Tobacco Budworm: *Heliothis virescens*

Historically, the tobacco budworm has been one of the most damaging and most costly insect pests of Mississippi cotton. However, since the introduction and widespread adoption of transgenic Bt cotton the overall importance of tobacco budworm has declined considerably. Bt cotton was first introduced in 1996 and approximately 42% of Mississippi's cotton acreage was planted to Bt varieties that first year. Since then the portion of acreage planted to Bt cotton varieties has steadily increased, reaching approximately 80% in 2002. Bt cotton is highly effective against tobacco budworm, and the primary reason that most producers use Bt cotton, and pay the technology fee of approximately $26 per acre, is because of its efficacy against this pest.

Despite, its high damage potential, tobacco budworm is essentially a secondary pest of cotton. The term "secondary pest" refers to a pest that rarely occurs in damaging numbers unless the parasites and predators that regulate it are destroyed by insecticide applications applied to control another pest. Tobacco budworm fits the criteria for a secondary pest quite well because there are a number of predators and parasites that help keep it in check, unless they are destroyed by treatments targeting other pests. Historically, the boll weevil served as a "key pest" of Mississippi cotton because the insecticides that had to be applied early in the season to control boll weevils also killed the predators and parasites of the tobacco budworm and released this damaging secondary pest. Currently, Mississippi is in the final phase of a statewide boll weevil eradication effort and elimination of this key pest will reduce the potential for flaring tobacco budworm infestations on non-Bt cotton. However, the tarnished plant bug is assuming the role of "key pest" in some areas of the state and early season insecticide treatments to control tarnished plant bug can also flare tobacco budworm on non-Bt cotton.

Biology: Female tobacco budworm moths lay approximately 1000 eggs, which are deposited individually. During the early portion of the season eggs are usually deposited in the terminal area of the plant, often on the upper surface of newly expanding leaves. However, eggs may be deposited on square bracts and at other locations on the plant. Under normal summer temperatures eggs hatch in approximately three days.

There are five to six larval instars, and the larval stage lasts 15 to 20 days, depending on temperature (each 2 degree drop in temperature adds approximately 1 day to the larval period). Mature larvae dig a pupal chamber, approximately 1 to 2 inches deep, in the soil near the base of their host plant. Before pupating, the larva also digs an exit tunnel to within approximately 1/8 inch of the soil surface. The larva then enters the pupal stage, which last approximately 8 to 12 days. Upon emergence from the pupa, the moth is able to push the remaining cap of soil from the top of the escape tunnel and emerge. Female moths produce a pheromone, which is attractive to male moths. Females attract males by "calling" or releasing pheromone while resting on a plant. Most calling and mating activity occurs on the second and third nights after adult emergence. Egg-laying normally begins on the third or fourth night and lasts approximately 8 to 10 days. Moths may lay between 100 and 200 eggs per night during this period.

Tobacco budworms overwinter as pupae in the soil. Overwintering pupal chambers are approximately 1 to 2 inches deep and the insulating effect of the soil provides a significant degree of protection from winter freezes. Although tobacco budworm pupae can tolerate some exposure to sub-freezing temperatures and successfully overwinter throughout Mississippi and into more northern states, winter mortality seems to be one of the major factors that limit its northern distribution. Moths emerge from overwintering during late April and early May and deposit their eggs on early spring hosts, such as crimson clover, Persian clover, wild geranium, and lespedeza. While a portion of the second generation will also deposit their eggs on weedy,

non-crop hosts, squaring cotton is one of the most attractive, and most abundant, hosts during the summer months. During September and October, moths may leave maturing cotton fields and complete an additional generation on alternate hosts, such as prickly sida, some morning glories, beggar weed, hophornbeam copperleaf, and velvetleaf. Tobacco budworm larvae that mature in September and October normally enter diapause and pupate near the host on which they developed. Consequently, overwintering tobacco budworm pupae may be found both in cotton fields and in non-crop areas near alternate hosts. Pupae that overwinter in cotton fields are usually destroyed by fall and/or spring tillage operations, if fields are tilled before mid-April. However, during recent years there has been a substantial shift toward no-till cotton production, which allows better survival of overwintering tobacco budworm pupae. Fortunately, this increase in survival potential for overwintering pupae in no-till fields appears to be more than offset by increased numbers of fire ants, which are very aggressive predators of tobacco budworms.

Damage and Yield Effects: Although tobacco budworm larvae can cause damage by feeding in the terminals of young cotton plants, this is not normally a major concern. Tobacco budworm larvae are voracious fruit feeders, and direct feeding on squares and bolls is the primary damage caused by this pest. All sizes of squares and bolls are attacked.

Newly hatched larvae usually begin by feeding on small, pin-head squares in the terminal, moving to progressively larger fruit, lower in the plant, as they grow. However, this is not an absolute, and small larvae are also capable of damaging immature bolls. Research indicates that once bolls reach approximately 18 to 21 days of age, they become relatively safe from damage by small tobacco budworms, but large larvae are capable of damaging bolls beyond this age. In one study tobacco budworm larvae that survived to pupation damaged a total of 10 squares and 2 bolls during their 16-day larval development period. Heavy infestations of tobacco budworm have the potential to cause near 100% fruit loss. Because of the high damage potential of this pest, treatment thresholds are very low. During the boll setting period treatment is recommended if counts exceed four larvae per 100 plants.

Historically, estimated annual yield losses to the tobacco budworm/bollworm complex ranged from 0.7 to 5.0 percent. Although losses to this caterpillar complex have declined relatively little since the introduction of transgenic Bt cotton, ranging from 1.9 to 4.2 percent, most of this loss is to bollworm, rather than tobacco budworm. The number of foliar sprays applied to control budworm/bollworm has dropped considerably. In 1995 the Hill Region of Mississippi experienced a heavy outbreak of tobacco budworms that were extremely difficult to control because of high levels of insecticide resistance. Growers in this region sustained an estimated 23.3% yield loss due to tobacco budworm, despite also incurring record high control costs. Many fields suffered several hundred pounds of lost yield due to this outbreak, and some fields suffered such high levels of boll damage that they were not harvestable.

Control: Currently, transgenic Bt cotton provides essentially 100% control of tobacco budworm, and this is the primary reason that approximately 80% of the state's cotton acreage is planted to Bt varieties. However, tobacco budworm has a history of quickly developing resistance to new insecticides, and there is well-founded concern that this could occur with Bt cotton as well.

When using foliar applied insecticides to control tobacco budworm on non-Bt cotton, it is important to apply insecticides while larvae are less than ¼ inches in length (approximately 3 days of age). Large larvae are extremely difficult to control because they occur inside fruit and deeper in the plant canopy where insecticide coverage is reduced. Consequently, it is important to scout non Bt fields on a three to five day schedule so that infestations can be detected and

treated while larvae are still small enough to control. Treatments recommended for control of tobacco budworm on non-Bt cotton are listed in Table 9.

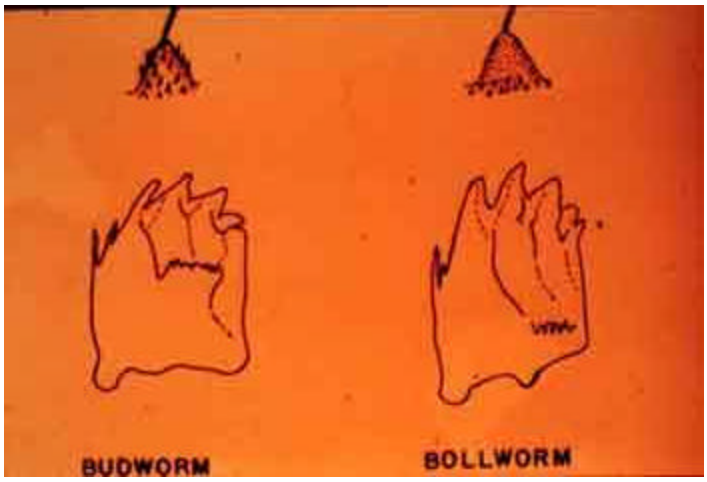
Table 9: Foliar Insecticides Recommended for Control of Tobacco Budworms *

Insecticide	Trade Name	Lbs ai/acre
Indoxacarb	Steward	0.09 to 0.11
Spinosad	Tracer	0.067 to 0.089
Thiodicarb	Larvin	0.6 to 0.9
Profenofos	Curacron	1.0

* Tobacco budworms are difficult to control. In addition to the products listed, tank mixtures of two insecticides, representing different classes of insecticide chemistry, are often used.

Source: Cotton Insect Control Guide, 2003, Publication 343, Mississippi State University Extension Service

Bollworm/Tobacco Budworm: Although bollworm and tobacco budworm are two distinct species, the larvae can be difficult to distinguish. Both are robust, variously colored caterpillars that feed on cotton fruit.



One of the best ways to distinguish between these two species of caterpillars is to check for the presence of an extra tooth on the inner surface of the mandible, a character that is present in tobacco budworm but absent in bollworm. However, this method is difficult to use with small caterpillars. The moths, on the other hand, are easy to distinguish.

The **tobacco budworm moth** has three distinct diagnoal strips on each wing

The **bollworm moth** is larger, buff tan in color, and usually has a distinct dark spot in the center of each front wing.

Both species deposit their **eggs** individually. Eggs are most commonly deposited on the upper surface of developing leaves, but eggs are lain on many other locations on the plant as well.

Small larvae of both species are most commonly found feeding in terminals or squares

Larger larvae are most often found feeding in bolls.

Both species form their **pupae** in the soil, which is also the stage and site in which overwintering occurs.