B-1204

Texas Agricultural Extension Service
The Texas A&M University System

Management of Cotton Insects in the Southern, Eastern and Blackland Areas of Texas 1994-1995

For recommended insecticides refer to B-1204A "Suggested Insecticides for Managing Cotton Insects in the Southern, Eastern and Blackland Areas of Texas, 1995."

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Management of Cotton Insects

in the Southern, Eastern and Blackland Areas of Texas

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A committee of state and federal research personnel and Extension specialists meets annually to review cotton pest management research and management guidelines. These guidelines are directed toward maximizing profits for the Texas cotton producer by minimizing inputs and optimizing production.

PEST MANAGEMENT PRINCIPLES

The term "pest management" applies to a philosophy used in the design of insect, mite, disease and weed pest control programs. It encourages the use of the most compatible and ecologically sound combination of available pest suppression techniques. These management techniques include: cultural control, such as manipulation of planting dates and stalk destruction; crop management practices such as variety selection and timing of irrigation; biological control, involving conservation of existing natural enemies; host plant resistance; and the wise use of selective insecticides and rates to keep pest populations below economically damaging levels.

Major factors to be considered when using insecticides include protecting natural enemies of cotton pests, possible resurgence of primary pests, increased numbers of secondary pests following applications and pest resistance to insecticides. Therefore, insecticides should be applied at the proper rates and used only when necessary, as determined by frequent field inspections, to prevent economic losses from pests.

The pest management concept rests on the assumption that pests will be present to some degree in a production system, and that at some levels they may not cause significant losses in production. The first line of defense against pests is prevention through the use of good agronomic practices or cultural methods which are unfavorable for the development of pest problems (discussed below). Properly selected control measures should be taken only when pest populations reach levels at which crop damage suffered could result in losses greater than the cost of the treatment. This potentially injurious pest population or plant damage level, determined through regular field scouting activities, is called an **economic threshold or action level.** Precise timing and execution of each production operation is essential. In short, pest management strives to optimize rather than maximize pest control efforts.

INSECTICIDE RESISTANCE MANAGEMENT

Experience has shown that reliance on a single group of insecticides that act in the same way may cause pests to develop resistance to the entire group of insecticides. A good strategy to help avoid pest resistance is to rotate the use of insecticide groups, taking advantage of different modes of action. Such insecticide management should delay the development of resistance and also provide better overall insect control.

Insecticides with similar chemical structures act on insects in similar ways. For example, pyrethroids (including esfenvalerate, bifenthrin, cyfluthrin, cyhalothrin and tralomethrin) all act on an insect's nervous system in the same way. Other types of insecticides such as organophosphates (methyl parathion, dicrotophos) or carbamates (thiodicarb) also affect the insect's nervous system but in a different way than do the pyrethroids.

BIOLOGICAL CONTROL

Insect and mite infestations are often held below damaging levels by weather, inadequate food sources and natural enemies such as disease, predators and parasites. It is important to recognize the impact of these natural control factors and, where possible, encourage their action.

Biological control is the use of predators, parasites and disease to control pests. Important natural enemies in cotton include minute pirate bugs, damsel bugs, big-eyed bugs, assassin bugs, lady beetles, lacewing larvae, syrphid fly larvae, spiders, ground beetles and a variety of tiny wasps that parasitize the eggs, larvae and pupae of many cotton pests.

Biological control includes the conservation, importation and augmentation of natural enemies. It is an environmentally safe method of pest control and is a component of integrated pest management programs in cotton. The Texas A&M University System is fully committed to the development of pest management tactics which use biological control.

Existing populations of natural enemies are conserved by avoiding the use of insecticides until they are needed to prevent the development of economically damaging pest infestations. Insecticide impact can also be minimized by using insecticides that are more toxic to the target pest than to the natural enemy. Classical biological control is the importation of natural enemies from other countries. This method has been effective where an exotic pest has entered Texas without its incumbent natural enemies, or to augment existent natural enemies of native pests.

Augmentation involves the purchase and release of natural enemies on a periodic basis. The most notable commercially available natural enemies include the egg parasite, *Trichogramma*, and the predators, lady beetles and lacewings. Although the control of both bollworms and tobacco budworms by the release of commercially reared *Trichogramma* wasps is theoretically possible, researchers have not been able to consistently achieve the level of parasitism necessary to reduce infestations below economically damaging levels. Multiple *Trichogramma* releases at high rates ranging from 50,000 to 150,000 parasitized eggs per acre were utilized in these studies. There are currently no economic thresholds established for augmentative releases of *Trichogramma* for bollworm/budworm control in cotton. Furthermore, parasite mortality from insecticides used to control

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other pests in or around parasite release areas would be a major factor adversely affecting the success of augmentative releases.

Research studies have shown that releasing large numbers of lacewing larvae (30,000 and more per acre) can reduce bollworm infestations below damaging levels. However, these release rates are currently cost prohibitive because of high production costs for rearing lacewings. The release of lacewing eggs has been less successful and there is little information on the efficacy of releasing adult lacewings in cotton. There is even less information pertaining to the utility of releasing either lady beetles or lacewings for the control of economically damaging infestations of aphids.

Because definitive information on the application of augmentation (when to apply, what density should be applied, etc.) is lacking, entomologists with the Texas Agricultural Extension Service cannot provide guidelines for the application of augmentation as a management tool in cotton.

CROP MANAGEMENT

The short-season cotton production system is crucial in reducing insect damage. This system includes cultural practices such as: 1) early, uniform planting of cotton varieties which bloom and set bolls early, mature rapidly and are ready to harvest 130 to 150 days from planting (refer to county cotton demonstrations for varieties that have performed well in your area); 2) optimum use of fertilizer and minimum irrigation; and 3) early, complete stalk destruction. These practices shorten the time that cotton is vulnerable to insect attack, minimize potential damage from adverse weather, and allow more time to prepare land for the next crop. Failure to implement these cultural practices will increase the probability of late-season boll weevil and bollworm outbreaks, increase the need for insecticides and cause larger populations of overwintering pests to develop. (See Early Stalk Destruction and Field Clean-up).

The first 30 days of blooming are critical for early boll set. The earliness factor in short-season production can be lost when damaging populations of insects occur as the first squares are fomed. Loss of first squares to overwintered boll weevils also will detract from short-season production. To ensure early fruit set, scout fields to determine pest population levels and plant damage, as well as beneficial insect numbers and cotton fruiting rate. Use chemical insecticides only when justified. Insecticides may destroy natural enemies of cotton insect pests, causing increased numbers of bollworms, tobacco budworms and spider mites.

Monitoring Cotton Growth and Fruiting Rate

To monitor fruiting rates, fields should be examined weekly or bi-weekly. During each visit, mark a point on a row and count 100 consecutive 1/3-grown or larger green squares; record the row feet required to gain that count. Later in the season when there are fewer squares, count 100 consecutive bolls, both green and open. Record the number of row feet required to make this count. To estimate the number of squares and/or bolls present per acre, divide the number of row feet counted into the number of row feet per acre (13,068 on 40-inch rows, 13,756 on 38-inch rows, 14,520 on 36-inch rows and 17,424 on 30-inch rows) and multiply by 100. Row feet per acre also can be obtained by dividing 522,720 by the row spacing in inches.

$$\text{Bolls and/or squares per acre} = \frac{13{,}068 \text{ or } 13{,}756 \text{ or } 14{,}520 \text{ or } 17{,}424}{\text{No. row feet examined}} \times 100$$

Table 1. Growth and fruiting rate of the cotton plant

Development period	Days per event[1]	Cumulative days from emergence	Accumulated heat units (DD 60's from planting required)[2]
Planting to emergence	4 to 10		59 to 159
Emergence to:			
first true leaf	7 to 9	7 to 9	127 to 205
sixth true leaf	23 to 27	23 to 27	321 to 608
pinhead square	27 to 30	27 to 30	378 to 663
Pinhead square to:			
matchead square	9 to 10	36 to 40	
1/3-grown square	12 to 16	39 to 46	508 to 996
1/3-grown square to:			
first white bloom	12 to 16	51 to 62	719 to 1129
first open boll	52 to 76	91 to 122	1857 to 2021
harvest	89 to 137	116 to 167	
Fully matured two-bale/acre crop			2500 to 2900
Boll development:			
fiber length established:		first 21 to 30 days	
fiber micronaire and strength determined:		second 20 to 60 days	
96% boll set period:		first 4 weeks bloom	
95% mature bolls:		129-163 days from planting	

[1] The rate of development is influenced by variety, planting date, weather, soil type and nutrient status.

[2] Calculated by the formula:

$$DD\ 60 = \frac{\text{high daily temperature} + \text{low daily temperature}}{2} - 60$$

For each day in which the result is a positive number, heat units are accumulated. For example, if the high for the day is 90 and the low is 60, then 90 + 60 = 150 divided by 2 = 75; 75 - 60 = 15; so 15 heat units would be accumulated for the day. This total would be added to those accumulated each day since planting to get accumulated heat units.

Early Stalk Destruction and Field Clean-up

Early harvest and stalk destruction are among the most effective cultural and mechanical practices for managing overwintering boll weevils if done on an areawide basis. These practices reduce habitat and food available to the boll weevil, pink bollworm, bollworm and tobacco budworm. Shred cotton at the earliest possible date and do not allow stubble, regrowth or volunteer seedlings to remain within fields or surrounding field margins or drainage system banks. Particular attention should be given to the destruction of green or cracked bolls and other plant debris left at the ends of rows following stripper harvest. Cotton present during the fall and winter months is illegal in the Rio Grande Valley and most counties in the Lower Coastal Bend, South Texas and the Blacklands (refer to "Cotton Pest Regulations" available from the Texas Department of Agriculture). This cotton provides the boll weevil with a host plant on which reproduction occurs throughout the year. Weevil infestations which are allowed to develop during the winter may be extremely difficult to control during the following season. If a thorough stalk destruction program is not carried out, the benefits of the pest management program can be reduced significantly.

The addition of 0.5 lb. methyl parathion or 0.25 lb. azinphosmethyl (Guthion®) to phosphate-type defoliants has proven effective in reducing potential overwintered boll weevils. Do not add methyl parathion or azinphosmethyl to chlorate-type defoliants because of the potential fire hazard. The use of insecticides at defoliation will be effective only if stalk destruction is promptly performed following harvest. If 3 to 4 weeks elapse between defoliation and stalk plow-up, the money spent on insecticides at defoliation will provide less benefit in boll weevil management. Weevils will continue to emerge, feed, reproduce and move from defoliated cotton fields following harvest.

Stalk Destruction Laws

Upon request and petition of Texas Cotton Producers, the Texas Legislature passed the Boll Weevil Control Law and the Pink Bollworm Quarantine Law in an effort to combat the two destructive cotton pests. These two laws, which are enforced by the Texas Department of Agriculture, require producers in a regulated county to culturally manage pest populations using habitat manipulation by planting and destroying cotton within an authorized time period. Appointed producers, who are members of local pest management zone committees, have established a series of cotton planting and stalk destruction deadlines for all producers in each regulated county.

The battle against pink bollworms has been extremely successful. Because farmers have adhered to authorized planting and stalk destruction deadlines over the past years, pink bollworm populations in most of the state have been reduced to levels that don't cause major economic damage. Boll weevil population control through stalk destruction efforts has been significant but progress has been slower. Strict adherence to the established deadlines is critical to success of boll weevil management.

SCOUTING AND MANAGEMENT DECISIONS

Regular field scouting is a vital part of any pest management program because it is the only way reliable information can be obtained to determine if and when pest numbers reach the economic threshold. Scouting involves more than just "checking bugs." It determines the insect density and damage levels through the use of standardized, repeatable sampling techniques. It is also a reliable way to monitor plant growth, fruiting, beneficial insect activity, weeds, diseases and the effects of implemented pest suppression practices.

Control measures are needed when a pest population reaches a level at which further increases would result in excessive yield or quality losses. This level is known as the "economic threshold" or treatment level. The relationship between pest level, amount of damage and ability of the cotton plant to compensate for insect damage is greatly influenced by crop phenology and seasonal weather. The economic threshold is not constant but varies with factors such as price of cotton, cost of control and stage of plant development.

Field inspections should be made every 3 to 7 days using the scouting procedures described in this guide for the various pests. When a cotton field is properly scouted, accurate and timely decisions can be made to optimize control efforts while minimizing risk.

The following general discussion briefly reviews the insect pests of cotton (for more detail see B-933,"Cotton Insects"). The insect pests are discussed as they normally would occur throughout the cotton production season.

EARLY-SEASON PESTS

Early-season is the time from plant emergence to first 1/4-inch diameter (1/3-grown) squares. Major early-season pests include thrips, aphids, fleahoppers and overwintered boll weevils.

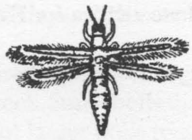
Cotton Square Diameter

1/16-Inch **3/16-Inch** **1/4-Inch**

Pinhead **Matchhead** **1/3-grown**

Scouting and management of early-season insect pests are extremely important, particularly in a short-season production scheme. Loss of early squares may prolong the length of the growing season required to get adequate fruit set.

Thrips



Thrips are slender, straw colored insects about 1/15 inch long, with rasping and sucking mouthparts. Adults are winged. Thrips attack leaves, leaf buds and very small squares, and may cause a silvering of the lower leaf surface, deformed or blackened leaves, terminal loss and square loss.

Under cool, wet conditions heavy thrips infestations may delay fruiting and crop maturity because of slowed plant growth and increased thrips damage. Generally, about the time thrips reach damaging numbers, favorable growing conditions negate the need for control.

Management and decision making. Only in the Blacklands and the northernmost region of the Upper Gulf Coast (Fort Bend County) has insecticide treatment for thrips been shown to be economically justified in years when heavy infestations of thrips have occurred. Inspect cotton from the cotyledons through the 4 true-leaf stage for thrips. If thrips are present and new leaves are curled, insecticide treatment may be justified. Thrips also can be controlled by applying systemic insecticides as seed-planterbox treatments or as granules in the seed furrow (see Systemic Insecticides for Early-Season Pests). Disulfoton (Di-Syston®) seed treatment will effectively control thrips for 2 to 3 weeks following plant emergence. Disulfoton, phorate (Thimet®) and aldicarb (Temik®) granules applied in the seed furrow will control these pests for 4 to 8 weeks following planting; however, use at the higher labeled rates sometimes results in greater numbers of bollworms and tobacco budworms later in the season.

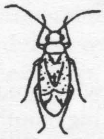
Aphids

Three species of aphids, or plant lice, feed on cotton plants: the cotton aphid, the black cowpea aphid and the green peach aphid. Cowpea aphids are shiny black with white patches on the legs and are common on seedling plants. Aphid infestations can occur from plant emergence to open boll. Aphids usually are found on the undersides of leaves, on stems, in terminals and sometimes on fruit. Heavy and prolonged infestations can cause leaves to curl downward and older leaves to turn yellow and shed.

Natural control by unfavorable weather, predators, parasites and pathogens can be effective in holding populations below damaging levels. Sometimes aphid numbers increase to moderate or heavy levels and then decline for no apparent reason.

Management and decision making. Insecticide treatment may be necessary if infestations are approaching heavy levels in large areas of the field and natural control has not been sufficient to limit aphid buildup. There is some risk that treating aphids will create favorable conditions for bollworm outbreaks. Therefore, make sure insecticide treatment is necessary before beginning applications. (See Systemic Insecticides for Early-Season Pests.)

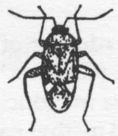
Cotton Fleahopper



Adult fleahoppers are about 1/8-inch long and pale green. Nymphs resemble adults but lack wings and are light green. They move very rapidly when disturbed. Adults move into cotton from host weeds when cotton begins to square. Both adults and nymphs suck sap from the tender portions of the plant, including small squares. Pinhead size and smaller squares are most susceptible to damage.

Management and decision making. The decision to apply insecticide should be based upon the number of fleahoppers present, cotton fruting rate and percent square set. As the first small squares appear (approximately 4- to 6-leaf stage), examine the main stem terminal buds (about 3 to 4 inches of plant top) of 25 plants at each of at least four locations across the field. More sites should be sampled in fields larger than 80 acres. **During the first 3 weeks of squaring, 10 to 15 fleahoppers per 100 terminals may cause economic damage in the Blackland area. In other areas, 15 to 25 fleahoppers per 100 terminals is considered economically damaging.** As plants increase in size and fruit load, larger numbers of fleahoppers may be tolerated without yield reduction. When plants are blooming, fleahopper control is rarely justified. In addition, insecticides applied early in the blooming period may result in outbreaks of bollworms and tobacco budworms because of the destruction of predaceous insects and spiders. Use suggested higher application rates only when infestations are severe.

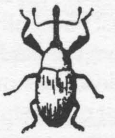
Tarnished Plant Bug (*Lygus* spp.)



The tarnished plant bug is one of several *Lygus* species that feed on cotton terminals, squares and small bolls. Adults are winged, vary in color from greenish to brown and are about 1/4 inch long. They prefer legumes to cotton and usually are found in large numbers in areas of alfalfa production. Lygus bugs are attracted to succulent growth; their feeding results in shedding of squares and small bolls, stunted growth and boll deformation. Damage shows up in white blooms as black anthers and puckered areas in petals.

Management and decision making. The need for lygus bug control is determined by their abundance in relation to the fruiting condition of the cotton plants. Inspect fields at 4- to 5-day intervals during the first 6 weeks of squaring. Take 50 sweeps at each of the four locations in the field by sweeping a 15- to 16-inch net across the top of one row only in such a way that the top 10 inches of the plants are struck. **During the first 6 weeks of squaring, control measures should be considered when lygus bug numbers average 10 (count nymphs as two) per 50 sweeps on more than two successive sampling dates.**

Overwintered Boll Weevil



Overwintered boll weevils emerge from winter hibernation and enter cotton early in the season. They occur in very low numbers and females lay few eggs until first squares are about 1/4 inch in diameter (1/3-grown). Insecticides applied at this time (see control suggestions) will help suppress boll weevil population buildup until after peak bloom. In many years this allows the plant to set a large number of bolls early, while having little adverse effect on mid- and late-season beneficial insects.

The need for insecticide applications to suppress overwintered boll weevils can be determined by: 1) pheromone trap collections as discussed below; 2) field scouting results; or 3) the history of the field. In some regions insecticides are automatically applied, particularly in fields bordered by wooded or brushy areas which serve as overwintering habitats.

Six to eight pheromone traps are required for a field of 50 to 300 acres. Traps should be evenly spaced around the field margin. The treatment decision is based on the "Trap Index" (TI) and scouting information. The TI is calculated by averaging the number of weevils captured per trap each week, then adding these averages together for the 6 weeks prior to the first 1/3-grown square stage. The following TI's were developed using the Hardee trap, and can be used for making treatment decisions in the Corpus Christi area (Nueces, San Patricio, Kleberg, Refugio and Jim Wells Counties). They should not be used in other areas.

Trap Index	Decision
Fewer than 1 weevil/trap	Do not treat.
1 to 2.4 weevils/trap	Do not treat unless damage and/or adult weevils are found.
More than 2.4 weevils/trap	Treat just before first 1/3-grown square and again 4 or 5 days later. A third application may be necessary in some fields.

Management and decision making. Control measures should be taken in fields where at least one weevil is found by the 1/3-grown-square stage, where pheromone trap results indicate the need for treatment, and/or where the field has a history of boll weevil infestations. These early applications should not be made in fields far from overwintering sites or where population buildup in past years has not occurred. As the plant develops and matchhead (3/16-inch diameter) squares are present, the field should be scouted for the presence of adult boll weevils. Inspect at least 100 plants in the portion of the field where plants are largest and/or nearest to overwintering habitats. If a single boll weevil is found, the economic threshold level has been reached, and an insecticide should be applied to prevent egg laying. Where possible, band insecticides over the row. The second application should be made 4 to 5 days after the first. Do not make this application within 10 days of bloom to allow beneficial insect and spider populations time to reestablish in anticipation of bollworm infestations. There is always a risk of increased bollworm activity after these treatments.

MID-SEASON AND LATE-SEASON PESTS

Mid-season is the 6-week fruiting period following the appearance of the first 1/4-inch diameter (1/3-grown) squares. Proper crop management and frequent field inspection for pests and beneficials will eliminate unnecessary insecticide applications during this period. This procedure ensures adequate fruit set and preserves beneficial insects.

Late-season is the remainder of the production season when the major concern is boll protection, as long as immature bolls that can be expected to mature are present. Heavy irrigation and high rates of fertilizer prolong cotton plant growth and increase the chance of late-season insect damage. Short-season cotton production schemes should avoid these practices.

Bollworms, tobacco budworms and boll weevils are the principle insect pests in mid- and late-season. A major goal of a well-planned pest management program (although not always achieved) is to avoid having to treat for bollworms and tobacco budworms. Naturally occurring parasites and predators and certain weather conditions often suppress bollworm and budworm populations. For this reason, chemical control for the boll weevil at this time of year should be avoided if possible. If a satisfactory fruit set occurred during the first 30 days of blooming, higher numbers of weevil-damaged squares can be tolerated. However, if fruiting is delayed, additional insecticide applications may be necessary to protect smaller bolls that are expected to mature. Fewer boll weevil-damaged bolls can be tolerated if cotton is to be picked instead of stripped.

Boll Weevil

Adult weevils puncture squares or bolls both for feeding and egg laying. Egg laying punctures can be distinguished from feeding punctures by the presence of a wart-like plug which the female places over the feeding site after she has deposited an egg in the cavity. The female deposits an average of 100 eggs during her life span of about 30 days.

Eggs hatch into larvae (grubs) within 3 to 5 days under mid-summer conditions. Grubs transform into pupae within the square or boll in approximately 7 to 11 days. Adults emerge 3 to 5 days later. Recently emerged adults feed on squares or bolls for 4 to 8 days before mating and laying eggs. The time required for development from egg to adult under summer field conditions averages 17 days, with a complete generation occurring in 21 to 25 days.

Punctured squares flare open and usually fall to the ground within a week. Small bolls that are punctured may also fall to the ground, but larger bolls remain on the plant.

When direct sunlight and hot, dry conditions cause fallen squares to dry out rapidly, large numbers of weevil larvae do not survive.

Boll weevil damage reaches its highest level late in the growing season. As cotton plants mature and the number of squares is reduced, the percentage of boll weevil-damaged squares becomes an unrealistic indicator of damage because boll weevils are competing for squares. As square numbers decrease, boll weevils may cause more damage to small bolls.

Management and decision making. Refer to the overwintered boll weevil section above before the first 1/4-inch diameter (1/3-grown) squares are present in the field. Later in the season, at weekly intervals, inspect 100 squares that are at least 1/3-grown. Take squares from at least four representative locations in the field and from various portions of the plants. **If 15 to 25 percent of the squares are weevil-damaged from the time of squaring to peak bloom, the economic threshold level has been reached and insecticide application is necessary.** It may be necessary to repeat applications at 5-day intervals, or at 3-day intervals if weevil population buildup is extremely heavy.

After peak bloom, if 60 percent or more of the bolls are at least 30 mm (1 1/4 inch) in diameter, higher rates of damaged squares can be tolerated. However, additional applications may be necessary to protect smaller bolls if they are to be harvested Where economic weevil infestations are encountered, protect bolls until the last bolls expected to be harvested are 12 to 15 days old.

Fire ants are effective predators of boll weevil larvae and pupae, although they will not prevent adults from migrating into the field and laying eggs. Fire ants can be sampled by the beat bucket method. Insecticides usually are not needed for boll weevil control when an average of four or more fire ants is collected per 10 terminal samples.

Bollworm and Tobacco Budworm

Bollworm and tobacco budworm larvae are similar in appearance and cause similar damage. Full-grown larvae are about 1 1/2 inches long and vary in color from pale green to pink or brownish to black, with longitudinal stripes along the back.

Tobacco budworm and bollworm moths are attracted to and lay eggs readily in cotton that is producing an abundance of new growth. Moths usually lay eggs singly on the tops of young, tender terminal leaves in the upper third of the plant. Eggs are pearly white to cream colored and about half the size of a pinhead. These should not be confused with looper eggs, which are flatter and usually laid singly on the undersides of leaves. Eggs hatch in 3 to 4 days, turning light brown before hatching. Young worms usually feed for a day or two on tender leaves, leaf buds and small squares in the plant terminal before moving down the plant to attack larger squares and bolls. When small worms are in the upper third of the plant, they are most vulnerable to control by insecticides and beneficial insects and spiders.

Sometimes moths deposit eggs on squares, bolls, stems and, in general, on lower parts of the plant. This may occur when cotton plants are stressed and making little new growth, or during periods of high temperatures and low humidity. Detection and control of eggs and small worms are more difficult when eggs are deposited in these locations.

Budworms are more resistant to insecticides than bollworms. Budworms are less numerous than bollworms early in the crop season and rarely reach high numbers until mid- to late season. Once certain kinds of conventional insecticides are used to control bollworms and budworms, the percentage of budworms in the infestation increases with each additional application because of selection pressure. Aphid and other secondary pest infestations may increase following bollworm/budworm sprays, especially when pyrethroids are used.

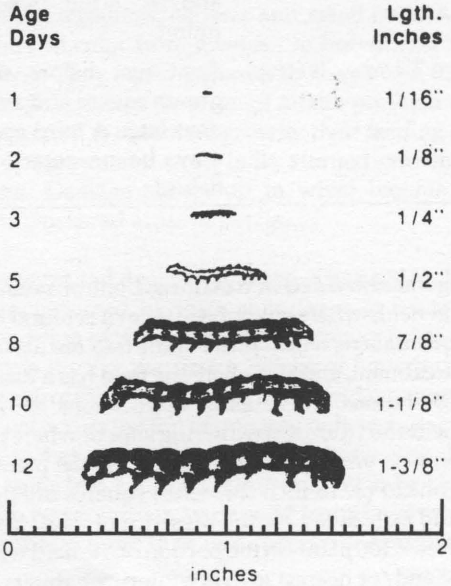
Management and decision making. Fields should be carefully scouted at least once a week and twice weekly during peak periods of egg deposition. Eggs and newly hatched worms are usually found in the plant terminals and indicate possible outbreaks. Natural mortality agents such as weather and predators frequently control these stages before any damage occurs. Once worms are 1/2 inch long, natural control factors are much less effective.

Frequently, examination of the upper third (terminal) of the plant (leaves, stems, squares, blooms and bolls) for eggs and small larvae is all that is needed to make a sound management decision. However, moths sometimes deposit eggs on the fruit and stems lower on the plant. This may occur when cotton plants are stressed and making little new growth, or during periods of high temperatures and low humidity. Detection and control of eggs and small worms are more difficult when eggs are deposited throughout the plant. Also, as bollworm/budworm larvae increase in size, they attack fruit lower on the plant. Whole plant inspections are, therefore, necessary to detect larger larvae.

Two methods are presented below for assessing bollworm/budworm infestations. The Terminal/Square Inspection Method can be used when infestations are concentrated in the terminal (upper 1/3 of the plant). The Whole Plant Inspection Method can be used when eggs and worms are found throughout the plant.

BOLLWORM IDENTIFICATION

Actual size of Heliothis
larvae of known age



Terminal/Square Inspection Method: Divide the field into four quadrants and examine 25 plant terminals (upper 1/3 of the plant), selected at random from each quadrant, for small larvae and eggs. Also, from each quadrant, examine 25 one-half grown and larger green squares for bollworms and bollworm damage. Squares should be selected at random and flared or yellow squares should not be included in the sample.

Before first bloom, insecticide application may be justified when 15 to 25 percent of the green squares are worm damaged. If bolls are present, treatment may be justified when 8 to 10 percent of the green squares are worm damaged.

If previous insecticide applications have eliminated natural enemies, fewer bollworms/budworms can be tolerated before economic damage occurs. **If insecticides have been applied after first bloom and have eliminated natural enemies, treatment may be justified when infestations reach or exceed 4 to 5 small worms plus eggs per 100 terminals and 5 percent of the squares and small bolls have been damaged by worms.**

Microbial insecticides may be considered during the squaring period through the first 10 days of blooming if infestations average 12 or fewer small (less than 1/4 inch) bollworms per 100 terminals. Unlike conventional insecticides, microbial insecticides do not destroy predators and parasites (see Microbial Insecticides, p. 11).

Whole plant inspection method. Divide the cotton field into four or more manageable sections depending upon field size. Make whole plant inspections of five randomly chosen groups of three adjacent cotton plants in each section. Count the number of eggs, worms and key predators per acre using the following formula:

$$\text{Worms, eggs or key predators per acre} = \frac{\text{No. eggs, worms or key predators counted}}{\text{No. of whole plants checked}} \times \text{No. of plants per acre}$$

The number of plants per acre is calculated from counts of plants on at least 10 feet of row in four locations in the field. The number of row feet per acre (see Monitoring Cotton Fruiting Rate) divided by the number of row feet examined multiplied by the number of plants counted equals the plants per acre.

Treatment may be justified when counts average 5,000 or more small worms per acre. However, if two or more key predators are found for each small worm, control measures may not be needed or microbial insecticide may be used (see Microbial Insecticides). The actual treatment level will vary according to the ability of the individual scout to locate small larvae, the age structure of the infestation, maturity of the crop and crop value.

Tarnished Plant Bug (*Lygus* spp.)

Lygus bugs can continue to damage the late-season crop. Use the same sampling techniques and chemical control suggestions given in the previous section.

Management and decision making. Begin treatment when lygus bug counts exceed 20 to 30 per 50 sweeps (count nymphs as two) in fields where plants failed to retain squares and set bolls normally during the first 4 to 5 weeks of fruiting.

Aphids

The cotton aphid is the most common aphid infesting cotton during mid- and late season. Aphids usually are found on the undersides of leaves, on stems, in terminals and sometimes on fruit. Heavy and prolonged infestations can cause leaves to curl downward and older leaves to turn yellow and shed, squares and small bolls to shed, and bolls to open prematurely, resulting in incomplete fiber development.

Honeydew excreted by the aphids can drop on fibers of open bolls. A black, sooty fungus sometimes develops on honeydew deposits during wet periods. Fiber from such bolls is stained, sticky and of lower quality, resulting in difficult harvest, ginning and yarn spinning.

Natural control by unfavorable weather, predators, parasites and pathogens can be effective in holding populations below damaging levels. Sometimes aphid numbers increase to moderate or heavy levels and then decline for no apparent reason.

Management and decision making. Insecticide treatment may be necessary if infestations are approaching heavy levels in large areas of the field and natural control has not been sufficient to limit aphid buildup. There is some risk that treating for aphids will create favorable conditions for bollworm outbreaks. Therefore, make sure insecticide treatment is necessary before beginning applications. (See Systemic Insecticides for Early-Season Pests.)

OCCASIONAL PESTS

Cutworms

Cutworms may damage cotton during the seedling stage, and control will be necessary if stands are threatened. The economic threshold is a matter of judgment. Keep fields as weed-free as possible 3 weeks before planting to minimize cutworm problems. Plow under cover crops at least 3 weeks before planting. Insecticide sprays or baits are recommended for band application over the drill. If the ground is dry, cloddy or crusty at the time of treatment, control may not be as effective as in moist soil.

Beet Armyworm

Beet armyworm eggs are laid on both leaf surfaces in masses covered by a whitish, velvety material. Young beet armyworms "web up" and feed together on leaves, but eventually disperse and become more solitary in their feeding habits. Early-season infestations feed on leaves and terminal areas. Occasionally they destroy the plant terminal, causing extensive lateral branch development and delayed maturity. Larvae skeletonize leaves rather than chewing large holes in them. Damaging infestations sometimes develop late in the season when beet armyworms also feed on terminals, squares, blooms and bolls. When beet armyworms begin to damage fruit, control may be justified. Infestations usually are spotty within a field, and careful scouting is necessary to determine the need for, and field area requiring, control. Beet armyworms longer than 1/2 inch may be difficult to control.

Management and decision making. Scout the field using the Whole Plant Inspection Method described in the bollworm and tobacco budworm section. **When small worm counts exceed 20,000 per acre and at least 10 percent of the plants examined are infested, control may be warranted.**

Spider Mites

Spider mites infest the undersides of leaves, where they remove the sap from the plant and cause the leaves to discolor. They may also infest bracts of squares and bolls, causing the bracts to desiccate and squares or small bolls to shed. Severe infestations can defoliate the cotton plant. Mite infestations most often occur in spots and in field margins. Increased spider mite populations usually follow multiple applications of insecticides for other pests, since insecticides destroy natural spider mite predators.

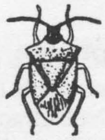
Management and decision making. Treat when mites begin to cause noticeable leaf damage. Spot treatment of fields is encouraged when infestations are restricted to small areas. Two applications at 5-day intervals may be required for acceptable control. In certain locations, some mite species are highly resistant to miticides and are difficult to control with available materials.

Cabbage Looper, Soybean Looper, Cotton Leafworm

Moths of these species lay eggs singly, mainly on the lower surfaces of leaves. Larval feeding damage is characterized by leaf ragging or large holes in the leaves. Larvae often are killed by a disease before economic foliage loss occurs.

Management and decision making. An economic threshold for these pests has not been established. **As a general guideline, treat when 10 percent of the "key leaves" are infested with worms.** The key leaf is the third one down the main stem from the tip (usually the highest leaf on the plant).

Stink Bugs



Several species of stink bugs feed on squares and bolls. Feeding on bolls may cause boll shed and/or seed damage and lint staining.

Management and decision making. Examine 10 row feet of cotton in several locations in the field. **When there is an average of five or more stink bugs per 10 feet of row, feeding can cause excessive loss of squares and small bolls and may stain lint.** Stink bugs often are clumped near field margins. Spot treatment provides effective control when this situation exists.

Grasshoppers

A number of grasshopper species are occasional cotton pests. They generally move into fields from adjacent fence rows, ditch banks or field margins.

Management and decision making. Twenty or more grasshoppers per square yard in crop margins or ten or more per 3 row feet in the field are suggested treatment levels if there are signs that the species is feeding on cotton.

Other Pests

Fall armyworms, yellowstriped armyworms, cotton square borers and salt marsh caterpillars rarely cause economic damage.

Management and decision making. Economic thresholds have not been established for these pests. Control is a matter of individual judgment.

SYSTEMIC INSECTICIDES FOR EARLY-SEASON PESTS

In areas where early-season pests such as thrips, aphids, spider mites and leaf miners consistently damage young cotton each year, preventive systemic insecticides are sometimes used instead of postemergence sprays. In choosing either approach to early-season pest control, key factors to consider include acreage, yield potential, available equipment and labor, knowledge of cotton pests and beneficial species, difficulties in getting a stand, drought tendencies, etc. Both the limitations and advantages of systemics used at planting should be evaluated carefully before choosing their use over postemergence insecticides.

Limitations of Systemics

- The decision to invest in systemics must be made before the severity of the early-season pest problem can be known; therefore, the net economic return is uncertain.
- If replanting is necessary, the initial systemic treatment is lost and a new treatment at additional expense is required.
- Continued pest exposure to and population selection by certain systemics may result in accelerated development of resistance to these and related insecticides.
- Excessive rates of systemics may result in increased numbers of damaging pests after the effective control period. This increase may be a result of reduced numbers of beneficial insects and/or stimulation of attractive plant growth.
- Under conditions unfavorable for plant emergence, such as poor seed quality, planting too deeply, seedling disease or cool, wet weather, some systemics used at planting time may contribute to further stand reduction.
- Special application equipment is required for granular systemics.

Advantages of Systemics

- For the producer who is unable to check his fields regularly for pest buildups during the early-season, and therefore cannot apply post-emergence pesticides based upon actual need, systemics offer a degree of protection during the first few weeks of growth.
- Using systemics frees labor and equipment and reduces the need to make pest control decisions during the protected period.
- Under optimum conditions, systemics often stimulate rapid early growth and sometimes cause yield increases which apparently cannot be attributed to early-season insect control alone.
- Protection from early-season insect damage may result in earlier and more uniform maturity, which may be important during years of deficient moisture or insect buildups late in the season.
- The activity of systemics within the plant is relatively unaffected by rain and weathering during their normal period of effectiveness.
- Systemics are effective when inclement weather precludes sprayer operation.

OVICIDES

These insecticides effectively reduce numbers of bollworm and tobacco budworm eggs. Because large numbers of eggs often fail to produce economically damaging worm infestations, **insecticidal control of eggs alone is not recommended**. Environmental factors such as hot, dry weather can significantly reduce field levels of eggs. Some other important natural control factors include predaceous insects and spiders and parasitic wasps. Natural egg control can vary greatly between fields and times of the season. Often, high numbers of sterile eggs are found. If larval infestations exceed suggested treatment levels and large numbers of eggs are present, the addition of an ovicide to the larvicide may be justified to enhance overall control.

MICROBIAL INSECTICIDES

Microbial products which are natural pathogens of the bollworm and the tobacco budworm are commercially available as preparations of *Bacillus thuringiensis (B.t.)*. Field studies indicate that microbials are best suited for square protection. They are slow acting and should be used only against infestations of worms during the squaring period through the first 10 days of blooming. They are not suggested for use after that point. Microbials are effective against worm numbers up to 12 per 100 plants (6,000 per acre). They do not destroy beneficial arthropods (predators and parasites), a characteristic which sets them apart from conventional insecticides. When beneficial arthropod populations are absent, other insecticides provide more consistent control.

Treat fields in which most of the larvae are not more than 1/4 inch long. Infestations of larger worms should not be treated with microbials. Maximum effectiveness with *B.t.* requires precise sampling of cotton plants during the fruiting period. Sampling should be conducted at least twice a week while squares are developing. Apply microbials with ground equipment at the rate of 5 to 15 gallons of liquid per acre, or by air using 2 to 5 gallons per acre. Good coverage is essential.

Table 2. Registered *Bacillus thuringiensis* products and labeled rates for controlling bollworm and tobacco budworm.

Product	Rate per acre (formulated material)
Biocot XL	0.33-2.33 pts.
Biocot XLP	0.5-3.5 pts.
Condor	0.5-1.67 qts.
Dipel 2X	0.5-2.0 lbs.
Dipel ES	1.0-2.5 pts.
Dipel ES-NT	1.0-2.5 pts.
Design	1.0-2.0 lbs.
Javelin	0.25-1.5 lbs.
MVP	2.0 qts.

PROTECTING BEES FROM INSECTICIDES

Pollination is extremely important in producing many seed crops such as alfalfa, clover and vetch. Honey bee pollination also is critical in the production of cucurbits throughout the state, and supplements native pollinators. The role of honey bees and wild pollinators in contributing to increased yield and fiber length of cotton is unclear. The importance of insect pollinators in the production of hybrid cottons is well recognized, however.

Where pollinating insects are required for flower fertilization, the crop producer, insecticide applicator and beekeeper should cooperate closely to minimize bee losses. The following guidelines will reduce bee losses:

1. Apply insecticides, if practical, before bees are moved into fields or adjacent crops for pollination. When bees are in the vicinity, evening applications after bees have left the field are less hazardous than early morning applications.

2. Where insecticides are needed, consider their toxicity. "Highly toxic" insecticides include materials that kill bees on contact during application or for several days following application. Insecticides categorized as "Moderately toxic" or "Relatively non-toxic" should be applied in late evening or early morning when bees are not foraging.
3. To prevent heavy losses of bees, avoid drifting or spraying any insecticide directly on colonies. Bees often cluster on the fronts of their hives on hot evenings. Pesticide drift or direct spray at this time generally results in high levels of mortality.

POLICY STATEMENT FOR MAKING PEST MANAGEMENT SUGGESTIONS

The information and suggestions included in this publication reflect the opinions of Extension entomologists based on field tests or use experience. Our management suggestions are a product of research and are believed to be reliable. However, it is impossible to eliminate all risks. Conditions or circumstances which are unforeseen or unexpected may result in less than satisfactory results even when these suggestions are used. The Texas Agricultural Extension Service will not assume responsibility for such risks. Such responsibility shall be assumed by the user of this publication.

Suggested pesticides must be registered and labeled for use by the Environmental Protection Agency and the Texas Department of Agriculture. The status of pesticide label clearances is subject to change and may have changed since this publication was printed. County Extension agents and appropriate specialists are advised of changes as they occur.

The **USER** is always responsible for the effects of pesticide residues on his livestock and crops, as well as problems that could arise from drift or movement of the pesticide from his property to that of others. Always read and follow carefully the instructions on the container label.

For additional information, contact your county Extension staff or write the Extension Entomologist, Entomology Department, Texas A&M University, College Station, Texas 77843, (409) 845-7026.

ENDANGERED SPECIES REGULATIONS

The Endangered Species Act is designed to protect and to assist in the recovery of animals and plants that are in danger of becoming extinct. In response to the Endangered Species Act, many pesticide labels now carry restrictions limiting the use of products or application methods in designated biologically sensitive areas. These restrictions are subject to change. Refer to the Environmental Hazards or Endangered Species discussion sections of product labels and/or call your local county Extension agent or Fish and Wildlife Service personnel to determine what restrictions apply to your area. Regardless of the law, pesticide users can be good neighbors by being aware of how their actions may affect people and the natural environment.

WORKER PROTECTION STANDARD

The Worker Protection Standard (WPS) is a set of new federal regulations that applies to all pesticides used in agricultural plant production. If you employ any person to produce a plant or plant product for sale and apply any type of pesticide to that crop, WPS applies to you. Beginning January 1, 1995, you must comply with all WPS regulations. The WPS requires you to protect your employees from pesticide exposure. It requires you to provide three basic types of protection for your employees: you must inform employees about exposure, protect employees from exposure, and mitigate pesticide exposures that employees might receive. In 1995 all agricultural pesticides will bear a Worker Protection Standard statement on the label. It will appear in the "DIRECTIONS FOR USE" part of the label. For more detailed information, consult EPA publication 735-B-93-001 (GPO #055-000-0442-1) *The Worker Protection Standard for Agricultural Pesticides -- How to Comply: What Employers Need to Know*, or call Texas Department of Agriculture, Pesticide Worker Protection Program, (512) 463-7717.

ADDITIONAL REFERENCES

Number	Title
B-933	Cotton Insects ($5.00)
B-1209	Management of Cotton Insects in the High Plains, Rolling Plains and Trans Pecos Areas of Texas
B-1210	Management of Cotton Insects in the Lower Rio Grande Valley
B-1593	Cotton Harvest-Aid Chemicals
MP-1576	Use of Pheromone Traps in Management of Overwintered Boll Weevil on the Lower Gulf Coast of Texas (Texas Agricultural Experiment Station)

These publications can be obtained through your county Extension office or ordered from the Texas Agricultural Extension Service, Distribution and Supply, P. O. Box 1209, Bryan, Texas 77806.

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5M—2-95, Revision

ENT, AGR 2

Suggested Insecticides for Management of Cotton Insects

in the Southern, Eastern and Blackland Areas of Texas

Roy D. Parker, Allen Knutson, Raymond L. Huffman, Christopher G. Sansone and Jim Swart*

A committee of state and federal research scientists and Extension specialists meets annually to review cotton pest management research and management guidelines. Guidelines are revised at this meeting to reflect the latest proven techniques for maximizing profits for the Texas cotton producer by optimizing inputs and production.

Management of Cotton Pests

The proper management of cotton pests is dependent upon the use of pest management principles. Pest management does not rely solely on insecticides. Therefore, the USER of this insert is strongly encouraged to refer to B-1204 for discussion of pest biology, scouting techniques, economic thresholds, insecticide resistance management, conservation of existing natural control agents, overall crop management practices which do not promote pest problems, ovicide use, microbial insecticide use, and guidelines for protecting bees from insecticides. If the insecticide recommendations in this insert are followed without regard to the other management techniques listed in B-1204, there is a risk of misusing insecticides, resulting in adverse economic and environmental consequences.

Policy Statement for Making Insecticide Use Recommendations

This is not a complete listing of all products registered for cotton or their uses. The insecticides and their suggested use patterns included in this publication reflect a consensus of opinion of Extension entomologists based on field tests. The data from these field tests met the minimum requirements as outlined in the Guidelines for the Annual Entomology Research Review and Extension Guide Revision Conference. Products listed must conform to our performance standards and avoid undue environmental consequences.

Suggested insecticide use rates have exhibited sufficient efficacy in tests to be effective in providing adequate control in field situations. However, it is impossible to eliminate all risks. Conditions or circumstances which are unforeseen or unexpected may result in less than satisfactory results. Weather, crop condition, pest situation and insecticide application can all have an impact on an insecticide's expected performance. The Texas Agricultural Extension Service will not assume responsibility for such risks. Such responsibility shall be assumed by the user of this publication.

Suggested pesticides must be registered and labeled for use by the Environmental Protection Agency and the Texas Department of Agriculture. The status of pesticide label clearances is subject to change and may have changed since this publication was printed. County Extension agents and specialists are advised of changes as they occur.

The USER is always responsible for the effects of pesticide residues on his livestock and crops, as well as problems that could arise from drift or movement of the pesticide from his property to that of others. The user is also responsible for preventing groundwater contamination by using the correct amount of pesticide, being cognizant of potential leaching or runoff problems and safe disposal of leftover pesticide and containers. Always read and follow carefully the instructions on the container label. Pay particular attention to those practices which ensure worker safety.

For additional information, contact your county Extension staff or write the Extension Entomologist, Entomology Department, Texas A&M University, College Station, TX 77843; or call (409) 845-7026.

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Extension entomologists, and Extension agents-entomology, The Texas A&M University System.

Table 1. Insecticide suggestion table.

Pest	Insecticides (listed alphabetically)	Insecticide class[1]	Pounds active ingredient per acre[2]	Formulated amount per acre	Precaution status[3]	Re-entry interval (hrs)[4]	Honey bee hazard[5]
Cutworms	Carbaryl	C					
	(Sevin® 5% bait)		1.5	30 lbs	C	*	H
	Chlorpyrifos	OP					
	(Lorsban® 4E)		0.75-1.0	1.5-2 pts	W	24	H
	Cyhalothrin	SP					
	(Karate® 1.0E)		0.02-0.03	2.56-3.84 oz	D	24	H
	Cypermethrin	SP					
	(Ammo® 2.5E)		0.04-0.1	2-5 oz	C	12	H
	Esfenvalerate	SP					
	(Asana XL® 0.66E)		0.03-0.05	5.8-9.7 oz	W	12	H
	Methyl Parathion (4E)	OP	1.0	32 oz	D	48***	H
	Methyl Parathion (7.5E)		1.0	17 oz	D	48***	H
	Permethrin	SP					
	(Ambush® 2.0E)		0.1-0.2	6.4-12.8 oz	W	12	H
	(Pounce® 3.2E)		0.1-0.2	4-8 oz	W	12	H
	(Ambush® 25W)		0.1-0.2	6.4-12.8 oz	W	12	H
	(Pounce® 25WP)		0.1-0.2	6.4-12.8 oz	W	12	H
Thrips (Granular in-furrow applications; based on 40-inch row spacing)	Acephate	OP					
	(Payload 15G)		0.75-1.0	5.0-6.67 lbs	C	*	**
	Aldicarb	C					
	(Temik® 15G)		0.3-0.55	2.5-4.5 oz/1000 ft of row	D	*	*
	Disulfoton	OP					
	(Di-Syston® 15G)		0.6	5 oz/1000 ft of row	D	*	**
	Phorate	OP					
	(Thimet® 20G)		0.5	3 oz/1000 ft of row	D	*	**
(Post emergence sprays)	Acephate	OP					
	(Orthene® 90S)		0.094-0.188	1.67-3.34 oz	C	24	H
	Azinphosmethyl	OP					
	(Guthion 2L)		0.125	8 oz	D	48***	H
	Dicrotophos	OP					
	(Bidrin® 8E)		0.05-0.1	0.8-1.6 oz	D	48***	H
	Dimethoate	OP					
	(Cygon® 4E)		0.125-0.25	4-8 oz	W	12	H
	(Dimate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	(Dimethoate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	Methyl Parathion (4E)	OP	0.125-0.25	4-8 oz	D	48***	H
	Methyl Parathion (7.5E)		0.125-0.25	2.1-4.3 oz	D	48***	H
Fleahoppers	Acephate	OP					
	(Orthene® 90S)		0.188-0.25	3.34-4.44 oz	C	24	H
	Chlorpyrifos	OP					
	(Lorsban® 4E)		0.19-0.5	6-16 oz	W	24	H
	Dicrotophos	OP					
	(Bidrin® 8E)		0.05-0.2	0.8-3.2 oz	D	48***	H
	Dimethoate	OP					
	(Cygon® 4E)		0.125-0.25	4-8 oz	W	12	H
	(Dimate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	(Dimethoate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	Methomyl	C					
	(Lannate® 2.4LV)		0.113-0.225	6-12 oz	D	72	H
	Methyl Parathion (4E)	OP	0.1-0.25	3.2-8 oz	D	48***	H
	Methyl Parathion (7.5E)		0.1-0.25	1.7-4.3 oz	D	48***	H
	Oxamyl	C					
	(Vydate® 2L)		0.25	16 oz	D	48	H
	(Vydate® 3.76C-LV)		0.25	8.5 oz	D	48	H
	Oxydemetonmethyl	OP					
	(Metasystox-R® 2E)		0.25	16 oz	W	48***	M
	Parathion (4E)	OP	0.1-0.25	3.2-8 oz	D	7 days	H
Cotton Aphids §§	Acephate	OP					
	(Orthene® 90S)		0.5-1.0	8.89-17.78 oz	C	24	H
	Chlorpyrifos	OP					
	(Lorsban®4E)		0.25-1.0	8-32 oz	W	24	H

*Refer to federal label for specific field re-entry instructions.

(continued)

**These products are applied to the soil and pose no hazard to honey bees.

***Re-entry interval is 72 hours in areas where the average annual rainfall is less than 25 inches.

§§Difficulty in controlling cotton aphids has been encountered in some areas of Texas. Poor or erratic control can be expected in the High Plains, Trans Pecos, Rolling Plains and Wintergarden areas. Resistance exists to most registered materials and continued excessive use of certain insecticides is apt to expand the resistance problem. Where resistance exists in an area, the initial insecticide application should be made at the higher labeled rate. Poorest control has occurred during periods of rapid population growth. Contact the county Extension agent in your area for the latest information on aphid control.

Table 1. Insecticide suggestion table. ***(Continued)***

Pest	Insecticides (listed alphabetically)	Insecticide class[1]	Pounds active ingredient per acre[2]	Formulated amount per acre	Precaution status[3]	Re-entry interval (hrs)[4]	Honey bee hazard[5]
	Dicrotophos (Bidrin® 8E)	OP	0.25-0.5	4-8 oz	D	48***	H
	Dicrotophos (Bidrin 8E) + Amitraz (Ovasyn 1.5E)	OP + T	0.25-0.5 + 0.125-0.25	4-8 oz + 0.67-1.33 pts	D + W	48***	H
	Dicrotophos (Bidrin 8E) + Profenofos (Curacron 8E)	OP + OP	0.25-0.5 + 0.125-0.25	4-8 oz + 2-4 oz	D + W	48***	H
	Dimethoate	OP					
	(Cygon® 4E)		0.125-0.25	4-8 oz	W	12	H
	(Dimate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	(Dimethoate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	Disulfoton (Di-Syston® 8E)	OP	0.1-0.2	1.6-3.2 oz	D	48***	M
	Methomyl (Lannate® 2.4LV)	OP	0.225	12 oz	D	72	H
	Methyl Parathion (4E)	OP	0.25-0.375	8-12 oz	D	48***	H
	Methyl Parathion (7.5E)		0.25-0.375	4.3-6.4 oz	D	48***	H
	Oxydemetonmethyl (Metasystox-R® 2E)	OP	0.125-0.25	0.5-1.0 pt	W	48***	M
	Parathion (4E)	OP	0.25-0.375	8-12 oz	D	7 days	H
	Parathion (8E)		0.25-0.375	4-6oz	D	7 days	H
	Profenofos (Curacron® 8E)	OP	0.5	8 oz	W	12	H
Tarnished Plant Bugs (*Lygus* spp.)	Acephate (Orthene® 90S)	OP	0.5	8.89 oz	C	12	H
	Dicrotophos (Bidrin® 8E)	OP	0.5 oz	8 oz	D	48***	H
	Dimethoate	OP					
	(Cygon® 4E)		0.25	8 oz	W	12	H
	(Dimate® 2.67E)		0.22	10.7 oz	W	12	H
	(Dimethoate® 2.67E)		0.22	10.7 oz	W	12	H
	Methomyl (Lannate® 2.4LV)	C	0.225	0.75 pt	D	72	H
	Methyl Parathion (4E)	OP	0.5-1.0	1-2 pts	D	48***	H
	Methyl Parathion encapsulated (Penncap-M® 2F)		0.25	1 pt	W	48	H
	Oxamyl	C					
	(Vydate® 2L)		0.25	1 pt	D	48	H
	(Vydate® 3.76C-LV)		0.25	8.5 oz	D	48	H
	Parathion (4E)	OP	0.5-1.0	1-2 pts	D	7 days	H
Boll Weevils (Overwintered)	Azinphosmethyl	OP					
	(Guthion® 2L)		0.25	1 pt	D	48***	H
	(Guthion® 3F)		0.25	0.67 pt	D	48***	H
	Carbaryl (Sevin® 80S)	C	1-2	1.25-2.5 lbs	C	12	H
	Endosulfan	CD					
	(Phaser® 3E)		0.375-1.5	1-4 pts	D	48	M
	(Thiodan® 3E)		0.375-1.5	1-4 pts	D	48	M
	(Thiodan® 2CO)		0.375-1.5	1.5-6 pts	D	48	M
	Malathion (91% ULV 9.33 lb)	OP	0.58-0.88	8-12 oz	C	12	H
	Methyl Parathion (4E)	OP	0.25-0.5	8-16 oz	D	48***	H
	Methyl Parathion (7.5E)		0.25-0.5	4.3-8.5 oz	D	48***	H
	Methyl Parathion encapsulated (Penncap M ® 2F)	OP	0.25-0.5	1-2 pts	W	48	H
	Oxamyl	C					
	(Vydate® 2L)		0.25	16 oz	D	24	H
	(Vydate® 3.76C-LV)		0.25	8.5 oz	D	48	H
Boll Weevils (In-Season)	Azinphosmethyl	OP					
	(Guthion® 2L or ULV 2 lb)		0.25	1 pt	D	48***	H
	(Guthion® 3F)		0.25	0.67 pt	D	48***	H
	Carbaryl (Sevin® 80S)	C	1.6-2.0	2.0-2.5 lbs	W	12	H

(continued)

Table 1. Insecticide suggestion table. *(Continued)*

Pest	Insecticides (listed alphabetically)	Insecticide class[1]	Pounds active ingredient per acre[2]	Formulated amount per acre	Precaution status[3]	Re-entry interval (hrs)[4]	Honey bee hazard[5]
	Endosulfan	CD					
	(Phaser 3E)		0.375-1.5	1-4 pts	D	48	M
	(Thiodan 3E)		0.375-1.5	1-4 pts	D	48	M
	(Thiodan® 2CO)		0.375-1.5	1.5-6 pts	D	48	M
	Malathion	C					
	(91% ULV 9.33 lb)		0.87-1.17	12-16 oz §§	C	12	H
	Methyl Parathion (4E)	OP	0.375-1.0	12-32 oz	D	48***	H
	Methyl Parathion (7.5E)		0.375-1.0	6.4-17.1 oz	D	48***	H
	Methyl Parathion encapsulated	OP					
	(Penncap M® 2F)		0.25	1 pt	W	48	H
	Oxamyl®	C					
	(Vydate® 2L)		0.25	1 pt	D	48	H
	(Vydate® 3.76C-LV)		0.25	8.5 oz	D	48	H
Bollworm & Tobacco Budworm Eggs	(Use only with a larvicide, see ovicide section, B-1204)						
	Amitraz	T					
	(Ovasyn® 1.5EC)		0.125-0.25	0.67-1.33 pts	W	24	R
	Methomyl	C					
	(Lannate® 2.4LV)		0.113-0.225	6-12 oz	D	72	H
	Profenofos	OP					
	(Curacron® 8E)		0.125-0.25	2-4 oz	W	12	H
	Thiodicarb	C					
	(Larvin® 3.2F)		0.125-0.25	5-10 oz	W	12	M
Larvae	Acephate	OP					
	(Orthene ® 90S)		1	1.11 lbs	C	24	H
	Bacillus thuringiensis (See listing in Table 2. See "Microbial Insecticides" section in, B-1204.)						
	Bifenthrin****	SP					
	(Capture® 2E)		0.04-0.1	2.6-6.4 oz	W	12	H
	Cyfluthrin****	SP					
	(Baythroid® 2E)		0.025-0.05	1.6-3.2 oz	D	12	H
	Cyhalothrin****	SP					
	(Karate® 1E)		0.025-0.04	3.2-5.12 oz	D	24	H
	Cypermethrin****	SP					
	(Ammo® 2.5E)		0.04-0.1	2-5 oz	C	12	H
	Esfenvalerate****	SP					
	(Asana XL® 0.66E)		0.03-0.05	5.8-9.6 oz	W	12	H
	Methomyl	C					
	(Lannate® 2.4LV)		0.45	1.5 pts	D	72	H
	Methyl Parathion (4E)	OP	1.25-2.0	2.5-4 pts	D	48***	H
	Methyl Parathion (7.5E)		1.25-2.0	1.33-2.13 pts	D	48***	H
	Permethrin****	SP					
	(Ambush® 2.0E)		0.1-0.2	6.4-12.8 oz	W	12	H
	(Pounce® 3.2E)		0.1-0.2	4-8 oz	C	12	H
	Profenofos	OP					
	(Curacron® 8E)		0.5-1.0	8-16 oz	W	12	H
	Sulprofos	OP					
	(Bolstar® 6E)		0.5-1.5	10.7-32 oz	C	48***	H
	Thiodicarb	C					
	(Larvin® 3.2F)		0.6-0.9	1.5-2.25 pts	W	12	M
	Tralomethrin****	SP					
	(Scout® X-tra 0.9E)		0.018-0.024	2.56-3.37 oz	D	24	H
	Zeta cypermethrin****	SP					
	(Fury® 1.5E)		0.033-0.045	2.82-3.83 oz	W	12	H

*****The synthetic pyrethroid insecticides (examples include fenvalerate, bifenthrin, esfenvalerate, cyfluthrin, cyhalothrin, permethrin, tralomethrin and cypermethrin) recommended for control of bollworms and/or tobacco budworms also will provide boll weevil control. However, application intervals similar to those recommended for the traditional phosphate insecticides (3 to 5 days under heavy pressure) are necessary to provide adequate control. When treatments are to be made for a bollworm or budworm-boll weevil complex a suggested treatment regime is to use a pyrethroid followed 3 to 5 days later by a phosphate boll weevil insecticide.*

Since pyrethroids are not more effective than phosphates for boll weevil control, but are more effective for bollworm-budworm control, they should be saved for bollworm-budworm management.

We do not recommend using pyrethroids for boll weevil control alone or for early season pests because increased use may enhance the opportunity for insects to develop resistance to pyrethroids.

Bifenthrin suppresses spider mites when used for control of bollworms and tobacco budworms.

The use of synthetic pyrethroid insecticides may increase cotton aphid numbers.

§§16 oz rate restricted to fall diapause application.

(continued)

Table 1. Insecticide suggestion table. ***(Continued)***

Pest	Insecticides (listed alphabetically)	Insecticide class[1]	Pounds active ingredient per acre[2]	Formulated amount per acre	Precaution status[3]	Re-entry interval (hrs)[4]	Honey bee hazard[5]
Beet Armyworms	Chlorpyrifos	OP					
	(Lorsban® 4E)		1	2 pts	W	24	H
	Diflubenzuron	IGR					
	(Dimilin® 2F)		0.0625-0.125	4-8 oz	C	12	R
	Methomyl	C					
	(Lannate® 2.4LV)		0.45	1.5 pts	D	24	H
	Profenofos	OP					
	(Curacron® 8E)		0.75-1.0	12-16 oz	W	12	H
	Sulprofos	OP					
	(Bolstar® 6E)		0.75-1.5	1-2 pts	C	48***	H
	Thiodicarb	C					
	(Larvin® 3.2F)		0.6-0.9	1.5-2.25 pts	W	12	M
Spider Mites	Avermectin B_1						
	(Zephyr® 0.15E)		0.01-0.02	8-16 oz	W	48	H
	Dicofol	CH					
	(Kelthane® MF)		1.0-2.0	1-2 qts	C	12	R
	Dimethoate	OP					
	(Cygon® 4E)		0.125-0.25	4-8 oz	W	12	H
	(Dimate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	(Dimethoate® 2.67E)		0.11-0.22	5.3-10.7 oz	W	12	H
	Parathion (4E)	OP	0.25	8 oz	D	7 days	H
	Parathion (8E)		0.25	4 oz	D	7 days	H
	Profenofos	OP					
	(Curacron® 8E)		0.5-0.75	8-12 oz	W	12	H
	Propargite	CD					
	(Comite® 6.55E)		0.8-1.6	1-2 pts	D	24	R
Cabbage Loopers	*Bacillus thuringiensis(See "Microbial Insecticides" section of B-1204)*						
Stinkbugs	Carbaryl	C					
	(Sevin® 80S)		2.0	2.5 lbs	W	12	H
	Methyl Parathion (4E)	OP	0.5-1.0	1-2 pts	D	48***	H
	Methyl Parathion (7.5E)		0.5-1.0	8.5-17.0 oz	D	48***	H
	Parathion (4E)	OP	0.5-1.0	1-2 pts	D	7 days	H
	Parathion (8E)		0.5-1.0	0.5-1.0 pt	D	7 days	H
Grasshoppers	Carbaryl	C					
	(Sevin®)						
	(80S)		0.5-1.5	10-30 oz	W	12	H
	(5% bait)		1.5	30 lbs	C	24	H
	(20% bait)		1.5	7.5 lbs	C	24	H
	(Sevimol® 4)		0.5-1.5	1-3 pts	C	12	H
	(XLR Plus 4)		0.5-1.5	1-3 pts	C	12	H
	Malathion	OP					
	(91% ULV 9.33 lb)		0.58	8 oz	C	12	H

[1] C=carbamate; OP=organophosphate; SP=synthetic pyrethroid; CD=cyclodiene; CH=chlonated hydrocarbon; T=triazapentadiene; IGR=insect growth regulator.

[2] Refer to Table 2 for converting pounds active ingredient per gallon to acres per gallon and to Table 3 for converting percent active ingredient of dry insecticides to formulated insecticide per acre.

[3] C=Caution; W=Warning; D=Danger

[4] Time after application before re-entering fields without protective clothing. The wearing of protective clothing as described on the label may shorten the re-entry interval. In general, no insecticide label will have the statement "allow spray to dry" or "allow dust to settle" as a re-entry interval. However, there may be limited instances where EPA could grant a shorter re-entry interval than the minimum of 12 hours following application. Re-entry intervals are determined by the product's federal label or by Texas Department of Agriculture regulations and are subject to change.

[5] H=highly toxic; M=moderately toxic; R=relatively non-toxic

Table 2. Registered *Bacillus thuringiensis* products and labeled rates for controlling bollworm and tobacco budworm.

Product	Rate per acre (formulated material)
Biocot XL	0.33-2.33 pts
Biocot XLP	0.5-3.5 pts
Condor	0.5-1.67 qts
Dipel 2X	0.5-2.0 lbs
Dipel ES	1.0-2.5 pts
Dipel ES-NT	1.0-2.5 pts
Design	1.0-2.0 lbs
Javelin	0.25-1.5 lbs
MVP II	2.0-4.0 pts

Table 3. Converting pounds active ingredient per gallon to acres per gallon.

Pounds active ingredient needed per acre	Pounds active ingredient per gallon																	
	0.15	**0.30**	**0.66**	**0.90**	**1.00**	**1.80**	**2.00**	**2.40**	**2.50**	**2.67**	**3.00**	**3.20**	**4.00**	**6.00**	**6.55**	**7.50**	**8.00**	**9.33**
	Acres per gallon*																	
0.01	15.0	30.0	66.0	90.0	100.0	180.0	200.0	240.0	250.0	267.0	300.0	320.0	400.0	600.0	655.0	750.0	800.0	933.0
0.015	10.0	20.0	44.0	60.0	66.7	120.0	133.3	160.0	166.7	178.0	200.0	213.3	266.7	400.0	436.7	500.0	533.3	622.0
0.019	7.9	15.8	34.7	47.4	52.6	94.7	105.3	126.3	131.6	140.5	157.9	168.4	210.5	315.8	344.7	394.7	421.1	491.1
0.02	7.5	15.0	33.0	45.0	50.0	90.0	100.0	120.0	125.0	133.5	150.0	160.0	200.0	300.0	327.5	375.0	400.0	466.5
0.025	6.0	12.0	26.4	36.0	40.0	72.0	80.0	96.0	100.0	106.8	120.0	128.0	160.0	240.0	262.0	300.0	320.0	373.2
0.03	5.0	10.0	22.0	30.0	33.3	60.0	66.7	80.0	83.3	89.0	100.0	106.7	133.3	200.0	218.3	250.0	266.7	311.0
0.04	3.8	7.5	16.5	22.2	25.0	45.0	50.0	60.0	62.5	66.8	75.0	80.0	100.0	150.0	163.8	187.5	200.0	233.3
0.05	3.0	6.0	13.2	18.0	20.0	36.0	40.0	48.0	50.0	53.4	60.0	64.0	80.0	120.0	131.0	150.0	160.0	186.6
0.0625	2.4	4.8	10.6	14.4	16.0	28.8	32.0	38.4	40.0	42.7	48.0	51.2	64.0	96.0	104.8	120.0	128.0	149.3
0.08	1.9	3.8	8.3	11.3	12.5	22.5	25.0	30.0	31.3	33.4	37.5	40.0	50.0	75.0	81.9	93.8	100.0	116.6
0.1	1.5	3.0	6.6	9.0	10.0	18.0	20.0	24.0	25.0	26.7	30.0	32.0	40.0	60.0	65.5	75.0	80.0	93.3
0.11	1.4	2.7	6.0	8.2	9.1	16.4	18.2	21.8	22.7	24.3	27.3	29.1	36.4	54.5	59.5	68.2	72.7	84.8
0.113	1.3	2.7	5.8	7.9	8.8	15.9	17.7	21.2	22.1	23.6	26.5	28.3	35.4	53.1	58.0	66.4	70.8	82.6
0.125	1.2	2.4	5.3	7.2	8.0	14.4	16.0	19.2	20.0	21.4	24.0	25.6	32.0	48.0	52.4	60.0	64.0	74.6
0.17	0.9	1.8	3.9	5.3	5.9	10.6	11.8	14.1	14.7	15.7	17.6	18.8	23.5	35.3	38.5	44.1	47.1	54.9
0.19	0.8	1.6	3.5	4.7	5.3	9.5	10.5	12.6	13.2	14.1	15.8	16.8	21.1	31.6	34.5	39.5	42.1	49.1
0.2	0.7	1.5	3.3	4.5	5.0	9.0	10.0	12.0	12.5	13.4	15.0	16.0	20.0	30.0	32.8	37.5	40.0	48.7
0.22	0.7	1.4	3.0	4.1	4.5	8.2	9.1	10.9	11.4	12.1	13.6	14.5	18.2	27.3	29.8	34.1	36.4	42.4
0.225	0.6	1.3	2.9	4.0	4.4	8.0	8.9	10.7	11.1	11.9	13.3	14.2	17.8	26.7	29.1	33.3	35.6	41.5
0.25	0.6	1.2	2.6	3.6	4.0	7.2	8.0	9.6	10.0	10.7	12.0	12.8	16.0	24.0	26.2	30.0	32.0	37.3
0.33	0.4	0.9	2.0	2.7	3.0	5.5	6.1	7.3	7.6	8.1	9.1	9.7	12.1	18.2	19.8	22.7	24.2	28.3
0.37	0.4	0.8	1.8	2.5	2.7	4.9	5.4	6.5	6.8	7.2	8.1	8.6	10.8	16.2	17.7	20.3	21.6	25.2
0.375	0.4	0.8	1.8	2.4	2.7	4.8	5.3	6.4	8.7	7.1	8.0	8.5	10.7	16.0	17.5	20.0	21.3	24.9
0.45	0.3	0.7	1.5	2.0	2.2	4.0	4.4	5.3	5.6	5.9	6.7	7.1	8.9	13.3	14.6	16.7	17.8	20.7
0.5	0.3	0.6	1.3	1.8	2.0	3.6	4.0	4.8	5.0	5.3	6.0	6.4	8.0	12.0	13.1	15.0	16.0	18.7
0.55	0.3	0.5	1.2	1.6	1.8	3.3	3.6	4.4	4.5	4.9	5.5	5.8	7.3	10.9	11.9	13.6	14.5	17.0
0.58	0.3	0.5	1.1	1.5	1.7	3.1	3.4	4.1	4.3	4.6	5.2	5.5	6.9	10.3	11.3	12.9	13.8	16.1
0.6	0.2	0.5	1.1	1.5	1.7	3.0	3.3	4.0	4.2	4.5	5.0	5.3	6.7	10.0	10.9	12.5	13.3	15.6
0.675	0.2	0.4	1.0	1.4	1.5	2.7	3.0	3.6	3.7	4.0	4.4	4.7	5.9	8.9	9.7	11.1	11.9	13.8
0.75	0.2	0.4	0.9	1.2	1.3	2.4	2.7	3.2	3.3	3.6	4.0	4.3	5.3	8.0	8.7	10.0	10.7	12.4
0.8	0.2	0.4	0.8	1.2	1.3	2.3	2.5	3.0	3.1	3.3	3.8	4.0	5.0	7.5	8.2	9.4	10.0	11.7
0.88	0.2	0.3	0.8	1.0	1.1	2.0	2.3	2.7	2.8	3.0	3.4	3.6	4.5	6.8	7.4	8.5	9.1	10.6
0.9	0.2	0.3	0.7	1.0	1.1	2.0	2.2	2.7	2.8	3.0	3.3	3.6	4.4	6.7	7.3	8.3	8.9	10.4
1	0.1	0.3	0.7	0.9	1.0	1.8	2.0	2.4	2.5	2.7	3.0	3.2	4.0	6.0	6.6	7.5	8.0	9.3
1.17	0.1	0.3	0.6	0.8	0.9	1.5	1.7	2.1	2.1	2.3	2.6	2.7	3.4	5.1	5.8	6.4	6.8	8.0
1.25	0.1	0.2	0.5	0.7	0.8	1.4	1.6	1.9	2.0	2.1	2.4	2.6	3.2	4.8	5.2	6.0	6.4	7.5
1.5	0.1	0.2	0.4	0.6	0.7	1.2	1.3	1.6	1.7	1.8	2.0	2.1	2.7	4.0	4.4	5.0	5.3	6.2
1.6	0.1	0.2	0.4	0.5	0.6	1.1	1.3	1.5	1.6	1.7	1.9	2.0	2.5	3.8	4.1	4.7	5.0	5.8
2	0.1	0.2	0.3	0.5	0.5	0.9	1.0	1.2	1.3	1.3	1.5	1.6	2.0	3.0	3.3	3.8	4.0	4.7

*See Table 1 for specific rates of insecticides for each insect or mite pest.

Table 4. Converting percent active ingredient of dry insecticides to formulated insecticide per acre.

Pounds active ingredient needed per acre	Percent active ingredient					
	5	**15**	**20**	**50**	**80**	**90**
	Pounds formulation per acre*					
0.09	1.80	0.60	0.45	0.18	0.11	0.10
0.188	3.76	1.25	0.04	0.38	0.24	0.21
0.25	5.00	1.67	1.25	0.50	0.31	0.28
0.3	6.00	2.00	1.50	0.60	0.38	0.33
0.45	9.00	3.00	2.25	0.90	0.56	0.50
0.5	10.00	3.33	2.50	1.00	0.63	0.56
0.6	12.00	4.00	3.00	1.20	0.75	0.67
0.75	15.00	5.00	3.75	1.50	0.94	0.83
1.0	20.00	6.67	5.00	2.00	1.25	1.11
1.25	25.00	8.33	6.25	2.50	1.56	1.39
1.33	26.60	8.87	6.65	2.66	1.66	1.48
1.5	30.00	10.00	7.50	3.00	1.88	1.67
1.6	32.00	10.67	8.00	3.20	2.00	1.78
2.0	40.00	13.33	10.00	4.00	2.50	2.22
2.4	48.00	16.00	12.00	4.80	3.00	2.67

*See Table 1 for specific rates of insecticides for each insect or mite pest.

The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Cooperative Extension Service is implied.

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