The Benefits of Insecticide Use: Peanuts

Southern Corn Rootworm

Tomato Spotted Wilt Virus: Treated Vs. Untreated

Lesser Cornstalk Borer

Spraying Peanut Fields

March 2009

Leonard Gianessi
Key Points

- There is a 94% correlation between damage from the lesser cornstalk borer and aflatoxin in peanuts
- Thrips transmit tomato spotted wilt virus to peanuts with the potential to reduce yield by 90%
- Insecticide control of southern corn rootworm increased the value of peanuts by 86%
- Insecticide control of corn earworm resulted in a cost to benefit ratio of 1:6

Technical Summary

Insects and related arthropod pests occupy every conceivable niche on the peanut plant [29]. Insects feed in terminal buds and flowers; on leaves, roots and pods; behind leaf axils and petioles; on plant fluids by inserting their mouthparts into cells or directly into the nutrient transport system; in tunnels that they form in the leaves, main stem, lateral branches or roots; and on or in pods and seed [29]. They damage the plant directly by removing photosynthate that would otherwise be used for vegetative or reproductive plant growth; damaging cells in photosynthetically active tissue; removing foliage that producers photosynthate; feeding on developing pegs, pods and seed; damaging the roots by removing tissue; and increasing the rate of water loss from an injured, stressed plant. To add to this biological complexity, arthropod pests generally do not occur in single-species groups but in groups of several species [29]. Equally important to the direct damage to plants by insects is the indirect damage that may result from the injury they cause. Insects are vectors of plant pathogens such as tomato spotted wilt virus. In addition, injured plant tissue is vulnerable to secondary infections by pathogens such as Aspergillus flavus.

The economic realities of peanut production in the southeastern US continue to justify the use of insecticides. Nonchemical control measures are helpful but usually inadequate [38]. Growing market demand for high quality peanuts has increased the need to prevent insect damage. Manufacturers of peanut products demand peanuts free of insect damage [38].

About 65% of the southwestern peanut acreage in Texas, Oklahoma and New Mexico is located in the western, more arid regions, where insect problems tend to be less severe compared to eastern, more humid areas [17]. Over three-fourths of the peanut acreage in Texas is monitored for insect pests but only one-fourth of the acreage is sprayed for insects. Thrips were the major insect pest identified by peanut growers in the Southwest. Two-soil insects, lesser cornstalk borer and burrowing bug concerned Texas growers. Foliage feeders, fall armyworms and spider mites also are treated for in the southwest [17].

The major insect pests of peanuts in the Virginia-North Carolina region are corn earworm, fall armyworm, southern corn rootworm, thrips and spider mites [18].
Damage to peanuts by soil insects was known as early as 1889 according to a record of lesser cornstalk borer attacking peanuts in Georgia [35]. However, such damage received little attention until the late 1940s. Research in the southeast began in 1947 to evaluate insecticides to control soil insects. In 1953 soil insect damage was reduced and the yield of peanuts was increased significantly where aldrin, dieldrin, or toxaphene granules were applied to the surface of the soil when the plants began to peg down. Gains from treatments on sandy soils in Alabama ranged from 289 to 442 pounds of cured peanuts per acre (20-25% increase) [35].

Recent increases in yield of 400 to > 1000 kg/ha have been reported from use of a granular insecticide in peanuts [36]. Over 90% of the North Carolina peanut acreage is treated annually with granular systemic insecticides applied in-furrow at planting [39]. This eliminates the need for most foliar insecticides unless worms or mites become a problem in August or September.

In Oklahoma, only 10-15% of the state’s peanut acres require insecticide sprays and the majority of the treated acres is dryland peanuts [32].

Insecticide costs are estimated at $44/acre in North Carolina which represents 6% of the total costs of producing the crop [40]. Insecticide costs are $12/A in Texas and $15/A in Georgia [42][8].

Georgia’s first crop of organic peanuts was harvested from two acres in 2007 [41]. Research trials demonstrated that organically-approved insecticides spinosad (Entrust formulation) and neem oil provide significant reduction ion thrips injury and tomato spotted wilt virus [41]. Arid western states produce most of the US’s organic peanuts because of less pest pressure in those states.

Lesser Cornstalk Borer

The lesser cornstalk borer (LCB) is the most economically-damaging insect pest of peanuts in the Southeast and Southwest. It is an annual pest in Oklahoma and Texas and a dry weather pest in Georgia and Alabama. LCB attacks at least 60 plant species. Eggs of the LCB are laid just under the soil surface under the peanut canopy. Newly hatched larvae crawl across the soil and feed on a peanut plant. The larva attacks plants at ground level and feeds above and below the soil level. Such feeding quickly kills newly emerged seedlings and severely weakens plants that survive [3]. Larvae bore into the plant stems just below the soil level, interrupting water and nutrient flow in the plant. Larvae spend most of their time below the soil surface and construct a silken tunnel into the surrounding soil into which they may escape or hide. Tunnels are constructed of sand, soil, and excrement tightly woven together with silk and attached to the plant. The LCB damages peanuts in all stages of growth and will feed on any part of the plant that is in contact with the soil. It also tunnels into the soil to feed on pegs and pods. LCB damages peanuts in two ways— external scarring, where it feeds on the outside of the pod and pod penetration where it goes into the pod and feeds on the kernel. Yield losses can exceed 70% following severe outbreaks [1].
Population outbreaks typically occur during periods of hot, dry weather in peanuts grown on sandy soils. Copulation takes place only at night and only occurs when temperatures are above 70 degrees F [3]. During hot weather, the LCB passes through its life cycle in 30 days or less. When conditions are less favorable, the life cycle may require more than 40 days. This shortening of the life cycle contributes to population explosion [5]. The feeding rate of lesser cornstalk borers greatly increases with hot weather. The total number of eggs laid per female increases in hot weather with a low of 20 eggs laid per female at 63 degrees to 120 eggs per female laid at 88 degrees [6]. Beneficial insects suffer high mortality at higher temperatures while LCB do not. At 86 degrees for 24 hours, no eggs, larvae or adults of the LCB were killed while 69% of big-eyed bugs and 100% of fire ants were killed [6].

Research in the 1950s demonstrated that effective control of LCB could be obtained with endrin with LCB infestations reduced by 90% [2]. The only insecticide in current use for LCB is chlorpyrifos which reduces LCB populations by 80% [7]. Control with chlorpyrifos can be expected to last about 28-60 days [12]. Treatment for LCB is usually recommended when 10-20% of the plants are infested. In a three year study, fields treated with chlorpyrifos, 45 to 60 days after planting, yielded 296 pounds more per acre than untreated fields.

In the Southeast, approximately 10% of the peanut acres are typically treated for LCB while in drought years, the percentage of acres treated has been as high as 50% [8].

In addition to the direct damage LCB feedings causes to peanut stems and pods, LCB feeding-wounds provide an entry point for soilborne plant pathogens, and weakens plants so they may be more susceptible to infection. LCB may also carry and transmit plant pathogens, including Aspergillus fungi [9]. Aspergillus fungi are of major concern to the peanut industry because they produce aflatoxins as metabolites. Hot and dry conditions that favor development of aflatoxin also favor population outbreaks of the lesser cornstalk borer.

Aflatoxins are powerful tasteless, odorless and colorless mycotoxins. Aflatoxins are mutagenic, carcinogenic, teratogenic, and actuely toxic to most animals and humans [14]. They can cause animals, including humans, to lose their appetite, decreasing their feeding efficiency, and/or cause death [4]. Evidence suggests that aflatoxins are one hundred times more likely to induce cancer than polychlorinated biphenyls (PCBs) [13]. Aflatoxins also inhibit the body’s immune system and reduce the effectiveness of vaccines.

Peanuts are frequently contaminated by aflatoxin if their pods develop during drought conditions and/or if the pods are partially eaten by an insect—the lesser cornstalk borer. Prior to 1960, the contamination of peanuts by aflatoxin was not considered to be a significant problem. By 1960, the peanut industry was much more concerned after it was discovered that animals had been poisoned by aflatoxin [10]. For example, farmers in Georgia reported that their swine had been poisoned after consuming moldy peanuts.
Also, more than one hundred thousand turkeys in England died after they consumed moldy peanut meal [10].

When the cornstalk borer larvae feed on peanut pods, they often weaken or pierce the shell. This provides a point of entry for the aflatoxin producing fungi. The amount of aflatoxin found in seed penetrated by insects is thirty to sixty times greater than the aflatoxin levels found in undamaged pods [9]. Tests conducted in Alabama during 1990 found a 94 percent correlation between damage caused by the lesser cornstalk borer and the number of aflatoxin producing fungi [11]. Peanut field studies found that over 50 percent of the lesser cornstalk borer larvae sampled were contaminated by aflatoxin fungus spores. Researchers also have found propagules of aflatoxin fungus in the gut of the lesser cornstalk borer larvae [9]. LCB is an excellent vector of A. flavus. Larvae carried spores of the aflatoxin-producing fungi on their cuticles, or skin, as well as internally.

Aflatoxin-producing fungi are predominant in the light soils in which peanuts are grown, and occur most frequently when hot dry conditions prevail. High temperatures favor growth of these fungi, limit growth of competing organisms, and stress peanut plants, thereby making infection more likely. Infestation of seed by aflatoxin-producing fungi also is greater in peanuts that are damaged in any way [11].

Research has shown that the use of insecticides significantly reduces the damage to peanut pods caused by the lesser cornstalk borer. Thus, insecticides indirectly reduce aflatoxin levels found in peanuts. When peanuts are treated with a single application of the organophosphate insecticide chlorpyrifos thirty days after planting, and again either forty-five or seventy-one days after planting, the damage caused by the lesser cornstalk borer larvae and the levels of aflatoxin are consistently lower than when no insecticides are applied [11]. Tests with chlorpyrifos applied 30 days after planting reduced the aflatoxin level by 109 ppb (from 114 ppb to 5 ppb) and doubled peanut yield [11]. Fungicides have not been shown to reduce aflatoxin levels in peanuts [10].

Pre-harvest management of aflatoxin relies heavily on control of soil dwelling insects such as the lesser cornstalk borer [15].

Aflatoxins are the only mycotoxins regularly monitored by the peanut industry. Peanuts with more than 20 ppb cannot be sold for human consumption. Visual monitoring for Aspergillus starts in the field, continues through harvest, drying and storage, and ends with processing. If contamination is detected in a peanut lot, the lot is graded Segregation III. Segregation III lots are not allowed into edible markets and end up being crushed into oil at a significant loss to the grower. During the drought of 1990, edible peanut lots were worth about $650 per ton, while Segregation III lots were worth $150 per ton.

Evaluation of cultivated and wild peanut species for resistance to LCB concluded that the levels of resistance are not sufficiently high enough to justify a breeding program for germplasm introgression from wild to cultivated peanuts [16].
**Southern Corn Rootworm**

Adult southern corn rootworms are mobile and feed on 208 plant species [19]. In the US, the southern corn rootworm has been recognized as a pest of peanuts since the beginning of the 20th century [19]. In 1916 it was reported that in Virginia in some instances the entire crop of pods borne by a plant were injured while in others the proportion of injured to uninjured pods was about equal [20]. In 1946 injury to peanut pods from the southern corn rootworm was very severe in Virginia. From 64 fields examined, an average of 28% of injured pods was obtained [22]. It has been estimated that from one-half to two-thirds of the peanut acreage in Virginia is subject to injury by this pest. Losses range from slight to complete destruction in the affected fields [23].

The southern corn rootworm is a major pest of peanut in Virginia and North Carolina and of peanut grown on poorly drained soils in the southeastern US. The southern corn rootworm is the larva of the spotted cucumber beetle. Adults prefer to lay eggs at the bases of plants in moist, dark soil with moderate levels of organic matter and clay. Southern corn rootworm eggs require 100% soil moisture to survive and the larvae need 70%. The insect does not survive in hot, dry years. Females lay eggs for about a month and lay from 116 to 895 eggs [21]. Adult rootworm beetles feed above the ground on peanut leaves (this adult damage is not important) and larvae feed below ground on roots or developing pegs or pods for about 21 days. Larvae make almost cylindrical entry holes and feed on the immature pods and developing seed. Damage by rootworm larvae also predisposes pods to invasion by fungi that induce pod rot. Three to four generations may occur each year in the southern latitudes. Adults emerge from corn and other habitats during June or early July in the Virginia-Carolina region and are attracted to flowering peanut plants.

Even superficial scarring from rootworm feeding can significantly reduce the value and marketability of the crop because Virginia-type peanuts are sold primarily in grocery stores and ballparks [21]. Losses from larval feeding can reduce the yield of whole seed by as much as 80% [19]. A major infestation of southern corn rootworm can result in 30-35% of the crop suffering some degree of damage. Even a minor infestation will typically damage 10 to 15% of the crop.

Prior to the early 1960s, the cyclodiene insecticides (aldrin, heptachlor) were used extensively as soil broadcast and banded treatments for southern corn rootworm control in peanuts. This method of control was so effective and in such widespread general use as a preventative control tactic that rootworm was seldom considered a pest. Aldrin and heptachlor gave season long control and were effective as spray, dust, and granular formulations [19]. The result of this continued spraying was southern corn rootworm resistance to cyclodiene insecticides in ten years [19]. Organophosphates came into use for rootworms in the early 1960s. Organophosphate treatments in Virginia experiments resulted in an increase in yield of nuts of more than 71% and an increase in the value of nuts of more than 86% as compared with the untreated check [23].
Effective insecticides are available for management of southern corn rootworm. These insecticides are normally applied over the row in a 12- to 16-inch band. The developing pods are protected after the insecticide is incorporated into the soil by rainfall or irrigation [12]. Additionally, most of the insecticides are effective against other pests, including the lesser cornstalk borer, cutworm, and potato leafhopper. In the Virginia-Carolina production region, preventive treatment with a soil insecticide is economically acceptable in any field with a soil organic matter content higher than 1%. If a field has a history of previous infestations, preventive treatment is also recommended [12]. An estimated 50 and 90% of North Carolina and Virginia peanut acres respectively is treated for rootworm annually [24].

The adult southern corn rootworm has very few parasites to endanger its life. In Virginia studies only two were found to occur with any degree of regularity; one was a tachnid fly (4% parasitism of rootworm), and the other a nematode (24% parasitism) [25].

NC 6 a large-seeded peanut with a Virginia-type growth characteristic was released in 1976. The cultivar possesses high levels of resistance to southern corn rootworm. NC 6 sustains about 50% less rootworm damage than other Virginia-type varieties [26]. When it was released, agronomic characteristics of the cultivar were comparable to all other commercial cultivars grown in the Virginia-Carolina production region. Resistance of NC 6 to southern corn rootworm is so high that one-fourth the normal rate of soil insecticide is recommended in poorly drained soils that are prone to severe infestation by this pest [12]. When the resistant cultivar was first released in 1976, it rapidly gained wide acceptance by peanut growers in the Virginia-Carolina production region. Recently, the percentage of acres planted to NC 6 has declined primarily because new, higher yielding susceptible cultivars have been released. These new cultivars have good seed and shelling qualities, and growers expect a greater net economic return from growing the susceptible cultivar and using insecticides than from growing NC 6 with less insecticide or no insecticide [12].

Lepidopterans

Several lepidopteran species produce the same injury by eating peanut leaves. Damaging populations of fall armyworms, corn earworms, and beet armyworms sometimes occur during midseason or late in the season while populations of velvetbean caterpillar sometimes occur late in the growing season. All lepidopteran pests have natural enemies that frequently prevent populations from reaching economic threshold densities. When populations do reach outbreak densities, numerous labeled insecticides are available [12]. New peanut varieties with less foliage may be more adversely affected by foliage feeders than older lush peanut varieties.

The fall armyworm and beet armyworm are major defoliators of peanut plants. Some damage occurs each season and occasionally the fall armyworm occurs in sufficient numbers to cause complete defoliation of peanuts [5]. Armyworm moths lay masses of up to 1000 eggs on the leaves and stems of the plant. After hatching, the young larvae feed
out from the mass and cover the entire plant and adjoining plant. The fall armyworm
prefers to feed on young leaf tissue and consumes about 100 square centimeters of foliage
during larval development. These insects are called armyworms because young larvae
feed together and crawl en masse to adjacent fields after all the foliage in one area has
been consumed.

The fall armyworm feeds on over 50 species of plants. It prefers members of the grass
family as hosts (corn sorghum), but it also feeds on peanuts, especially in the southern
US. In Georgia, peanut yield losses attributable to the fall armyworm were negligible
from 1971-1976. In 1977, however, fall armyworm populations reached epidemic
proportions throughout the southern US, and peanut losses in Georgia alone exceeded
$17 million [27]. Chemicals were immediately tested on an emergency basis in August
1977 with reductions of 96% in fall armyworm populations[28]. Fall armyworm is
estimated to infest 20% of southeastern peanut acreage with a potential yield loss of
8%[7].

A corn earworm larva consumes 175-200 square centimeters of peanut foliage during
development [29]. In the Virginia-Carolina region, the corn earworm is considered the
major foliage-feeding pest. Growers typically control this pest with a single application
of a foliar insecticide based on scouting. Approximately 25% of North Carolina peanut
acres are treated for corn earworm which is reduction from 40% in 1995 due largely to
improved scouting [18].

The velvetbean caterpillar is a tropical to subtropical New World pest. It does not
overwinter in peanut-producing regions of the US and survives the winter only in the
most southern Florida latitudes. The moths migrate northward each year. Damage by the
velvetbean caterpillar in the US is most severe in northern Florida and southern Georgia,
where high larval densities often occur on peanut late in the growing season [29]. They
are voracious feeders. A larva consumes approximately 100 square meters of leaf tissue
during its development. Velvetbean caterpillar is estimated to infest 20% of the
southeastern peanut acres each year with a potential yield loss of 8%[7].

The velvetbean caterpillar is often the limiting factor in the production of peanuts in
Florida. In the early 1900s lead arsenate was the insecticide most used against the
velvetbean caterpillar. It gave fairly satisfactory control when applications were made
early. A minimum of ten pounds per acre was required for effective control. In the early
1950s Florida growers were largely dependent on DDT for velvetbean caterpillar control
with treatments increasing yield by 15%.

Peanuts tolerate considerable foliage loss without a reduction in yield, so an insect-free
field is not necessary to make optimum yields. Virginia-type peanuts can tolerate up to
40% leaf loss without yield reduction if the defoliation occurs in mid-July or after mid-
September. But leaf loss of 10-20% or higher from August 1 to September 1 will reduce
yields [33]. Therefore, it’s generally not profitable to control worms to prevent foliage
loss of less than 10% during August or 20% after the first of September and less than
40% after mid-September.
A nine year study was conducted in South Carolina to control naturally occurring corn earworm populations with foliar applied insecticides\[34\]. When canopy growth was slowed by drought, yield losses were substantial (233-734 lb/acre). A treatment cost to benefit ratio of 1:6 was calculated.

Spider Mites

The twospotted spider mite is a major pest of peanut in the US, especially in Virginia and North Carolina. The mites injure the plants by inserting their piercing-sucking mouthparts into plant cells and sucking out the contents. In the spring, mites initially feed on early hosts and then become established on corn. Populations increase rapidly on tasseling corn and then disperse on the wind as it begins to mature. Dispersal from maturing corn occurs during flowering and pod development on peanut, stages that are favorable for mite establishment and population increase. Outbreaks of spider mites usually occur during periods of hot, dry weather. Apparently, hot, dry weather favors spider mite reproduction and development while adversely affecting populations of natural enemies \[12\]. Spider mites multiply rapidly (as many as 17 generations per year) which accounts for population explosions when hot dry conditions exist for extended periods. Significant mite densities may kill large areas of plants resulting in considerable yield loss \[19\]. All the leaves on a plant can be lost if spider mites are left uncontrolled \[30\]. Spider mites are estimated to typically infest 15% of US peanut acres across all regions with a potential yield loss of 5%\[7\].

Irrigated peanuts in Georgia and Texas have less incidence of spider mite infestations than the “dry” peanuts in North Carolina and Virginia. The mites have to have a drought-stressed plant to thrive on. In an average year 5-7% of North Carolina peanut acres are treated for spider mites while in a drought year (such as 1993), 25-33% of the acres can require treatment for mites \[30\].

Thrips

For many years, research did not demonstrate a positive yield response from controlling thrips \[37\]. Then, beginning in 1997 a consistent positive result was seen. In 1997, the variety Georgia Green was introduced, and that variety is more sensitive to thrips damage. Yield data shows an average yield response from thrips control of 724 pounds per acre from 23 comparisons with a range from 121 pounds to 1578 pounds per acre \[37\].

Thrips have rasping mouthparts and feed by scraping the upper surfaces of developing terminals and imbibing the exuded fluid. Thrips are intracellular feeders that injure plants primarily by feeding on unopened leaflets. Thrips injury to terminals results in deformed leaves that are crinkled and slightly cupped upon emergence. The leaves have reduced photosynthetic ability and young plants are stunted. Thrips damage to peanut foliage is
most severe during the first thirty days after plant emergence. Environmental conditions during the spring favor population development and survival of thrips. The largest population densities occur in leaflet terminals during the seedling plant growth stages. In the Virginia-Carolina production area, where cultivars with long maturity requirements are being produced in a relatively short growing season, preventing thrips from delaying crop maturity is crucial to profitable peanut production [12]. (The peanuts need to be harvested before the threat of freeze damage). Several granular insecticides are efficacious against thrips and can easily be applied at planting. Most of the acreage in the Virginia-Carolina and southeast production regions is treated in this preventive manner [12].

In addition, the recent finding that thrips transmit tomato spotted wilt virus has altered opinion on the importance of thrips [29].

Tomato spotted wilt virus is one of the most devastating pathogens of peanut. Infection by the virus reduces plant vigor, kernel size and weight, kernel oil content and overall yield (70-80%) [31]. Thrips acquire the virus from infected plants as larvae and once replication has occurred, they can transmit the virus while feeding on plant tissue for the duration of their lives. Recent experiments have shown that reduced plant injury and virus incidence results from insecticide suppression of thrips populations early in the season [31]. Peanut yields also were increased by 14-64% with applications of in-furrow insecticides [31]. These increased yields were due to a combination or interaction of both the reduction of thrips injury and tomato spotted wilt virus incidence. Thrips are estimated to infest 60% of southeastern peanut acreage [7].

Virginia farmers are treating more than 95% of their acreage for thrips [32].

In the southern peanut-growing area of Texas, thrips are the top insect problem [32].

References


42. Texas Crop and Livestock Budgets, Extension Agricultural Economics, Department of Agricultural Economics : http://agecoext.tamu.edu/budgets/