
<b>Remarks and precautions:</b> MOA = 11 Apply as a spray. <b>Do not allow prepared sprays to stand in tank more than 12 hrs.</b>		

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Cabbage loopers</b> (cont'd)	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zeon, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	Remarks and precautions: MOA = 3A Restricted Use. Apply as a spray. There is a 40-day preharvest interval for lambda-cyhalothrin. Do not apply bifenthrin after layby.	
	Methomyl (Lannate) 90SP	½ lb
	(Lannate) 2.4 LV	1 ½ pt
	<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. <b>Restricted Use.</b>	
	Spinosad (Tracer) 4F	1½ to 2 fl oz
	<b>Remarks and precautions:</b> MOA = 5 Apply as a spray in at least 20 gal of water per acre.	
<b>Cut- worms</b>	Acephate (Acephate AG) 75SP	1 lb
	(Acephate) 97UP	¾ lb
	(Orthene) 97PE	¾ lb
	<b>Remarks and precautions:</b> MOA = 5 Apply as a spray overtop of plants in affected areas when 5% of plants are injured by cutworms. Make application during late afternoon using at least 25 gal of spray per acre.	
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	<b>Remarks and precautions:</b> MOA = 3A <b>Restricted Use.</b> Apply in the late afternoon when cutworms are causing damage. Do not apply within 40 days of harvest.	
<b>Flea beetles</b>	Acephate (Acephate AG) 75SP	2/3 lb
	(Acephate) 97UP	½ lb
	(Orthene) 97PE	½ lb
	<b>Remarks and precautions:</b> MOA = 1B Apply as a spray. Prime before treating	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	<b>Remarks and precautions:</b> MOA = 3A Do not apply after layby. <b>Restricted use.</b>	

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Flea beetles (cont'd)</b>	Carbaryl (Sevin) 80S	1 ¼ lb
	(Sevin XLR Plus) 4F	1 qt
<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. Do not apply until plants are established and growing. Aphids often become problems on tobacco following two or more applications of Sevin.		
	Imidacloprid (Provado) 1.6F	4 fl oz
<b>Remarks and precautions:</b> MOA = 4A Apply as spray. <b>Do not apply to tobacco already treated with imidacloprid (Admire Pro), acetimidrid (Assail), TMOXX, or Platinum (thiamethoxam).</b>		
	Lambda-cyhalothrin (Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
<b>Remarks and precautions:</b> MOA = 4A <b>Restricted Use.</b> Apply in sufficient water for coverage.		
	Methomyl (Lannate) 90SP	¼ to ½ lb
	(Lannate) 2.4LV	1 ½ pt
<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. <b>Restricted Use.</b>		
	Thiamethoxam (Actara) 25WDG	2 to 4 oz
<b>Remarks and precautions:</b> MOA = 4A Do not apply to tobacco already treated with Admire Pro, Assail, Platinum, Provado, or TMOXX. Apply only once during the growing season.		
<b>Grass-hoppers</b>	Acephate (Acephate AG) 75SP	1/3 to 2/3 lb
	(Acephate) 97UP	¼ to ½ lb
	(Orthene) 97PE	¼ to ½ lb
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
<b>Remarks and precautions:</b> MOA is 1B for acephate and 3A for bifenthrin. Do not apply bifenthrin after layby. <b>Bifenthrin is restricted use.</b>		
	Carbaryl (Sevin) 80S	2/3 to 1 7/8 lb
	(Sevin XLR Plus) 4F	½ to 1 ½ qt
<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. Treat crop and a strip around field to reduce grasshopper movement into the field.		

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Grass-hoppers</b> cont'd	Lambda-cyhalothrin Warrior) 1CS	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
<b>Remarks and precautions: MOA = 3 Restricted Use.</b> Apply in sufficient water for coverage. There is a 40-day preharvest interval.		
<b>Hornworms</b>	Acephate (Acephate AG) 75SP	$\frac{2}{3}$ lb in water
	(Acephate) 97UP	$\frac{1}{2}$ lb
	(Orthene) 97PE	$\frac{1}{2}$ lb
<b>Remarks and precautions: MOA = 1B</b> Apply as a spray. Treat infested fields before worms are more than 1½ inches long. Direct insecticides toward the upper half of the plants. Prime before treatment.		
<i>Bacillus thuringiensis</i>		
	(Agree) WSP	1 to 2 lb
	(Crymax) WG	$\frac{1}{2}$ to 2 lb
	(Dipel) DF	$\frac{1}{4}$ to 1 lb
	(Dipel) ES	$\frac{1}{2}$ to 1 pt
	(Javelin) WG	$\frac{1}{8}$ to 1 ¼ lb
	(XenTari) WDG	$\frac{1}{2}$ to 2 lb
<b>Remarks and precautions: MOA = 11</b> Apply as a spray. Do not allow dilute sprays to stand in tank more than 12 hours. Dipel can be tank-mixed with maleic hydrazide (Royal MH-30).		
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
<b>Remarks and precautions: MOA = 3A</b> Do not apply after layby. <b>Restricted use.</b>		
	Carbaryl (Sevin) 80S	1 ¼ to 2 ½ lb
	(Sevin XLR Plus) 4F	1 to 2 qt
<b>Remarks and precautions: MOA = 1A</b> Apply as a spray.		
	Chlorantraniliprole (Coragen) 1.67SC	3.5 to 7.5 fl oz
<b>Remarks and precautions: MOA = 28</b> Make no more than 4 applications per acre per season. <b>Do not use an adjuvant.</b>		

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Hornworms</b> cont'd	Emamectin benzoate (Denim) 0.16EC	8 to 12 fl oz
	<b>Remarks and precautions:</b> MOA = 9 <b>Restricted Use.</b> Apply in sufficient water for through coverage before damaging infestations occur.	
	Flubendiamide (Belt) 4SC	2 to 3 fl oz
	<b>Remarks and precautions:</b> MOA = 28 Apply in at least 10 gal/acre. Do not exceed four applications per year.	
	Lambda-cyhalothrin (Warrior) 1EC	1.9-3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
	<b>Remarks and precautions:</b> MOA = 3A <b>Restricted Use.</b> Apply as a spray. There is a 40-day preharvest interval.	
	Methomyl (Lannate) 90SP (Lannate) 2.4LV	¼ to ½ lb ¾ to 1 ½ pt
	<b>Remarks and precautions:</b> MOA = 1A Apply as a spray. <b>Restricted Use.</b>	
	Spinosad (Tracer) 4F	1 to 2 fl oz
<b>Remarks and precautions:</b> MOA = 5 Apply as a spray in at least 20 gal of water per acre.		
<b>Japanese beetles</b>	Acephate (Acephate AG) 75SP (Acephate) 97UP (Orthene) 97PE	⅔ to 1 lb ½ to ¾ lb ½ to ¾ lb
	<b>Remarks and precautions:</b> MOA = 1B Apply as a spray in 10 to 50 gal/acre. Prime before treating.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
	<b>Remarks and precautions:</b> MOA = 4A Do not apply after layby. <b>Restricted use.</b>	
	Carbaryl (Sevin) 80S (Sevin) 50W (Sevin XLR Plus) 4F	1 ¼ lb 2 lb 1 qt
	Imidacloprid (Provado) 1.6F Thiamethoxam (Actara) 25WDG	4 fl oz 3 oz
	<b>Remarks and precautions:</b> MOA is 1A for carbaryl and 4A for acetamiprid, imidacloprid, and thiamethoxam. Apply as a spray. Damage is usually less severe than it appears. Repeated applications with carbaryl or pyrethroids may flair up aphid populations.	

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Japanese beetles</b> cont'd	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
<b>Remarks and precautions:</b> MOA = 3A <b>Restricted Use. Apply as a spray. There is a 40-day preharvest interval.</b>		
<b>Slugs</b>	Metaldehyde (Dealine Bullets) 4 % Bait	12 to 40 lb
	<b>Remarks and precautions:</b> Apply as a broadcast treatment to the soil surface in the late evening. Metaldehyde is most effective after irrigation or a rain.	
<b>Stink bugs</b>	Acephate (Acephate AG) 75SP	$\frac{2}{3}$ to 1 lb
	(Acephate) 97UP	$\frac{1}{2}$ to $\frac{3}{4}$ lb
	(Orthene) 97PE	$\frac{1}{2}$ to $\frac{3}{4}$ lb
	<b>Remarks and precautions:</b> MOA = 1B Apply as a spray. Stinkbug injury is usually much less severe than it appears.	
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
<b>Remarks and precautions:</b> MOA = 3A Do not apply after layby. <b>Restricted use.</b>		
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
<b>Remarks and precautions:</b> MOA = 3A <b>Restricted Use.</b> Apply as a spray. There is a 40-day preharvest interval. <b>Restricted use.</b>		

**Table 10. Insects on Field Tobacco - Foliar Treatments (Cont'd)**

Insect	Insecticide and formulation	Rate per acre
<b>Thrips</b>	Acephate (Acephate AG) 75SP	$\frac{2}{3}$ to 1 lb
	(Acephate) 97UP	$\frac{1}{2}$ to $\frac{3}{4}$ lb
	(Orthene) 97PE	$\frac{1}{2}$ to $\frac{3}{4}$ lb
<p><b>Remarks and precautions:</b> MOA = 1A Apply as a spray in 10 to 50 gal/acre. Use highest rate for heavy infestations or if control was poor with previous application. Prime before treating. Foliar applications for thrips control are not effective for reducing tomato spotted wilt virus after the disease is observed.</p>		
	Bifenthrin (Brigade/Capture) 2EC	4.0 to 6.4 fl oz
<p><b>Remarks and precautions:</b> Do not apply after layby. <b>Restricted use.</b></p>		
	Lambda-cyhalothrin (Warrior) 1EC	1.9 to 3.8 fl oz
	(Karate with Zion, Warrior II) 2.1SC	0.96 to 1.92 fl oz
<p><b>Remarks and precautions:</b> MOA = 3A Apply as a spray. Foliar applications for thrips control are not effective for reducing tomato spotted wilt virus after the disease is observed.. There is a 40-day preharvest interval. <b>Restricted Use.</b></p>		
<b>Tobacco splitworm/ potato tuberworm</b>	Chlorantraniliprole (Coragen) 1.67SC	3.5 to 7.5 fl oz
	<p><b>Remarks and precautions:</b> MOA = 28 Make no more than 4 applications per acre per season. Do not use an adjuvant.</p>	
<b>Whitefringed beetle</b>	<p>No chemicals are currently registered for whitefringed beetle control on tobacco. In one trial, imidacloprid and thiamethoxam applied as tray drench and transplant water treatments provided good control.</p>	
	<p><b>Remarks and precautions:</b> Cultural control: Rotate tobacco with grass crops. Control legumes and broadleaf weeds. Do not plant tobacco after legumes.</p>	