8. Efficient and Effective Insect Management in a Changing Burley World

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Dramatic changes in North Carolina's burley tobacco production picture continue two years after the end of the tobacco support programs. While burley remains an important crop in the mountains of the state, increasing acreages are being planted in areas in the eastern two-thirds of North Carolina, where insect pressures are much more intense than the traditional high-altitude production areas. These shifts, and the changing economics of tobacco in the post-buyout world, will ensure that insect management in burley tobacco will continue to be a challenge.

Tomato spotted wilt (TSWV) is becoming a fact of life for at least some burley growers, and the disease may well limit the geographical range of the crop in some parts of the state. In addition to the disease-endemic eastern production regions, TSWV is beginning to show up in some areas in the mountains. While it is unclear exactly how big a problem it is ever likely to become in the mountains, it is quite clear that TSWV will be a consideration for eastern burley growers. We have work to do to understand how the disease impacts burley.

Weather, as usual, threw us a couple of punches in 2006. The spring before planting was, in general, mild and fairly dry; but over much of the state, the month following transplanting was abnormally cool and dry. In most of the eastern half of the state, the remainder of the growing season returned to more typical temperatures and good rainfall, while drought persisted in much of the western part of the state well into the growing season. This weather pattern had big implications for tobacco pest management in some areas, exacerbating insecticide phytotoxicity.

In most other respects, 2006 was unexceptional. Tobacco budworm populations were generally low to moderate; aphids appeared to be well managed in most fields. There were heavier than normal hornworm populations in scattered localities in much of eastern North Carolina, and the mid-season and late-season flights were more protracted than usual. Splitworm problems were generally very low.

Flea beetle populations were relatively high in scattered mountain production regions.

Every year, of course, is different; we can't today forecast what the weather holds in store for us in the 2007 growing season, or what economic tremors might shake tobacco production over the next year. But sound tobacco pest management will continue to be a critical component of profitable tobacco production enterprises; the changing, post-buy-out landscape will only make prudent pest management decisions more important.

Protecting Plant Beds

Insects can cause enough damage in plant beds to limit the supply of good quality transplants. Insects can also move on their own or be carried on tobacco seedlings from the bed to the field.

Insects Attacking Plant Beds

Cutworms. Cutworms are common pests in plant beds. Damage ranges from a few small half-circles cut in leaf margins to plants cut off or even entirely eaten away. If the damage is heavy, some areas of beds may be left bare. Cutworms feed mostly at night and hide beneath the soil surface during the day. If damage appears, dig around the edges of the damaged areas and look for small to medium (½ to 2 inches long), dark-colored worms that curl up when disturbed.

Slugs. The best evidence of slugs is the combination of ragged holes in leaves and slime trails. Damage is most likely in beds with weedy borders during wet seasons. Like cutworms, slugs hide in the soil or under trash during the day.

Vegetable weevils. These weevils chew small, irregular holes in the leaves. Look for the small (less than ½ inch long), legless, grub-like worms on the underside of leaves. Their size and pale green color make them hard to see.

Grasshoppers. Grasshoppers sometimes attack plant beds, but are easily seen and recognized.

Other insects. Other insects that attack plant beds include flea beetles, crickets, aphids, June beetle grubs, midge larvae, and even budworms.

Table 8-1. Plant bed insect control

Insect	*Insecticides & Formulation*	*Amount/ 100 Sq Yd*	*Remarks and Precautions*
Aphids and flea beetles (preventive control)	*disulfoton (Di-Syston) 15 G*	*9 oz*	*Broadcast just before seeding or shortly after plants are up. Water in.*
Aphids, Cutworms, Flea beetles, or Vegetable weevils	*acephate (Orthene) 75 SP* *97 PE*	*1 tbsp in 1 gal water* *¾ tbsp in 1 gal water*	*Spray entire bed.*
Grasshoppers	*acephate (Orthene) 75 SP* *97 PE*	*1 tbsp in 1 gal water* *¾ tbsp in 1 gal water*	*Also treat area around bed if possible.*
Slugs and snails	*metaldehyde bait (Deadline Bullets)* *hydrated or air-slaked lime*	*4 to 13 oz* *4 lb*	*Apply to ground (not foliage) in late afternoon.* *Apply lime in a band along margins. If damage is extensive, dust lime over entire surface when plants and soil are dry.*

Steps in Protecting Plant Beds

Step 1. Locate beds where they can be checked regularly.

Step 2. Keep the plant bed site as clean and weed-free as possible. Weeds and trash may harbor pests such as slugs, cutworms, and flea beetles. Also, keep garden greens and wild mustard, on which aphids spend the winter, at least 100 yards away from plant beds.

Step 3. If desired, use granular Di-Syston 15G at seeding or just after plants emerge for preventive control of aphids and flea beetles (Table 8-1). *Only the granular form is recommended;* the liquid formulation may damage plants.

Step 4. Check the plant bed at least weekly for insects and damage. If insects threaten to reduce the supply of healthy transplants below your needs, treat with an insecticide (Table 8-1). Remember, tender plants are easily injured. Treat only when necessary; use only

insecticides recommended for use in plant beds, and follow the label carefully. If insects are present shortly before transplanting, treatment can reduce the risk of carrying them to the field. Keep in mind, however, that all insecticides require a waiting period between treatment and reentry into the bed.

Step 5. Destroy beds as soon after transplanting as possible so they do not become a breeding ground for insect pests and tobacco diseases.

Protecting Seedlings in Greenhouses

Growing seedlings in a greenhouse or float bed does not protect them from insect damage. In fact, some insect problems may be greater in greenhouses or outdoor float beds than in conventional beds. The most common problems have been crickets, vegetable weevils, and aphids, but some growers have reported problems with ants, slugs, and other pests. Managing pests in greenhouses requires careful planning, close observation, and a systematic approach.

Sanitation

Sanitation in and around greenhouses and float beds is essential. Keep houses free of trash, supplies, equipment, or other items that are not necessary. Insects (and other pests) can be supported or protected by materials left in the greenhouse. Keep the area surrounding the greenhouse clean. A strip of bare soil, sand, or gravel around the house may reduce entry of insect pests.

Cold

Keeping empty greenhouses or covered float beds open during cold periods may help reduce insects wintering inside. Do not leave any materials (trays or pots) in the house to provide pests with insulation from the cold.

Solarization

Closing the greenhouse or covered float bed during the summer and bringing the temperature up to 140ºF (but not higher) for several days may help reduce insect numbers. Again, you should remove

any insulating material that protects the insects. Also, remove any materials that can be damaged by high heat.

Fallow Periods

Growing other plants, such as ornamentals or vegetable seedlings, in greenhouses may be an attractive way to help recover the cost of the house. Remember, however, that these plants can introduce or sustain insect pests that may be new to you and very difficult to control. If possible, use greenhouses only for tobacco production. Otherwise, keep them empty as much as possible, especially just before beginning tobacco production. Growing other plants from seed is preferable to bringing in seedlings from another location.

Insecticides

Watch plants carefully and treat with an insecticide if insects threaten an adequate supply of healthy plants. Orthene 97 PE may be used at ¾ tablespoon per 3 gallons of water for each 1,000 square feet of bed. (Orthene 75 SP can be used at 1 tablespoon per 3 gallons of water.) Uniform and thorough coverage is important. Metaldehyde bait (Deadline Bullets) is labeled for control of slugs in tobacco greenhouses. Metaldehyde, however, is most effective when slugs do not have access to water. Thus, metaldehyde may lose some effectiveness when used around float beds. Other insecticides are labeled for use around the outside of the greenhouse or outdoor float bed or within a greenhouse if other crops (but not tobacco) are present. Check with your county Extension agent or the *North Carolina Agricultural Chemicals Manual*.

Managing Soil Insects in the Field

Soil Insects

Wireworms. Wireworms, the most important of the soil-inhabiting insects that attack tobacco, are present in the soil when tobacco is transplanted. They may stunt or kill young plants and can open up even resistant varieties to soilborne diseases. Tobacco often recovers from wireworm damage with no yield loss. If conditions are not favorable, however, yield loss may occur. In any case, stunting and resetting result in an uneven, more difficult-to-manage crop. Any

time young plants are stunted or dying, check for wireworms. Dig up several plants, and check the underground stem for feeding scars and tunnels.

Cutworms. Cutworms are also fairly common in North Carolina, particularly during wet springs. Feeding at night, these pests cut off small plants near the ground or, occasionally, cut off individual leaves. During the day, they hide beneath the soil surface. If you find cut plants, dig around the base of several injured plants to be sure cutworms are present.

Controlling Soil Insects

Step 1. Prepare fields as far in advance of transplanting as practical to reduce the chance of problems with cutworms. Also keep fields and field borders as free of weeds as possible to reduce cutworm and slug problems.

Step 2. Because there are no rescue treatments for wireworms, you must decide in advance whether to use a soil-applied insecticide. Insecticides for wireworm control are expensive. On the other hand, wireworms sometimes cause serious damage. If there is a history of significant wireworm damage in the field, preventive treatment is probably justified.

Table 8-2. Soil-applied insecticides for wireworm control

Insecticide and Formulation	***Amount***	***Remarks***
Lorsban 15G	*13½-20 lb per acre*	*Apply to soil surface. Disk in within 30 minutes. Some of these materials are highly toxic (Table 8-9). Use with care. Liquid formulations are generally more hazardous to handle. Lorsban also provides some cutworm control.*
Lorsban 4E	*2-3 qt per acre*	
Lorsban 75WG	*2.67 lb per acre*	
Mocap 15G	*13 lb per acre*	
Mocap 6EC	*1/3 gal per acre*	
Admire Pro	*0.4 - 1.2 oz per 1,000 plants*	*Apply to tobacco in greenhouses or float beds 1-3 days before transplanting and wash off leaves immediately, OR apply in transplant water.*
T-MOXX, Platinum 2SC	*1.3 oz per 1,000 plants*	

If you decide that chemical control of wireworms is justified, you have two choices (Table 8-2). You can use a contact material (Lorsban or Mocap) that only controls soil insects, or you can use a systemic insecticide that will also control aphids and flea beetles (Admire or Platinum). Both contact and systemic insecticides provide good control of wireworms. There is seldom any need to use both a broadcast and a systemic insecticide. Keep in mind that some of these materials are very toxic (Table 8-9).

Control of wireworms depends on good application. Broadcast and thoroughly incorporate Lorsban or Mocap in the top 6 inches of the soil. If using a disk, disk twice for best incorporation. It is also important to give the insecticide adequate time to work before transplanting; approximately two weeks is recommended unless the label requires a shorter time. Admire and Platinum can be applied to seedlings in the greenhouse or float bed (but not to outdoor plant beds) one to three days before transplanting. Immediately after application, wash the insecticide from the leaves onto the potting soil. These insecticides may also be used as a transplant water treatment.

Step 3. Cutworms occur in scattered locations, are rarely damaging enough to cause measurable yield loss, and can be controlled with remedial (rescue) treatments (Table 8-10). Therefore, preventive control is not generally recommended. However, in rare cases, preventive treatment is an option for fields that consistently have cutworm problems (usually low-lying fields with heavy soils or high weed populations). Lorsban is relatively effective; Orthene transplant water treatment and Admire used in the greenhouse or in transplant water may also provide some control.

Managing Leaf-Feeding Insects in the Field

Major Pests

Flea Beetles. Flea beetles spend the winter in litter and plant trash around or in tobacco fields. In the spring, they move into plant beds or the fields. Most farmers know the shot-hole appearance of leaves chewed by adult beetles, but the tiny, white larvae also feed on tobacco roots. If heavy, this feeding can stunt plant development. Three or four generations are produced each year. Adult beetles are most common just after transplanting and after topping. The late-season beetles are often overlooked.

Budworms. Budworms occasionally tunnel in the stalk or leaf midribs, and they sometimes top plants. The most common damage, however, is from feeding on small bud leaves before the plant has flowered. Budworms spend the winter in the soil in a resting stage called a pupa. In May and June, moths emerge from the soil and begin to lay eggs on tobacco and other hosts. There are three or four generations each year, but only the first two cause much damage. Later generations feed on mature tobacco, suckers, and regrowth. It is these budworms that overwinter and start the cycle again the following year.

Aphids. Aphids (sometimes called plant lice) draw plant juices from the leaves with their sucking mouthparts. This can distort leaves and reduce leaf body. Aphids also produce a waste product called honeydew, which collects on leaves. This material encourages the growth of sooty mold, which darkens the leaf before and after curing. As a result of these effects, aphids affect quality as well as yield. During the fall, winter, and spring, aphids are found on wild hosts such as mustard and dock and on garden greens. In the spring, winged forms fly to tobacco, where they give birth to wingless forms. These quickly produce young of their own, and large colonies of aphids can build up rapidly.

Several species of aphids, including the tobacco aphid, transmit viral tobacco diseases such as etch, potato virus Y (PVY), and vein banding. It takes only a few seconds for a winged aphid to transmit the disease after landing on a plant. Thus, no insecticide acts quickly enough to prevent transmission.

Hornworms. Hornworms overwinter in the soil as pupae. When adults (moths) emerge, they fly to tobacco or other plants to lay eggs. Hornworms can be a problem throughout the season and sometimes feed on tobacco in the barn. Late in the season, most hornworms feed on suckers and plant regrowth. These worms make up most of the overwintering population.

Steps in Managing Insects

The goal of insect management is not to kill insects but to keep net profits high. Thus, it is not only necessary to protect the crop from significant loss but also to keep the costs of protection as low as possible. Growers stand the best chance of doing this, especially over several years, if they combine a variety of insect control tools

into an efficient system. There are four basic types of insect control: (1) cultural control, (2) biological control, (3) preventive chemical treatments applied to the soil, and (4) insecticides applied after a problem develops (remedial treatment).

Cultural Control Practices. Several production practices reduce the chance of insect problems. These practices work to reduce the numbers of an insect pest in a wide area, make individual fields less attractive to insects, or help the plant tolerate insect attack with less loss. Most of these practices (listed below) are important in good crop management as well. Also, most add little or nothing to the cost of production; some may actually reduce costs.

1. Destroy overwintering sites and hosts of aphids and flea beetles near plant beds, float beds, or greenhouses (garden greens, wild mustard, dock, and other leafy greens).

2. Control pests such as aphids and flea beetles in the plant bed or greenhouse to avoid taking them to the field with the transplants. Destroy plant beds or unused plants in greenhouses as soon as transplanting is complete. Undestroyed plants may become a breeding site for insects and diseases.

3. Consider planting as early as practical. Early planting reduces the chance of hornworm and aphid problems. (Late planting may reduce budworm numbers, but late-planted tobacco usually yields less and may be damaged by frost.)

4. Keep fields and field borders free of weeds and trash.

5. Practice early topping and good sucker control to make the crop less attractive to budworms and hornworms. Moths of these pests are strongly attracted to flowers to lay their eggs. Topping and sucker control also often speed the decline of aphids, especially under hot, dry conditions. Early topping is important in controlling a difficult population or in preventing a low population from reaching damaging levels.

6. To reduce the chance of grasshopper invasion, avoid haying grasshopper-infested meadow strips near tobacco.

7. To prevent regrowth, destroy roots immediately after harvest,

denying food and shelter to pests like flea beetles, budworms, and hornworms. Disking and plowing may also kill overwintering budworms and hornworms in the soil. Root destruction is most effective when practiced by everyone.

8. Give the crop a good start, keep it healthy, and get it out of the field (where it is exposed to pests) within a reasonable time.

Conservation of Beneficial Insects. The importance of beneficial insects for controlling insect pests is great. For example, stilt bugs (thin brown or gray bugs with long, thin legs and antennae) are common in tobacco. Each may eat up to 80 budworm eggs in its lifetime. These are eggs that never hatch to damage your crop. Hornworms are attacked by a series of predators (including the stilt bug and paper wasps) and parasites (like the wasp that forms white cocoons on the backs of the hornworm) that often kill over 90 percent of the worms. To make the most of these free, natural controls, follow three steps.

1. Minimize or avoid using systemic insecticides that may reduce the populations of beneficial, as well as pest, insects. Systemics are insecticides that are taken up by the plant and later kill insects feeding on the leaves of stems. Stilt bugs are especially sensitive to systemic insecticides.

2. Avoid unnecessary insecticide sprays after transplanting. Make treatment decisions on a field-by-field basis. Some fields may not need treatment, and these can serve as a refuge for beneficials.

3. If an insecticide is necessary, consider the effect on beneficials in choosing materials.

Soil-Applied Systemic Insecticides for Preventive Control. Several soil-applied systemic insecticides are available. There are several reasons these materials might be used: (1) They offer some insurance against loss to undetected or uncontrolled insects. (2) They offer some protection against the need to apply rescue treatments later in the season when you might be busy with other things. (3) They may slow the buildup of pests like aphids and give you more time to detect and react to the pest. (4) They may do things besides control leaf-feeding insects (control wireworms or suppress tomato spotted wilt infection, for example).

On the other hand, there are disadvantages to using a systemic

insecticide: (1) Most offer protection against only one or two pests. For even those insects controlled, protection is seldom season-long, and pests may reach damaging levels and require over-the-top sprays for control. (2) Systemics may reduce the numbers of beneficial insects, increasing pest pressures. (3) If the pest does not occur, the treatment may have been an unneeded expense. (4) Most pesticides pose some risk to the environment (water contamination, for example). (5) Under certain conditions, systemics can reduce yield or quality. (6) Most insects can be controlled with over-the-top sprays once it is certain they will be a problem. In low pest years, this will probably be cheaper.

Soil-applied systemic insecticides are not generally recommended unless the risk of insect attack is high and there is reason to think remedial treatments will not be possible or effective.

Admire and Platinum can be used as a transplant water treatment like some other insecticides, but they may also be applied as a spray to greenhouse or float-bed plants one to three days before transplanting and then washed off the leaves onto the potting soil. These insecticides are then moved into the field in the plant and potting soil and help protect plants from aphids, early-season flea beetles, and wireworms. Treating plants in a plant bed with Admire or Platinum does not provide adequate insect control in the field; most of the chemical is left in the plant bed when plants are pulled.

Table 8-3. Test of systemic insecticides for flea beetle and aphid control in flue-cured tobacco, average of four tests, 2000-2003

Treatment [a]	*Application* [b]	*Flea Beetle Feeding Holes/ 10 Plants*	*% Plants Aphid Infested at Peak Infestation*
Untreated check		*236*	*34.1*
Orthene 97 PE, 0.77 lb/a	*TPW*	*27*	*21.3*
Admire 2F, 1.4 oz/1,000 plants	*TRAY*	*1* [c]	*0.3* [c]
Platinum 2SC, 1.3 oz/1,000 plants	*TRAY*	*1* [c]	*0.3* [c]

[a] *Treatment rates are shown in units of formulation.*

[b] *TPW = transplant water treatment. TRAY = applied as spray to transplants in greenhouse trays, washed off immediately.*

[c] *Results with transplant applications were similar to results with greenhouse application in tests where both were applied.*

Table 8-4. Range of uses and ratings for soil-incorporated insecticides

Insecticide	Wireworm	Aphid	Flea Beetle [a]
Admire	**	***	***
Di-Syston			**
Furadan			***
Lorsban	**		
Mocap	**		
Orthene (transplant water)		*	***
Platinum	**	***	***

*** = best control; ** = intermediate control; * = fair or inconsistent control; blank = not recommended.

[a] Ratings for flea beetle control are for early season.

Table 8-5. Preplant systemic insecticides for insect control in the field

Insects	Insecticides and Formulations	Amount/ Acre	Remarks
Flea beetles	acephate (Orthene 75 SP) (Orthene 97 PE)	1 lb ¾ lb	Transplant water treatment. Higher rates may injure plants. Use 100+ gallons water per acre.
	carbofuran (Furadan 4 F)	1-1½ gal	Broadcast in 15 to 40 gallons spray. Under certain weather conditions, flecking of leaves or premature flowering may occur.
Aphids and flea beetles	imidacloprid (Admire Pro)	0.4 - 0.6 fluid oz. per 1,000 plants	Apply in transplant water, OR apply as a spray over top of greenhouse plants in trays and wash off immediately.
	thiamethoxam (Platinum 2SC) (T-MOXX)	0.5 - 1.3 fluid oz. per 1,000 plants	Transplant within three days.
Aphids (suppression only)	acephate (Orthene 75 SP) (Orthene 97 PE)	1 lb ¾ lb	Transplant water treatment. Higher rates may injure plants. Use 100+ gallons water per acre. Rarely adequate for season-long control

Note: Most soil-applied insecticides can injure plants under some conditions. Greenhouse and float-bed plants may be more sensitive to this type of injury.

If you use a systemic insecticide, first decide which insects most need control. (It is best to concentrate on the most important pest in the field.) Table 8-3 shows the average results from four tests of common systemics, and Table 8-4 rates these insecticides and lists the pests for which they are recommended. Recommendations, including rates and application methods are shown in Table 8-5.

Be cautious about combining systemics. Most provide similar ranges of control. There is no advantage in using two chemicals that do similar jobs, and doing this increases costs and the likelihood of crop damage.

Remember, systemics are not a guarantee against pests; you should still check fields at least weekly.

Determining the Need for Remedial Control (Rescue Treatments)

Treatment Thresholds. You can reduce your profit by applying insecticides when they are not needed. Tobacco can compensate for some damage, so a small number of pests in a field may not affect yield or quality at all. The point at which it will pay to treat for a pest is called a threshold. Thresholds have been used successfully by North Carolina farmers for many years.

When the value of tobacco per pound goes down, the economic threshold goes up. However, the changes in value we expect will not change thresholds by more than a few percentage points. Thus, we will continue to recommend the same thresholds as in the past (see below). Be aware, nonetheless, that these thresholds are even more conservative for lower value tobacco. Do not think that because your profit margins are smaller, you have to do more to protect what you have left. The truth is, cheaper tobacco deserves less protection, not more.

Tobacco budworms. Before flowering, treat when 10 percent or more of the plants checked are infested with live budworms of any size. Do not count plants that have damage but no live worms. Budworms will not usually cause significant loss after buttoning and, therefore, are not counted after this point. This threshold is very conservative. In most recent tests on flue-cured tobacco, 100 percent infestation has not significantly lowered yields.

Tobacco hornworms. Treatment is justified when the equivalent of at least one worm larger than 1 inch without parasite cocoons is found per 10 plants checked. Because worms with cocoons feed less, they

should be counted as one-fifth of a worm (in other words, five worms with cocoons = one healthy worm).

Flea beetles. Treat when small plants average four or more beetles per plant. Treat large plants when you estimate there are 60 or more beetles per plant or when the lower leaves begin to look ragged or lacy at the base (near the stalk).

Aphids (plant lice). Treat when 10 percent or more of plants have as many as 50 aphids on any upper leaf before topping. Do not wait until there are hundreds of aphids to count a plant as infested. Treatment at 10 percent is effective and will prevent losses. However, populations can increase rapidly beyond this point. Do not delay treatment. At or after topping, treat when 20 percent or more of plants are infested.

Japanese beetles, loopers, grasshoppers. No exact thresholds have been established. But, as a rule of thumb, treat when anticipated damage is equal to or greater than that caused by a 10 percent budworm infestation.

Cutworms, vegetable weevils, mole crickets, slugs. Treat (within three weeks after transplanting) when 5 percent or more of small plants are killed or severely injured.

If you suspect a field may soon reach threshold for a pest (for example, if you find many hornworms less than 1 inch long or many plants with small aphid colonies), check the field again in two to three days. It is better to check again than to treat below the threshold because beneficial insects, weather, or other factors may keep the pest from reaching threshold. Also keep in mind that these thresholds were developed as guidelines for average conditions. In unusual situations (drought stress, multiple pests), use your judgment in applying thresholds.

Scouting. To use thresholds, you need to know the pest level in each field. Thus, you must check or scout fields regularly. To scout a field, walk through it (being sure to cover all areas). Stop at several representative locations to check plants for insects. Make eight stops in a field of 3 acres or less and 10 in fields of 4 to 8 acres. The pattern of stops is not critical, but stop once or more in each area of the field. Check, but do not concentrate on, the field borders. Do not bias

your sample by stopping to count when you see damage. Instead, determine where you will stop before you get there. For example, say to yourself, "I'll stop 10 plants up this row." At each stop, check five plants in a row for insects. Count the plants that have a budworm present and the number that have 50 or more aphids on any leaf. Count hornworms and estimate the number of flea beetles per plant. Also note other insects or damage. Then compare your results with the thresholds. Avoid the temptation to make decisions on several fields based only on information from one or two. Insect levels may vary greatly even among similar fields.

Choosing a Remedial Insecticide

No one insecticide is best for all pests or even for a single pest under all conditions. If you need to use an insecticide, choose one that fits the conditions and your needs when the pest problem occurs. To make this choice, ask yourself:

1. What insect pest or pests need to be controlled? Obviously, to do a good job of control, you must know which pests you are dealing with.

2. Which insecticides are the most effective against the pest or pests? If two or more insects are damaging a field, the best choice would be an insecticide providing good control of them all. Table 8-6 shows the effectiveness ratings for insecticide sprays against major leaf-feeding insects. Table 8-7 shows the results of four tests against budworms, and Table 8-8 shows results against aphids.

3. Which insecticides offer the longest-lasting control? If pest pressures are expected to continue over a long period, choose a pesticide with a long-lasting effect. On the other hand, these materials may be more harmful to beneficials and may not be needed if the pest pressure will be brief. In on-farm tests, Sevin, Tracer, and Orthene have provided the longest-lasting suppression of newly hatched hornworms.

4. What are the hazards to the applicator and other workers? Do not take lightly the hazards of using pesticides, particularly when using hand or backpack sprayers. When choosing pesticides, consider the hazard potential and the ability of the person doing the application. Pesticides bear signal words to indicate hazards of use. Products bearing the words ***Danger-Poison*** are highly hazardous; those marked ***Warning*** are moderately hazardous; and those marked ***Caution***

Table 8-6. Effectiveness of foliar insecticides against insect pests

	Insect Pest			
Insecticide	**Aphid [a]**	**Budworm**	**Flea Beetle**	**Hornworm**
Actara	****		****	
Assail	****			
B. thuringiensis spray [b]		** [c]		****
Denim		***		****
Fulfill	***			
Lannate	*	** [d]	***	****
Orthene	****	**	****	****
Provado	****		****	
Sevin			***	***
Tracer		***		****
Warrior		** [d]		****

*Note. **** = excellent control, *** = good control, ** = moderate control, * = fair control, blank = not recommended.*

[a] *Aphid control ratings are based on maximum labeled rates.*

[b] B.t. *is sold under a variety of trade names.*

[c] B.t. *products seem to be more effective against budworms as the season progresses.*

[d] *In some tests, Lannate, Thiodan and Warrior have performed at a *** level against budworms*

Table 8-7. Effect of insecticides on budworms in six field trials

	Percent Reduction in Budworm Damage [b]					
Treatment [a]	**Burley 1999**	**Burley 2002**	**Flue 2000**	**Flue 2002**	**Flue 2004**	**Flue 2004**
Orthene 97PE 0.77 lb/acre, Sp.	64.1	77.3	25.7	56.0	52.9	36.2
Lannate 2.4LV 1.5 pt/acre, Sp.	72.8	—	36.7	—	—	—
Denim 0.16EC 8 oz/acre	—	—	—	—	87.6	79.8
Tracer 4SC 1.5 oz/acre, Sp.	75.0	89.4	55.0	74.0	90.6	91.0
DiPel ES 1-2 pt/acre, Sp.	66.8	78.8	20.2	59.0	59.0	17.1
Warrior 1CS 2.5 oz/acre	—	—	—	—	87.3	82.9

[a] *Rates in units of formulated product; Sp. = applied as spray over top, Hand = a pinch of bait applied by hand to bud.*

[b] *Compared to untreated check.*

are slightly hazardous (Table 8-9). Also, consider the protective equipment required by Worker Protection Standards in deciding whether to use a specific pesticide (Chapter 14).

5. What are the hazards to groundwater and surface water? Pesticides differ in their potential for leaching into groundwater or running off into surface water. You should consider these risks when choosing remedial and soil-applied insecticides (see Chapter 13).

6. Will the insecticide restrict field work? Worker Protection Standards prohibit hired workers from entering treated areas to do routine field

Table 8-8. Effect of foliar insecticides on aphids in five field trials

	Aphid Infestation Rating 1 - 2 Weeks after Treatment [a]	
Treatment, Rate/Acre	***Burley 2001***	***Flue-Cured Avg. of Four Trials 2001-2005*** [a]
Untreated	*2.28*	*2.65*
Actara 2.0 oz	*1.01*	*0.39*
Fulfill, 2.75 oz	—	*0.73*
Lannate 2.4LV, 1.5 pt	—	*2.11* [b]
Orthene 97, 0.77 lbs	*0.91*	*0.42*
Provado, 3 oz	—	*0.45*
Assail	—	*0.29* [b]

[a] *Individual plants rated 0-5 based on the number of aphids on most infested leaf, averaged over plot.*
[b] *Lannate was included in only two tests; the untreated check in those tests averaged 3.61. Assail was included in only one test; the untreated check in that test was 1.75.*

Table 8-9. Hazards of insecticide formulations for use on tobacco

Signal Word	***Insecticide Formulation***
Caution	*Actara, Admire, Agree, Assail, Belay, Biobit, Condor OF, Crymax, Deliver, DiPel, Fulfill, Javelin, Lorsban (15G), Orthene, Platinum, Provado, Sevin (4F, XLR Plus), Tracer*
Warning	*Lepinox, Lorsban (4E, 75WG), Mocap (10G), Sevin (80S), Warrior*
Danger-Poison	*Denim, Di-Syston, Furadan, Lannate, Mocap (6EC), Vydate*

work for a period after treatment. The length of this period depends on the chemical and is given on the label. Restricted entry periods usually range from 4 to 48 hours (see Chapter 14).

7. Will the insecticide restrict time of harvest? Regulations may require a waiting period of up to 40 days between application of insecticides and harvest. Check the label and choose a material that fits your harvest needs.

8. What effect will various insecticides have on beneficial insects? Some insecticides are more detrimental to beneficial insects than others. The Bacillus thuringiensis products, such as DiPel, have no effect on beneficials. Orthene and Sevin are relatively harmful to beneficials. Other tobacco sprays are intermediate in their effect.

9. Do tobacco buyers have concerns about insecticide residues? Most farmers are aware of the concern many buyers have about maleic hydrazide (MH) residues. There is also concern about residues of endosulfan (Golden Leaf Tobacco Spray, Phaser, Thiodan), acephate (Orthene), and pyrethroids (Warrior). If your buyers are concerned about residues, choose another insecticide or restrict the use of problem insecticdes to the early season—several weeks before harvest begins.

10. How much does the material cost? Remember that a poorly chosen insecticide can actually increase your pest problems. The real costs of such a choice could be much more than just the cost of the material.

Spray Adjuvants. Adjuvants are materials you add to pesticide sprays to improve performance, reduce drift, improve coverage, or reduce pesticide breakdown. Some insecticide labels suggest an adjuvant be used for best results; most do not. If the label does not suggest using an adjuvant, it is safest not to use one. There have been instances in recent years of growers damaging tobacco with adjuvants, and on-farm tests have shown little if any improvement in control with them. If an insecticide label does suggest using an adjuvant, you should investigate any adjuvant carefully before using it. Be sure the material has been tested or has a history of use specifically in tobacco. Adjuvants that work well in other crops may damage tobacco, at least under some conditions. Follow insecticide and adjuvant labels carefully.

Table 8-10. Remedial treatments for insect control in the field

Insect	Insecticides and Formulations	Amount/ Acre	Reentry Time [a]	Remarks
Aphids	*acephate*			*Good coverage is essential with any material.*
	(Orthene 75 SP)	*1 lb*	*24*	
	(Orthene 97 PE)	*¾ lb*	*24*	
	imidacloprid			
	(Provado 1.6 F)	*3-4 oz*	*12*	
	thiamethoxam			
	(Actara 25WDG)	*2-3 oz*	*12*	
	acetamiprid			
	(Assail 70WP)	*1.1-1.7 oz*	*12*	
	pymetrozine			
	(Fulfill 50 WG)	*¾ oz*	*12*	
	methomyl			
	(Lannate 90 SP)	*½ lb*	*48*	*Initial control is fair to good, but aphids rebound quickly*
	(Lannate 2.4 LV)	*1½ pt*	*48*	
Budworms	*spinosad (Tracer)*	*1.4-2 oz*	*4*	*Use one or three solid cone nozzles 12 inches over-top of row. Apply 25 to 50 gallons of water per acre with 40 to 60 lb pressure*
	emamectin benzoate			
	(Denim 0.16EC)	*8 oz*	*48*	
	methomyl			
	(Lannate 90 SP)	*½ lb*	*48*	
	(Lannate 2.4 LV)	*1½ pt*	*48*	
	acephate			
	(Orthene 75 SP)	*1 lb*	*24*	
	(Orthene 97 PE)	*¾ lb*	*24*	
	Bacillus thuringiensis			
	(Agree)	*2 lb*	*4*	
	(Biobit HP)	*1 lb*	*4*	
	(Crymax)	*1-1½ lb*	*4*	
	(Deliver)	*1-1½ lb*	*4*	
	(DiPel ES)	*2 pt*	*4*	
	(DiPel DF)	*½-1 lb*	*4*	
	(Javelin WG)	*1-1¼ lb*	*4*	
	(Lepinox WDG)	*1-2 lb*	*12*	
	lambda-cyhalothrin			
	(Warrior 1CS)	*2½-3 oz*	*24*	*Use Warrior only in first 6 weeks (40-day preharvest interval)*
Cutworms	*acephate*			
	(Orthene 75 SP)	*1 lb*	*24*	*In late afternoon, apply in 25 to 50 gallons water.*
	(Orthene 97 PE)	*¾ lb*	*24*	

Table 8-10. (continued)

Insect	Insecticides and Formulations	Amount/ Acre	Reentry Time [a]	Remarks
Flea beetles	*acephate*			
	(Orthene 75 SP)	*2/3 lb*	*24*	*Spray entire plant.*
	(Orthene 97 PE)	*½ lb*	*24*	
	imidacloprid			
	(Provado 1.6 F)	*3-4 oz*	*12*	
	thiamethoxam			
	(Actara 25WDG)	*2-3 oz*	*12*	
	methomyl			
	(Lannate 90 SP)	*¼-½ lb*	*48*	
	(Lannate 2.4 LV)	*1½ pt*	*48*	
	carbaryl			
	(Sevin 80 S)	*1¼-2½ lb*	*12*	*To avoid plant injury, do not*
	(Sevin XLR Plus)	*1-2 qt*	*12*	*use carbaryl on small plants.*
	(Sevin 4F)	*1-2 qt*	*12*	
Grass-hoppers	*acephate*			
	(Orthene 75 SP)	*1/3 - 2/3 lb*	*24*	*If possible, also treat a few*
	(Orthene 97 PE)	*½ lb*	*24*	*yards outside field.*
Hornworms	*acephate*			
	(Orthene 75 SP)	*2/3 lb*	*24*	
	(Orthene 97 PE)	*½ lb*	*24*	
	Bacillus thuringiensis			
	(Agree)	*1-2 lb*	*4*	
	(Biobit HP)	*¼-½ lb*	*4*	
	(Crymax)	*½-1 lb*	*4*	
	(Deliver)	*½-1 lb*	*4*	
	(Dipel DF)	*¼-½ lb*	*4*	
	(Dipel ES)	*½-1 pt*	*4*	
	(Javelin WG)	*1/8 -¼ lb*	*4*	
	(Lepinox WDG)	*1 lb*	*12*	
	carbaryl			
	(Sevin 80 S)	*1¼-2½ lb*	*12*	
	(Sevin XLR Plus)	*1 qt*	*12*	
	(Sevin 4 F)	*1-2 qt*	*12*	
	methomyl			
	(Lannate 90 SP)	*¼-½ lb*	*48*	
	(Lannate 2.4 LV)	*¾-1½ pt*	*48*	
	spinosad			
	(Tracer)	*1-1½ oz*	*4*	
	emamectin benzoate			*Denim may not be used*
	(Denim 0.16EC)	*8 oz*	*48*	*within 14 days of harvest.*

Table 8-10. (continued)

Insect	*Insecticides and Formulations*	*Amount/ Acre*	*Reentry Time* [a]	*Remarks*
Japanese beetles	*carbaryl* *(Sevin XLR Plus)* *(Sevin 80 S)* *(Sevin 4 F)*	 *1-2 qt* *1¼-2½ lb* *1-2 qt*	 *12* *12* *12*	*Do not use carbaryl on small plants.*
	imidacloprid (Provado 1.6 F)	*4 oz*	*12*	
	thiamethoxam (Actara 25WDG)	*2-3 oz*	*12*	
Slugs	*metaldehyde (Deadline Bullets)*	*12-40 lb*	*12*	*Treat at dusk. Do not put on plants.*

[a] *Minimum interval (hours) between application and worker reentry into field. Reentry times may change; follow directions on the label.*

Pesticide Issues

Bayer has introduced a new formulation of its imidacloprid product, called Admire Pro. The active ingredient is identical to the 2F formulation, but this new formulation appears to wash down off the plants more completely after application. However, it is important to remember that Admire Pro is about 2.3 times more concentrated than the old 2F formulation; miscalibration or over-application with worn spray nozzles could result in substantially higher residues in transplants than intended.

We have known for many years that higher than necessary rates of imidacloprid can cause phytotoxic reactions in tobacco. Calibrate your spray equipment, and apply this more concentrated formulation carefully to reduce the possibility of over-application. Don't use a higher rate than is necessary for your management goal. For aphid and flea beetle control, 0.5 oz per 1,000 plants should suffice; 0.8 oz per 1,000 will provide TSWV suppression while reducing the potential for phytotoxicity.

Concern over endosulfan residues in harvested leaf remains a significant issue with some tobacco buyers, particularly those buying for foreign markets. While there is little evidence that endosulfan (Thiodan, Phaser, Golden Leaf Tobacco Spray) residues are a significant problem in North Carolina flue-cured tobacco, we are recommending that growers seek alternative insecticides to help allay

these concerns. We have several good options for any pests that might be controlled with this material.

Precautionary Statement on Pesticides

Pesticides must be used carefully to protect against human injury and harm to the environment. Diagnose your pest problem, and select the proper pesticide if one is needed. Follow label use directions, and obey all federal, state, and local pesticide laws and regulations.

Postscript

I would like to take this opportunity to thank Dr. P. Sterling Southern for his many years of dedicated, enthusiastic service to the North Carolina tobacco community, North Carolina Cooperative Extension, and the N.C. State University Department of Entomology.—C. E. S.