

Biology & Control of
THRIPS
on Seedling Cotton

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Thrips are the smallest of all cotton insect pests with an overall body length of less than one-twelfth of an inch. Despite their small size, these insects have the potential to cause yield reductions of more than 100 pounds of lint per acre; extremely heavy infestations can even cause death of seedling plants. Heavy infestations of thrips can also cause delays in fruiting. How can an insect that is so small cause such damage?

Cotton is much more susceptible to thrips injury than most other row crops. This is because during the first 7 to 10 days after emergence, the terminal bud of cotton seedlings develops relatively slowly (Figure 1). This terminal bud contains the tissue that will eventually develop into the true leaves and fruiting structures. Thrips tend to concentrate their feeding in this terminal bud, and the injury that occurs to these young developing plant parts is greatly magnified as they grow, resulting in leaves that are crinkled and distorted (Figure 2). A crude analogy can be seen by folding a piece of paper four or five times, punching several holes in it, and then unfolding the paper.

Once cotton seedlings develop three or four true leaves, the rate of growth in the terminal bud is faster. At this point, cotton plants become less susceptible to thrips injury, because the thrips have more feeding sites available, and their feeding is less concentrated. Therefore, cotton is most susceptible to thrips injury between emergence and the 3- to 4-leaf stage, and it is most important to scout for thrips and to protect the cotton plant from excessive thrips injury during this period (Figure 3).

Identification

Thrips belong to the order Thysanoptera. This order has more than 5,000 recognized species world wide, but only a few are pests on row crops. In Mississippi, the primary pest thrips belong to the genus *Frankliniella*. These are the tobacco thrips [*Frankliniella fusca* (Hinds)], western flower thrips [*Frankliniella occidentalis* (Pergande)], and flower thrips [*Frankliniella tritici* (Fitch)]. Soybean thrips [*Neohydatothrips variabilis* (Beach)] are also found on cotton, along with other species that occur incidentally. The tobacco thrips is by far the most common species on cotton in Mississippi, comprising more than 90 percent of most collections from seedling cotton (Figure 4).

All of these thrips are minute, and rarely exceed one-twelfth of an inch in length. Adult

Figure 1. Seedling cotton. Thrips feed on the cotyledons and in the developing terminal of young cotton seedlings. Damage to cotyledons is of little consequence, but damage to young leaves and fruiting branches forming in the young terminal is magnified as these plant parts expand.

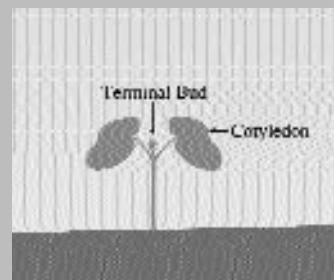


Figure 2. "Possum-eared" cotton. Cotton seedlings that suffered from heavy thrips injury to young leaves developing in the terminal bud will have tattered or crinkled leaves that often curl upward and fail to expand properly. The leaf area of severely damaged seedlings often is greatly reduced compared to that of undamaged seedlings.

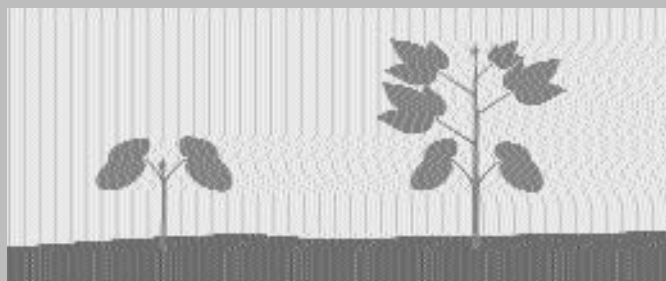


Figure 3. "Window of Susceptibility." Cotton is most susceptible to thrips injury between emergence and the 3- to 4-leaf stage.

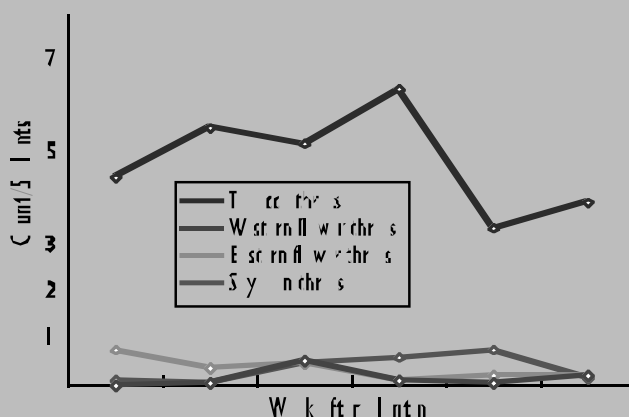


Figure 4. Average number of adult thrips per five cotton seedlings in untreated plots, 1986 - 1998. Tobacco thrips was by far the most common species.



Figure 5. Electron micrograph of an adult female thrips. Most thrips are less than one-twelfth of an inch long when fully mature. Despite their small size, they have all of the body parts of larger insects: three body segments, six legs, antennae, compound eyes, ovipositor, etc. Adult thrips usually have elongate, fringed wings.



Figure 7. Western flower thrips adult and second instar larva on cotton leaf. Because the presence of immature thrips indicates that thrips are successfully reproducing in a field, it is important for scouts to be able to distinguish between adults and immatures. Immature thrips can be distinguished by their lighter color, usually semi-transparent to light yellow, and by their lack of wings. However, a good hand lens is usually required to make this distinction.

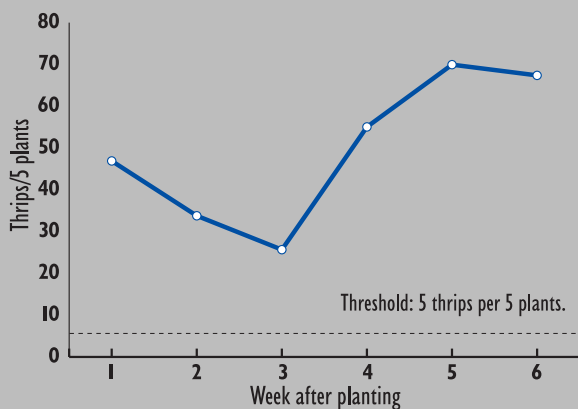


Figure 8. Average number of larval thrips per five plants in untreated plots, 1986 – 1998. Note that these numbers are much higher than those shown for adults in Figure 4, indicating that immatures are usually more numerous than adults in untreated fields.

thrips have a slender, spindle-shaped body and possess all of the body parts characteristic of larger insects (Figure 5). Immature thrips are shaped similarly, but they have no wings and are smaller and usually lighter in color.

Some species of thrips are predators.

However, these are rarely found on cotton in Mississippi, with the exception of western flower thrips and soybean thrips, which may prey on spider mites. Western flower thrips and soybean thrips, however, are not primarily predators and feed mainly on plants. Therefore, none of the thrips occurring on seedling cotton are beneficial insects.

The dark-colored tobacco thrips that occurs on seedling cotton should never be confused with the “black hunter,” a commonly mentioned, fairly large predatory thrips [*Leptothrips mali* (Fitch)] that does not occur on cotton in the state.

During the bloom stage, flower and western flower thrips occur in cotton, sometimes in high numbers. Adults concentrate in blooms, where they feed on pollen, but larvae feed on the undersides of leaves. Heavy populations of immature western flower thrips may cause a russetting or bronzing of the undersides of leaves. This russetting usually will be concentrated along the major veins and near the base of the leaf. Such infestations are most common during periods of drought, increasing stress caused by drought. However, because western flower thrips are extremely difficult to control, there are no recommended controls for western flower thrips in blooming cotton. Therefore, this publication primarily addresses thrips as pests of seedling cotton.

Biology

Although mated female thrips lay eggs that produce both sexes, a very high percentage of the thrips on seedling cotton are female. In some species, including species of *Frankliniella*, unfertilized eggs develop into males, a phenomenon known as parthenogenesis.

The life cycle has six distinct stages: egg, two larval stages, prepupa, pupa, and adult (Figure 6). Thrips in the prepupal and pupal stages are non-feeding and are usually found in the soil, but they may occasionally be found on a plant. An adult and a second instar larva are shown in Figure 7. It is important for scouts to be able to distinguish between larvae and adult thrips. The larvae are always wingless and are usually lighter in color. Although most adult thrips possess long fringed wings, wingless adults also occur.

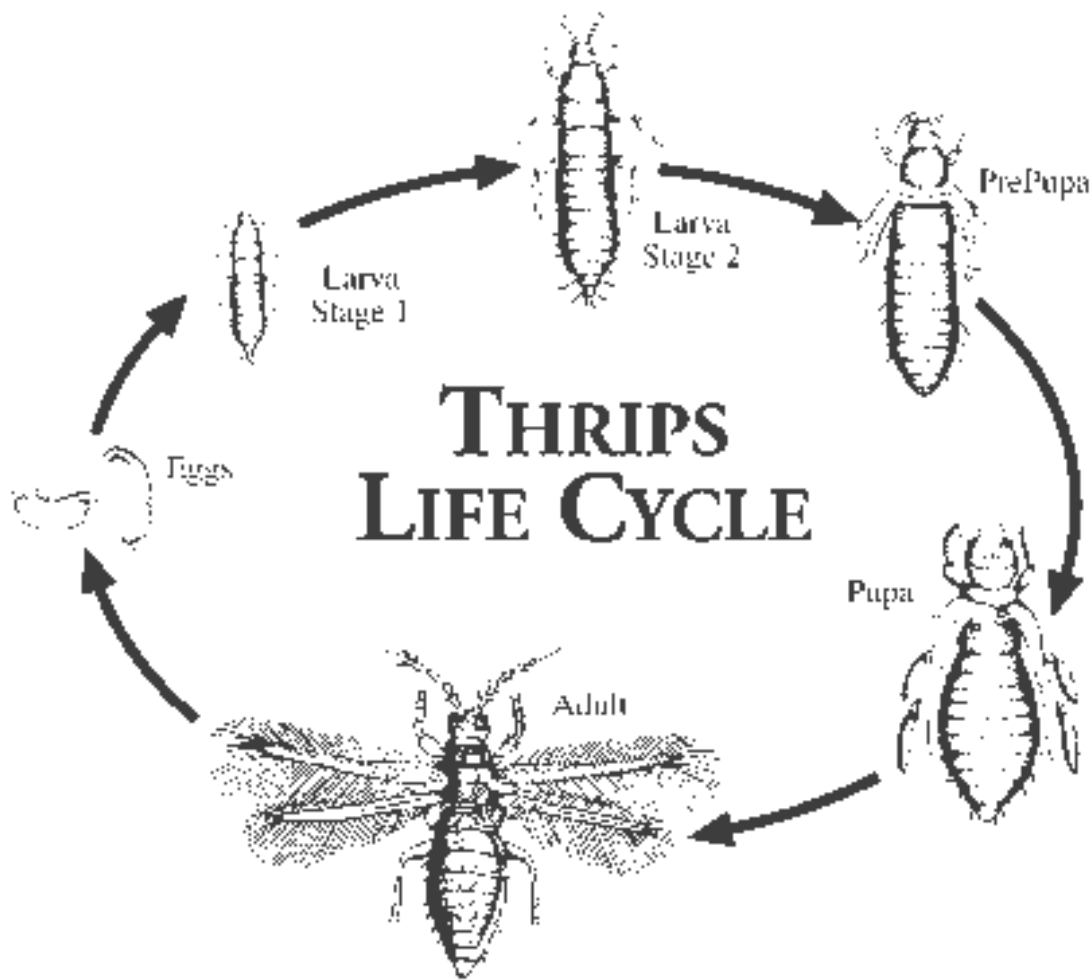


Figure 6. General thrips life cycle. Adult female thrips use their sharp ovipositor to insert eggs into the tissue of the cotton plant. Eggs hatch within 3 to 20 days. The rate of development strongly depends on temperature. There are two larval stages, which together last from 8 to more than 20 days. The thrips then enters the nonfeeding prepupal stage, followed by the pupal stage. These stages are usually completed in the soil at the base of the plant. After 3 to 6 days, the adult thrips emerges.

The life cycle of thrips varies greatly with temperature. Development from egg to adult may last from less than 15 days at very warm temperatures to several weeks at cool temperatures. Therefore, at cool temperatures, immature thrips will remain on plants for long periods of time before pupating. Because adults require a high-protein food source for optimum egg production, it is possible that female thrips maturing in seedling cotton leave the field as adults in search of pollen before reproduction. Much of the damage to seedling cotton, therefore, may result from immature thrips. These immature thrips can be much more numerous than adults, especially in untreated fields (Figure 8). Under optimum conditions (about 68 °F), a single female may lay nearly 100 eggs in her lifetime of about 60 days. Eggs are inserted into the plant tissue by means of a sharp ovipositor (Figure 5). Thrips may be found in seedling cotton immediately following emergence.

Thrips overwinter as hibernating adults, as larvae on winter plants, or as pupae in the soil. They begin reproducing on weed hosts and other available plants, such as winter wheat, in early spring. They may have completed one or more generations by the time cotton emerges. During late spring, adults that have developed on alternate hosts, which may be maturing and becoming unattractive, begin looking for more favorable host plants. Although thrips are capable of short-range directed flight, their small size dictates that they will move with prevailing winds.

Wind can have a considerable influence on the intensity of thrips infestations in cotton. Planting seasons with strong windy conditions are usually seasons with heavy thrips pressure in seedling cotton. This is because

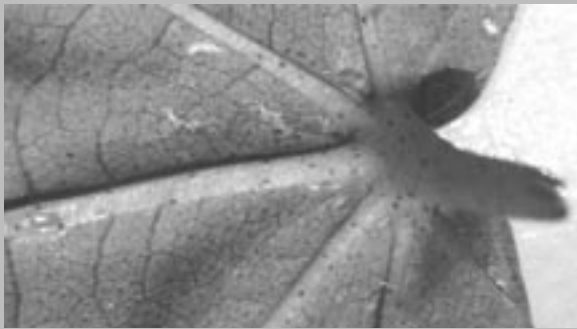


Figure 9. Thrips feeding sites on an older cotton leaf. Note the small silvery colored areas. Injury of this type to leaves that are already expanded has little adverse impact on the plant.



Figure 10. A "thrips box" is one of the most effective methods of sampling for thrips. Seedling plants are pulled up and beaten over a piece of hardware cloth placed over the top of the box. Then the hardware cloth is removed and any thrips in the bottom of the box are counted. The box is emptied and the procedure repeated at several locations in the field. Counts are expressed as average number of thrips per plant.

the windy conditions are continuously blowing new infestations of adult thrips into cotton fields. Injury to seedling plants caused by wind-blown sand can often be mistaken for thrips injury. And, cotton seedlings that have been mechanically damaged by wind-blown sand are more susceptible to injury by thrips.

This relationship between thrips and wind also explains why thrips infestations appear so early in cotton. Because adult thrips are constantly being blown into fields, including unplanted fields, adult thrips are usually present in most fields before cotton is planted. These thrips are hungry and often ready to lay eggs. They will begin feeding and laying eggs on seedling plants as soon as they emerge from the soil. This explains why it is often possible to find immature thrips on seedling cotton plants that are only a few days old.

Damage and Yield Impact

Thrips have "punch and suck" mouthparts that allow them to punch a hole in a leaf cell, insert their maxillary stylets, and suck up the cellular fluids. Air often partially fills the damaged cells giving damaged areas a silvery sheen that is often visible along the veins and other feeding sites (Figure 9). When it occurs on leaves and other plant parts that have already expanded, this type of injury causes little or no significant harm to the plant. However, when such injury occurs within the terminal bud, on tiny developing leaves and fruiting structures, the effect can be quite different.

When thrips feed on young undeveloped leaves within the terminal bud, the resulting damage is magnified as those leaves develop and expand. This is because the damaged tissue fails to develop properly, while undamaged tissue continues to grow. After prolonged feeding or feeding by high numbers of thrips, seedlings have a ragged appearance, with visible silvery feeding sites on cotyledons and terminal leaf tissue. Over time, these silver areas will turn brown in color. Heavily injured leaves usually have a crinkled, tattered appearance and often curl upwards at the margins (Figure 2). Seedlings with this type of injury are often described as "possum-eared cotton." Heavy thrips populations can stunt growth, cause death of the terminal bud (resulting in "crazy cotton"), delay fruiting, and reduce stand.

Thrips damage often is magnified by cool weather or drought, which can slow plant growth and/or lengthen thrips' developmental time, thereby increasing the probability of seedling damage. Seedlings that emerge under warm,

favorable growing conditions are much less susceptible to thrips injury than seedlings that emerge under conditions conducive to slow seedling development.

The ultimate impact of thrips injury on yield is highly variable. Cotton that is planted under good growing conditions can withstand relatively heavy infestations without suffering yield loss. However, severe thrips injury can result in substantial yield reductions. In 14 trials conducted in Mississippi between 1994 and 2000, yield losses in untreated fields ranged from 10 to 271 pounds of lint per acre. The average yield increase for the standard treatment (aldicarb) was 114 pounds of lint. Although these trials were generally planted in a manner that would result in heavy thrips pressure, these data show that thrips can often have a significant adverse impact on yield.

Sampling, Thresholds, and Treatment Decisions

Scout for thrips by sampling 5 to 10 plants in each of several locations in the field. Take samples by beating the plants over a small white-bottomed box (about the size of a cigar box) or even a white cloth (Figure 10). Place a piece of 1/2-inch hardware cloth over the top of the box to improve collection of dislodged thrips. Scouts may choose to pull and sample plants one at a time, or in groups of five, and beat the plant or plant bundle against the hardware cloth several times to dislodge the thrips. It is best to rotate the plant, or plant bundle, so that all “sides” are beaten against the hardware cloth. Examine the bottom of the box for thrips and record the number. Be sure to remove all thrips from the box before taking another sample. It is best to examine 50 to 100 plants per field before determining the average number of thrips per plant, although smaller samples may be adequate on small fields.

An example of the type of information that might be collected in a small field using the “thrips box” sampling procedure is shown in Figure 11. Treatment decisions are usually easy to make with this type of detailed information. The current treatment threshold, **one thrips per plant**, is based on this “thrips box” sampling procedure. Other sampling procedures, such as collecting plants and washing them over a fine sieve, or carefully examining individual plants, will normally result in increased numbers of thrips being found per plant, and thresholds should be adjusted accordingly. It is important to look carefully

for the immature thrips, which are very small and are pale yellow or amber in color (Figure 7).

When making a treatment decision, several questions should be considered in addition to the average number of thrips per plant. First, it is extremely important to consider whether or not the field received a soil- or seed-applied treatment for thrips at planting. Counts that exceed the standard threshold of one thrips per plant do not necessarily mean that the in-furrow insecticide has failed. For instance, windy periods, which favor constant migration of adult thrips into cotton fields, can cause counts of adult thrips to exceed the economic threshold, even though the in-furrow insecticide is working well. The field is simply being continuously reinfested. If newly arrived adults eventually are succumbing to the systemic insecticide present in the plants, application of a foliar spray will do little to improve control.

On the other hand, other situations can cause failure of seed- or soil-applied insecticides. These include excessive drought, which can result in poor plant uptake of the insecticide; excessive rainfall, which can leach the insecticide out of the root zone; and faulty application or calibration. The presence of significant numbers of immature thrips in a field that received an in-furrow insecticide treatment indicates that the insecticide is not working properly. In such cases, promptly apply supplemental foliar insecticide treatments if counts exceed the threshold of one thrips per plant and if the seedlings are still in the susceptible stage.

The stage of plant development influences treatment decisions. For example, a field that is in the 3-leaf stage and is growing vigorously may not require treating even if it has an average population that is a bit higher than one thrips per plant. On the other hand, it may be best to go ahead and treat a field that is still in the cotyledon stage and is experiencing sustained windy conditions, even if the average thrips count is slightly below threshold. This would be especially true if the field had not received thrips treatment at planting.

Once plants reach the 3- to 4-leaf stage and are growing vigorously, they normally are no longer susceptible to yield-limiting thrips injury. However, there are occasional exceptions to this rule. Plants that have suffered severe injury and/or are growing under extremely adverse conditions may require longer protection. When evaluating the need for additional thrips treatments on fields that have sustained heavy thrips injury and have

already received one or more treatments, it is often helpful to carefully examine the very small expanding leaves in the terminal. If these appear to be developing normally, additional treatment is probably not required. However, if these very young leaves are also showing signs of severe injury, and if significant numbers of thrips are present, an additional treatment may be in order.

Control

Several methods are available for applying insecticides to control thrips. These include the following:

- seed treatments that can be ordered preapplied to the seed
- seed treatments that are mixed with the seed at planting
- granular insecticides that are applied in-furrow at planting through special granular applicators
- liquid insecticides that are applied as in-furrow sprays at planting
- foliar sprays applied as needed after seedling emergence.

Generally, those treatments that are applied as in-furrow granules or sprays will provide control for a longer period (about 4 to 5 weeks of control) than those products applied as seed treatments (about 2 to 3 weeks of control). However, it is important to keep in mind that control failures can occur with any of the at-planting type treatments, and all fields should be scouted frequently for thrips until plants reach the 4-leaf stage.

Of the five methods listed above, the first four must be applied on a preventative basis, before there is any evidence that a potentially yield-limiting infestation of thrips has occurred. Thrips are the only cotton insect pests for which such preventative treatments are recommended. However, because of the nature of thrips' migration into cotton fields and the nature of the cotton plant's susceptibility to thrips, these preventative, at-planting type treatments are usually recommended over the "no at-planting treatment and spray as needed" approach.

Regardless of whether or not a field is treated with a soil- or seed-applied insecticide at planting, all fields should be scouted carefully for thrips until plants reach the 4-leaf stage. Scout fields at least every 5 days, but a 3- to 4-day schedule is even more effective. As previously mentioned, a

number of situations can cause soil-applied treatments to fail, and frequent scouting, combined with prompt application of supplemental foliar sprays, can prevent yield-limiting injury.

Treatments and rates of insecticides recommended as foliar sprays for control of thrips are listed in Extension Publication 343 *Mississippi Cotton Insect Control Guide*. As a rule, thrips can be controlled with very low rates of insecticides. Resistance has not historically been a problem with thrips, primarily because thrips that occur in seedling cotton in Mississippi migrate from weed hosts and crops such as wheat, which are not treated for thrips; therefore, there is little selection for resistance. However, it should be noted that the western flower thrips exhibits a high degree of natural tolerance to many insecticides. Western flower thrips normally represent only a very small portion of the total thrips population present on seedling cotton (Figure 4). However, heavy populations of western flower thrips do occasionally occur on seedling cotton, and such infestations can be difficult to control.

Some key factors that growers should consider when choosing thrips control options and specific thrips insecticides are discussed below:

■ PLANTING CONDITIONS/TIME OF SEASON.

Fields planted in warm, ideal growing conditions are less susceptible to thrips injury than are fields planted under cool or otherwise adverse conditions that are likely to result in slow seedling development and a prolonged period of thrips susceptibility. Therefore, when planting early in the season or under adverse conditions, choose a highly effective, long-lasting control option, even if that option is more costly. When planting later in the season under ideal conditions, growers can choose a less costly option, such as a hopper box seed treatment, which can be supplemented with a foliar treatment if needed.

■ COMPATIBILITY WITH AVAILABLE

EQUIPMENT. Obviously, growers who do not have planters equipped with granular applicators will not be able to use in-furrow granules.

■ **COMPATIBILITY WITH PLANTING METHOD.** The in-furrow granules or in-furrow spray treatments may not be economically or logistically feasible to use in fields planted on extremely narrow row patterns. Hopper box treatments, supplemented with foliar sprays if necessary, or foliar sprays alone, are usually more economical for fields planted to unusually narrow rows.

■ **NEED FOR NEMATODE CONTROL.** Some specific products have activity against both thrips and nematodes. Growers who have problems with nematodes may want to choose such products.

■ **INSECTICIDE-HERBICIDE INTERACTIONS.** Insecticides applied at planting for control of thrips can interact with cotton herbicides in a variety of ways. Certain insecticides can increase plant susceptibility to certain herbicides. Conversely, some insecticides can actually "safen" plants, allowing the use of a herbicide that would otherwise cause serious plant injury. Therefore, growers must be very aware of these interactions and plan their insecticide/herbicide programs accordingly.

■ **INSECTICIDE/DISEASE INTERACTIONS.** Many soil-applied insecticides also cause seedlings to be more susceptible to seedling disease. For this reason, the use of an appropriate at-planting fungicide is recommended any time a soil-applied insecticide is used.

■ **CALIBRATION.** When using in-furrow granules or liquid in-furrow treatments, take care to ensure proper calibration and to check all row units frequently for proper operation and calibration. Rates that are too low may not provide adequate control, and application of excessive rates results in unnecessary expense. In addition, excessive rates of soil-applied insecticides can have adverse effects on plant growth. Risks of such insecticide-related crop injury are higher in sandier soils and in late-planted crops.

Field Name: Purdy Date: May 24			
At Planting Treatment: None			
Stage of Development: 1 - 2 leaf stage			
Stop No.	No. Thrips/5 Plants		
	Immatures	Adults	Total
1	6	2	8
2	7	3	10
3	3	4	7
4	5	4	9
5	9	2	11
Total	30	15	45
Avg. = 45/25 or 1.8 thrips per plant			
Recommendation: Treat ASAP with a recommended foliar insecticide			

Figure 11. Example of the type of information that must be collected before a thrips treatment decision can be made on a small field. Note that information on crop development stage is included.

KEY FACTS ABOUT THRIPS AND THRIPS CONTROL IN COTTON

Thrips are small, less than one-twelfth of an inch in length.

Cotton is more susceptible to thrips injury than other crops because of the initial slow growth of the terminal bud.

Cotton is most susceptible to thrips injury during the period between emergence and the 3- to 4-leaf stage.

Seedlings that have reached the 3- to 4-leaf stage and are growing vigorously are relatively safe from yield-limiting injury by thrips.

Fields planted early in the season under cool, adverse growing conditions are more susceptible to thrips injury than are fields planted later in the season under warm, ideal growing conditions.

Thrips are controlled by the use of insecticides applied as seed treatments or in-furrow treatments at planting, or by foliar insecticide sprays.

Results of long-term research show that at-planting treatments are more effective in preventing yield loss than are foliar sprays.

The presence of significant numbers of immature thrips in a field that was treated with a soil- or seed-applied insecticide at planting is an indication that the insecticide is not working well.

Growers must be very aware of the interactions that occur between various insecticides and cotton herbicides. Certain combinations are not compatible and can result in crop injury.

Cotton treated with certain in-furrow thrips insecticides may be more susceptible to seedling diseases. Use of an "at-planting" fungicide is recommended when in-furrow insecticides are used.

Excessive rates of in-furrow insecticides can cause seedling injury. Insecticide applicators should be carefully calibrated and frequently checked.



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