Crop Profile for Tobacco Production in Tennessee

Updated: March, 2008

General Production Information

- Tennessee ranked 3rd of top 5 states producing tobacco. This ranking includes all types of tobacco produced during 2007.
- Tennessee produces burley and dark types of tobacco, however more burley tobacco is produced than dark types (air-cured and dark fire-cured).
- Total 2007 production in Tennessee for all tobacco was reported at 39,135,000 pounds.
- There were approximately 14,000 acres in burley production during 2006, with an average yield of 2,200 pounds per acre, valued at $49,280,000. In 2007, approximately 13,000 acres were harvested yielding 20,800,000 pounds, with an average of 1,600 lbs per acre valued at $33,072,000.
- All tobacco produced in Tennessee for 2007 was valued at $75,823,000, receiving an average price of $1.96 per lb for all types (Tennessee Agricultural Statistics Service).
- Tennessee produces approximately 6% of the total US tobacco.
- In 2006, a total of 18,335,000 lbs of dark tobacco and 30,800,000 lbs of burley were produced in Tennessee.

Production Regions

Macon County was the top producer of tobacco in 2005, followed by Robertson, Green, Hawkins, Claiborne, Washington, Sumner, Montgomery, Smith, and Henry Counties. Similar production trends were observed in 2007, however production was reduced slightly due to markets.

Cultural Practices

Worker Activities

- **Plant sources** – plants may be grown on the farm, locally grown or grown in other areas and transported to the producer. If plants are grown on the farm they may either be seeded in a plant bed, seeded in small container for plug and transfer, or direct seeded in a float tray. Plants obtained from sources off the farm are generally pre-finished plants or field-ready transplants. Producers are discouraged from purchasing plants grown south of the state, due to possible introduction of blue mold earlier than usual.
- **Plant bed preparation** - generally begins in late December to early January. The area is worked up using a tractor with a tiller attachment and/or tiller. The area

would be treated with various pesticides for control of weeds, diseases and insects. Then seeded after treatment.

- **Float bed preparation** – a flat area is selected and a frame is built for placement of plastic to retain water. Float trays would be added at various times (March to May) depending on method of plant production selected.
- **Field preparation** – The field is disked up generally one to two weeks prior to planting to aid in making the soil more workable for planting and may aid in weed control.
- **Transplanting** – usually begins from April 19th until June 15th. Plants are removed from the plant bed or float trays by hand and placed into a one or two row planter.
- **Fertilization** – occurs prior to planting, usually several days prior or the day of planting. Occasionally, a side dressing of fertilizer may be applied 2 to 6 weeks after planting to improve growth.
- **Varieties** – several varieties are available for producers. Variety selection is often dependent on black shank pressure. Producers must take precautions to select a variety which is tolerant of black shank. Often producers select a variety which has characteristics which allow manageability of the plant when harvesting. These characteristics include height and stalk size. The varieties, TN90, TN96, KT200, KT204, and NC5 are the some of the most common burley varieties grown. Dark varieties commonly grown included; VA 309, VA 359, TND950, and KTD4LC.
- **Row spacing** – Spacing within the row ranges from 16" to 24" depending on setter settings and spacing between the rows varies from 3.5 to 4 feet.
- **Planting dates and Rates** - For burley tobacco, plant population runs from 7,500 to 8,000 plants per acre. Optimum plant dates are usually from May 1 to June 15, however some producers do try to get a jump start on production an may plant as early as April 20th where other producers may be inhibited by slow growing plants or weather conditions and may delay planting until late June.
- **Pesticide applications:**
    - **Herbicide applications** – may be made in the plant bed or in the field. If applied to the plant bed, may be applied using a pump hand sprayer. If applied to the field, are normally applied prior to planting using a boom low pressure (<45psi) sprayer. Very rarely, are herbicide applications made after planting. If needed after planting, a grass control product may be used where heavy populations occur. Light cultivation with a tractor generally occurs within the first 6 weeks after planting.
    - **Fungicide applications** – may be made to the plant bed, float bed and made prior to planting and/or directed to the base of the plant or directed to the foliage when treating plants in the field. In the plant bed, application would be made with a hand sprayer. Field application method selected depends on targeted pest. Sprayer pressure may need to be adjusted to obtain effective coverage of the foliage.
    - **Insecticide applications** – may be made to the plant bed or in the field. If applied in the plant bed, would be applied with a hand sprayer. If applied to the field, would be applied in the setter water or to the foliage or soil using a boom sprayer with spray directed to the soil or to the plant foliage. Occasionally, transplants grown in float trays are treated just prior to setting.

- **Irrigation**: only a small percentage of tobacco acreage was irrigated during 2007. More dark fired tobacco (30%) was irrigated than burley (10%). Irrigation is either by over head or in rare cases using drip.
- **Topping** – generally occurs when plants begin to develop a flower bud. The best time is when the flower bud begins to elongate when 50% of the plants have reached this stage. This is done by hand using a knife. Workers generally wear cloth gloves.
    - **Sucker control applications** – are normally applied after topping, usually within two days. Dark types generally have less maleic hydrazide use and would be substituted with products containing butralin, flumetralin and/or fatty alcohols. However, combinations of these products are often used to achieve superior sucker control.
- **Harvest** – usually occurs 3.5 to 4.5 weeks after topping. Cotton gloves are normally worn. Plants are cut one to 4 inches above the soil line. The stalk is pierced and placed on a wooden stake. Up to 5 stalks are placed on one stake. Stalks may remain in the field for several hours up to two days, before being transported to a curing structure.
- **Post harvest -**
    - **Stripping -** usually occurs from November until mid January when leaves become encased (moisture level optimum and leaf is pliable). Leaves are removed from stalks and sorted by stalk placement for each quality and then placed into bins to create compressed bales. Bales are tied with string for easier handling and transport. All work is done by hand.

Insect Control

The major pests that re-appear from year to year in tobacco production, include; aphids, budworms and hornworms. The most common products used for control of these pests include acephate, and lambda-cyhalothrin. Admire (imidacloprid) is labeled for use in the filed at transplant. It has been extensively used for aphid control and generally provides season long control. It has excellent efficacy on aphids and provides fair control for flea beetles, however it does not control budworms and/or hornworms. The use of this product will help reduce the number of other insecticide applications (acephate and/or endosulfan) during seasons when aphids are abundant. However, if budworms and/or hornworms reach economic thresholds, products containing other materials must be used.

Economic thresholds have been developed for various pests of tobacco. The University of Tennessee recommends using materials to control budworms, hornworms, flea beetles and aphids only if populations of these pests reach economic thresholds. Economic threshold (ET) is the population level of an insect pest in which it is economically feasible to apply a chemical control agent.

Arthropod Pests

Tobacco budworms (*Heliothis virescens* and the corn earworm *Heliothis zea*)

Budworms are one of the most serious pests of tobacco. The adults lay eggs on the tobacco plant and when the egg hatches the larvae chew small holes often into the terminal bud of the plant. Budworms, primarily the tobacco budworm, are important pests of tobacco in Tennessee. Both species feed on tobacco leaves, but such feeding causes little appreciable damage. Damage is most serious when feeding is in the vegetative bud of the plant. The larvae often cause distorted leaves by feeding upon the tips of the leaves in the developing bud. Large holes develop from earlier feeding as the leaf tissue expands. Plants prematurely topped by budworm feeding produce profuse sucker growth. Both species of caterpillars may also bore in stalks or midribs. These pests can severely reduce yield of tobacco if control is not obtained. Pupation occurs in the soil. Tobacco budworm pupae enter diapause in September in Tennessee and corn earworms begin diapause in August. Both species have four generations in Tennessee.

Chemical Controls:

- **Acephate** (Orthene 97PE):
- **Bacillus thuringiensis** (Dipel 2XWP): very safe product.
- **Spinosad** (Tracer): fairly safe.
- **Emamectin benzoate** (Denim 0.16EC):
- **Lambda-cyhalothrin** (Warrior 1CS):
- **Carbaryl** (Sevin 10D, 50WP, 80SP):
- **Methomyl** (Lannate 2.4LV, 90SP):

Alternative Controls:

- **Methidathion** (Supracide 2EC): product no longer labeled for tobacco production.

Cultural Controls:

- Economic threshold of 5 infested plants per 50 plants (10% infestation)

Biological Controls:

- The parasitic wasp *Campoletis sonorensis* (Ichenumonidae) kills small budworms.
- Another parasitic wasp *Cardiochiles nigriceps* (Braconidae) kills large budworms near pupation.
- Predators include several *Polistes* spp. paper wasps.
- Several diseases, including the microsporidian *Nosema heliothidis*, also reduce budworm populations.

Post Harvest Control Practices:

- None

Other Issues:

- None

Hornworms, Tobacco and Tomato (*Manduca sexta* and *M. quinquemaculata*)

Hornworms are a very serious pest and potentially the most destructive pest of tobacco. They chew and feed on leaves of the plant reducing yield and quality. Severe damage most commonly occurs during late July and August. Hornworms overwinter in the soil as pupae. Moths of this overwintering generation begin to emerge in early June and may continue to emerge as late as August. Nocturnal in habit, hornworm moths frequently can be seen

hovering over plants at dusk. At night, eggs are deposited on the underside of leaves. Each moth deposits one to five eggs per plant visit and may lay up to 2,000 eggs. Larvae emerge about 4 days later, depending upon temperature. After feeding for 3 weeks, hornworms burrow into the soil and spend 3 weeks after which a new generation of moths emerges. Heavy egg deposition is common in August and early September due to a peak in overwintering moth emergence along with that of a second (or possibly third) brood.

Chemical Controls:

- **Acephate** (Orthene 97PE):
- **Bacillus thuringiensis** (Dipel):
- **Spinosad** (Tracer):
- **Emamectin benzoate** (Denim 0.16EC): product availability was limited.
- **Lambda-cyhalothrin** (Warrior 1CS):

Alternative Controls:

- **Methidathion** (Supracide 2EC): product no longer labeled for tobacco production.

Cultural Controls:

- Economic threshold of 5 worms per 50 plants (10% infestation). If worms are 1" in length and parasitized, 25 worms per 50 plants (50% infestation).
- Early planted tobacco, proper (not excessive) nitrogen fertilization, sucker control.

Biological Controls:

- Stilt bug *Jalysus spinosus* attacks eggs.
- *Polistes* spp. Wasps prey on larvae.
- The braconid parasite, *Apanteles congregatus* lays eggs in first to third instar larvae.
- *Bacillus sphingidis* causes hornworm septicemia disease.
- Two flies (Tachinidae) lay their eggs on hornworm larvae and the developing fly larvae kill the hornworm pupae.

Post Harvest Control Practices:

- Stalk destruction, and fall plowing all help to reduce overwintering populations.

Other Issues:

Tobacco flea beetles (*Epitrix hirtipennis*)

Flea beetles are often observed immediately after transplant. They attack plant beds and new plants that have been recently transplanted. Feeding may occur until harvest. Feeding by flea beetles weakens and stunts plants and may reduce leaf quality.

Chemical Controls:

- **Disulfoton** (Di-Syston 15G): use in ground beds.
- **Carbaryl** (Sevin 10D, 50WP, 80SP): use in ground beds.
- **Acephate** (Orthene 97PE, 75SP): use in plant beds.
- **Endosulfan** (Thiodan, Thionex 3EC, 50WP): used in ground beds and the field.
- **Imidacloprid** (Admire 2F, Pro 4.6, Provado 1.6): Admire formulation is added to trays or setter water. Provado is used in the field.
- **Thiamethoxam** (Actara 25WG, Platinum 2SC): The Platinum formulation is added to trays or setter water. Actara formulation would be applied to the field.
- **Clothianidin** (Belay 16WSG): product availability was limited.
- **Oxamyl** (Vydate 2L): highly dangerous material.

- **Methomyl** (Lannate 90SP, 2.4LV):
- **Lambda-cyhalothrin** (Warrior 1CS): inexpensive.

Alternative Controls:

- **Methidathion** (Supracide 2EC): product is **no** longer labeled in tobacco.

Cultural Controls:

- Economic threshold of and average of 3 beetles per plant for young transplants and an average of 10 beetles per plant for older transplants.

Biological Controls:

- None

Post Harvest Control Practices:

- None

Other Issues:

- None

Tobacco aphids (*Myzus persicae*)

Aphids are found on the underneath side of the leaves of a tobacco plant. They can be difficult to control when using contact products. When leaves are infested with large numbers of these pests, the result is a thin light weight leaf that often ripens prematurely. Aphids were not a severe problem during 2007, however during favorable environmental conditions, aphids can become a serious pest in tobacco production if preventative controls are not used.

Chemical Controls:

- **Disulfoton** (DiSyston 15G): use in plant beds.
- **Acephate** (Orthene 97PE): used in the field or transplant water.
- **Thiamethoxam** (Platinum 2SC, Actara 25WG): The Platinum formulation is used as a preventative in the transplant bed just prior to setting. Actara may used in the field, however the 25WG can be extremely expensive.
- **Imidacloprid** (Admire 2F, Admire Pro 4.6) is used as a preventative in the transplant bed just prior to setting.
- **Clothianidin** (Belay 16WSG): low availability of product.
- **Pymetrozine** (Fulfill 50WDG): difficult to find product.
- **Methomyl** (Lannate 90SP, 2.4LV):
- **Malathion** (Malathion 5D, 5EC): use in plant beds.
- **Endosulfan** (Thiodan, Thionex 3EC, 50WP): some use in ground beds.
- **Acephate** (Orthene 97PE): use in plant beds and in the field.
- **Methyl-parathion** (Penncap-M 2EC): highly dangerous.
- **Lambda-cyhalothrin** (Warrior 1CS):
- **Acetamiprid** (Assail 70WP, 30SG):

Alternative Controls:

- None

Cultural Controls:

- An economic threshold when 10% of plants have 50 aphids on any upper leaf prior to topping and after topping should be treated when 20% or more of the plants are infested.

Biological Controls:

- Lady bugs
- Various parasitic wasps

Post Harvest Control Practices:

- None

Other Issues:

- None

Slugs

Slugs are similar to snails, both are molluscs. Slugs feed on young tobacco plants and high populations can reduce the number of transplants available to take to the field.

Chemical Controls:

- **Calcium Hydroxide** (Slaked lime, hydrated lime): use in plant beds when plants are dry, may cause burning of foliage when leaves are wet.
- Metaladehyde (Deadline Bullets):

Alternative Controls:

- None

Cultural Controls:

- Placement of wooden boards around plant bed or float bed. Remove boards every two-three days and hand pick slugs from board and dispose of slugs.
- Remove weedy areas surrounding young plants.

Biological Controls:

- None

Post Harvest Control Practices:

- None

Other Issues:

- None

Cutworms (*Agrotis ipsilon, Peridroma saucia* and others)

Infestations of cutworms are often observed when tobacco follows sod or when there has been an abundance of winter annual weeds prior to tillage. Young cutworms climb plants and feed on leaves. The mature cutworm, however, are sluggish, nocturnal, and soil burrowing. They typically sever plant stems during the night and hide in soil near the base of plants during the day. Cutworms overwinter as larvae or pupae, depending on the species. In early spring, overwintering larvae of some species become active, feed, and complete their development. In other cases, moths emerge from overwintering pupae and lay eggs on host plants or other vegetation. Therefore, depending on the species, damaging cutworms found in spring may be overwintered larvae or new generation cutworms. Cutworms develop through five to eight larval instars (again depending upon the species). Pupation occurs in the soil and lasts about 2 weeks for nonoverwintering pupae. Moths emerge and deposit 50 to several hundred eggs on host plants. The number of annual generations depends on latitude. Generally, there are two generations per year in Canada, four generations per year in Tennessee, and five to six generations per year in Florida. The spotted cutworm, however, produces only two generations per year throughout the U.S.

Chemical Controls:

- **Acephate** (Orthene 97PE):
- **Chlorpyrifos** (Lorsban 4EC, 15G):
- **Lambda-cyhalothrin** (Warrior 1CS):

Alternative Controls:

- None

Cultural Controls:

- Rotation
- Mowing weedy areas surrounding field

Biological Controls:

- None

Post Harvest Control Practices:

- None

Other Issues:

- None

Grasshoppers (*Melanoplus* spp.)

Most grasshoppers prefer other plants, however they will feed on tobacco. Grasshoppers often migrate to tobacco from weedy field edges and ditch banks especially during drought conditions. Control of grasshoppers is critical, because grasshoppers can chew large holes in leaves reducing leaf quality and yield.

Chemical Controls:

- **Malathion** (57EC, 5D):
- **Acephate** (Acephate 97PE):
- **Lambda-cyhalothrin** (Warrior 1CS):

Alternative Controls:

- None

Cultural Controls:

- Mow weedy areas near field prior to planting.

Biological Controls:

- *Nosema locustae* (various trade names) is a microsporidian protozoa.
- *Beauvaria bassiana* (various trade names) Effectiveness in tobacco production has not been researched.

Post Harvest Control Practices:

- None

Other Issues:

- None

Japanese Beetles (*Popillia japonica*)

The adults feed on leaf tissue where larvae feed on roots of the plant. Japanese beetles are voracious foliage and fruit feeders. Damaged foliage is characteristically ragged, with only the larger leaf veins intact. Stringy, black excrement is also present. Japanese beetle grubs overwinter as third instars within 13 cm of the soil surface. As the soil warms in the spring,

the grubs move closer to the surface and feed on fine rootlets. Shortly thereafter, they remain inactive for a 10-day period prior to pupation. After a pupal stage of 8 to 20 days, adults emerge. Emergence usually begins in late-May in Tennessee. On warm days the beetles fly and often congregate on host plants to feed and mate. In the afternoon, females burrow into loose, moist soil (usually in sod), and deposit one to four eggs. Over her 1.0 to 1.5 month life span, each female produces 40 to 60 eggs. Grubs emerge 2 weeks after egg deposition, feed on rootlets, and remain active until cold weather arrives. In Tennessee, a single generation is produced annually.

Chemical Controls:

- **Acephate** (Orthene 97PE):
- **Carbaryl** (Sevin 10D, 50WP, 80SP):
- **Lambda-cyhalothrin** (Warrior 1CS):
- **Imidacloprid** (Provado 1.6): formulation is expensive.
- **Thiamethoxam** (Platinum 2SC, Actara 25WG):

Alternative Controls:

- None

Cultural Controls:

- Disc up sod areas surrounding tobacco field

Biological Controls:

- *Bacillus popillae* applied in the fall in areas where larvae are present.

Post Harvest Control Practices:

- Disc field after harvest

Other Issues:

- None

Stink bugs (*Acrosternum hilare, Nezara viridula, Euschistus servus*)

Stink bugs inject a salivary secretion into the leaves of plant causing a rapid wilting of the leaf and/or stem. Scalded areas often appear on injured leaves during hot dry weather. Damage occurs more often in border rows, near weedy fields. Stinkbugs are rarely a severe pest in tobacco production.

Chemical Controls:

- **Acephate** (Orthene 97PE):
- **Endosulfan** (Thionex 3EC, 50WP):
- **Malathion** (57EC):
- **Lambda-cyhalothrin** (Warrior 1CS):

Alternative Controls:

- None

Cultural Controls:

- Mow weedy areas around field frequently.

Biological Controls:

- None

Post Harvest Control Practices:

- None

Other Issues:

- None

Vegetable Weevil (*Listroderes costirostris obliquus*)

The larvae of this pest feeds primarily in plant beds and often damage the buds and chew holes in leaves. This pest is rarely observed since most activity occurs at night. The adult vegetable weevil is active during fall, winter, and spring and aestivates (enters dormancy) during the summer in trash, leaves or grass at the edges of fields. Reproduction is parthenogenetic (no males, females lay eggs which develop into females) and some individuals may live two years. After coming out of aestivation, adults feed for several days to a month before depositing eggs on turnips or collards. Oviposition begins in fall and may continue into spring of the next year. Hatch occurs after an incubation period of two or more weeks depending on the temperature. Larvae feed on tobacco seedlings (and other vegetable crops) and become fully grown in 23 to 45 days. Pupation occurs in earthen cells in the soil in spring or in fall and late winter and will last from a few days to two weeks depending on the temperature. Adults emerge from January to June. The length of time from egg hatch to adult emergence may vary from 1 to 4 months. There is one generation per year.

Chemical Controls:

- **Acephate** (Orthene 97PE):
- **Lambda-cyhalothrin** (Warrior 1CS):

Alternative Controls:

- None

Cultural Controls:

- None

Biological Controls:

- None

Post Harvest Control Practices:

- Cultivation in fall and winter is important in reducing populations.

Other Issues:

- None

Wireworms (*Conoderus vespertinus* and others)

Tobacco following sod is most often damaged by wireworms. Problems from this pest can be reduced by selecting a site which did not previously have sod production, corn or tobacco. The preferred site for tobacco production would be an area which had no history of these crops, since these crops generally favor build up of this pest.

Chemical Controls:

- **Thiamethoxam** (Platinum 2SC):
- **Imidacloprid** (Admire 2F, Admire Pro 4.6F):
- **Ethoprop** (Mocap 10G, 6EC): also aids in root knot nematode control.
- **Chlorpyrifos** (Lorsban 15G, 4EC):

Alternative Controls:

- **Fonofos** (Dyfonate 10G, 4EC): no longer manufactured
- **Disulfoton** (Di-Syston 15G): no longer labeled for use.

Cultural Controls:

- Rotation

- Not to plant in areas with recent history of sod, corn or tobacco production.

Biological Controls:

- None

Post Harvest Control Practices:

- None

Other Issues:

- Should be applied as a preventative.

Thrips (*Frankliniella fusca* and other spp.)

Several species of thrips damage tobacco leaves, but the tobacco thrips is the principal, damaging species in Tennessee. Flower thrips, *F. tritici*, sometimes feed on the flowers but do no economic damage. Thrips are most damaging to young tobacco plants. As the upper surfaces of developing leaflets unfold, they appear scarred and even deformed. Damage is usually minor but, with heavy insect infestations in combination with other stresses, stunting occurs during early development and the damaged plants recover slowly. Thrips are vectors of Tomato Spotted Wilt Virus (TSWV).

Chemical Controls:

- **Thiamethoxam** (Platinum 2SC): very safe product.
- **Lambda-cyhalothrin** (Warrior 1CS):

Alternative Controls:

- None

Cultural Controls:

- Mow clover and weeds in surrounding areas.

Biological Controls:

- Heavy rains usually play a large role in reducing thrips populations.

Post Harvest Control Practices:

- None

Other Issues:

- None

Insecticides

Organophosphate insecticides :

- **Chlorpyrifos** (Lorsban 15G, 4EC): the 4EC formulation has Warning listed as the signal word, where the 15G formulation has Caution. Each have a 24-hr REI and a 7-day PHI. Is a Restricted Use Pesticide. Applied at the 4EC formulation rate of 2 quarts or 2 lbs ai per acre. The 15G formulation is applied at the rate of 13.5 lbs per acre. May be applied to the plant bed (48 hours before planting) or in the field, with no more than one application of chlorpyrifos containing products per season. Used to control cutworms, flea beetles, mole crickets, root maggots, wireworms and provides fire ant suppression. Depending on formulation selected, cost would vary from $13.00 for the 4EC formulation to $17.55 for the 15G formulation per acre treated.

- **Disulfoton** (Di-Syston 15G): has Danger listed as the signal word, has a 48-hr REI and is a Restricted-Use Pesticide. Previously used in the ground bed, however **no longer labeled**.
- **Fonofos** (Dyfonate 10G) product has been discontinued. The company that produced this pesticide is officially discontinuing all products containing fonofos effective December 31, 2000. Fonofos is an insecticide for the control of wireworm in tobacco. The products containing fonofos (Dyfonate 10-G, Dyfonate II 20-G) have **not** been marketed in Tennessee for several years.
- **Malathion** (Malathion 5EC, 5D): has Warning listed as the signal word and has a 12-hr REI. Product is currently **not labeled** for use in tobacco production, however there is some interest in the industry to use it to control several pests.
- **Methyl-parathion** (Penncap-M 2EC) has Warning listed as the signal word, has a 4-day REI and is a Restricted Use Pesticide. This product is **no longer labeled** for use in tobacco production.
- **Methidathion** (Supracide 2EC) has Danger listed as the signal word, has a 48-hr REI, and is a Restricted Use Pesticide. Product is **no longer labeled** in tobacco.

Carbamate insecticides :

- **Acephate** (Orthene 75, 97, 90S): has Caution listed as the signal word, has a 24-hr REI and a 21-day PHI. Applied at the rate of 1.5 lbs of the 97 formulation to 200 gallons of transplant water or 0.75 lbs formulation as a foliar spray. Used to control aphids, and flea beetles in ground beds. Used to control slugs in float system, and plant beds. In the field, used to control aphids, budworms, cutworms, flea beetles, grasshoppers, Japanese beetles, stink bugs, thrips, and the vegetable weevil. Depending on method selected cost would vary from $7.20 per acre for foliar treatment to $14.40 for transplant water treatment.
- **Carbaryl** (Sevin XLR, 80SP): has Caution listed as the signal word, has a 12-hr REI and a 0-day PHI. The XLR formulation is applied at the rate range of 1 – 2 quarts or 1 to 2 lbs ai per acre per application. No more than 8 lbs ai per acre per season may be applied. May be applied to the plant bed or in the field. Labeled for control of budworms, fall armyworms, tobacco flea beetles, hornworms, Japanese beetle, and June beetle. Cost would range from $8.60 to $17.20 per acre per application.
- **Methomyl** (Lannate 90SP, 2.4LV) has Danger listed as the signal word and is a Restricted Use Pesticide. It has a 48-hr REI and a 14-day PHI. No more than 5 applications per crop. The 90SP formulation is applied from 0.25 to 0.50 lbs per acre per application. Labeled to control flea beetles, hornworms, fall armyworm, loopers, tobacco budworm and aphids. Cost would range from $5.88 to $11.75 per acre per treatment using the 90SP formulation. Cost would range from $5.69 to $11.38 for the 2.4LV formulation.
- **Oxamyl** (Vydate 2L): has Danger listed as the signal word and is a Restricted-Use-Pesticide. Has a 48-hr REI and a 0-day PHI. Product is incorporated within the soil 4 to 6 inches of depth. Applied at the rate of one gallon formulation or 2 lbs ai per acre in the field or 1 gallon formulation per 40 gallons solution used in plant beds. Transplanting would not occur for at least 48 hours or more after treatment. Used to treat plant beds for control of flea beetles and nematodes. Cost would be $72.30 per acre.

Pyrethroid insecticides

- **Lambda-Cyhalothrin** (Warrior 1CS) has Warning listed as the signal word, has a 24-hr REI, is a Restricted Use Pesticide and has a 40-day PHI. Applied at the formulation rate range of 1.92 to 3.84 fl.oz. or 0.015 to 0.03 lbs ai per acre per application. No more than 0.09 lbs ai per acre per season. Cost would range from $.62 to $9.24 depending on rate selected.

Cyclodiene Organochlorine insecticides

- **Endosulfan** (Thionex 3EC): has Danger listed as the signal word, has a 2-day REI and is a Restricted Use Pesticide. In plant beds, applied at the rate of 0.66 quarts per 100 gallons of solution. In the field applied at the formulation rate range of 0.66 to 1.33 quarts or 0.5 to 1 lb ai per acre. No more than 2 lbs ai per acre per season and no more than two applications per season. Labeled to control aphids, budworm, cabbage looper, flea beetles, stink bugs and hornworms. Cost would range from $18.33 to $36.58 depending on rate used.

Neonicotinoid insecticides

- **Acetamiprid** (Assail 70WP, 30SG) has Caution listed as the signal word, has a 12-hr REI and a 7-day PHI. Applied at the formulation rate range for 70WP of 0.6 to 1.7 oz or 0.025 to 0.075 lbs ai per acre with no more than 4 applications per season. Labeled to control aphids, leafhoppers and budworms.
- **Clothianidin** (Belay 16WSG): has Caution listed as the signal word, has a 12-hr REI and has a 0-day PHI. Applied at the formulation rate range of 5 to 10 oz. or 0.8 to 0.16 lbs ai per acre. Used as a drench for transplants. Labeled to control aphids and flea beetles.
- **Imidacloprid** (Admire 2F, Admire Pro 4.6, Provado 1.6): has Caution listed as the signal word, has a 12-hr REI and has a 14-day PHI. The 4.6 formulation is applied at the formulation rate range of 0.6 to 1.2 floz per 1,000 plants not to exceed 0.5 lbs ai per acre per season. Labeled to control aphids, fleabeetles, mole crickets, whiteflys, wireworms, and aids in suppression of cutworms and the spread of tomato spotted wilt virus. The Provado formulation is labeled to control flea beetles and Japanese beetles in the field. Cost would range from $5.19 to $10.38 per 1,000 plant treated in a float system or in a transplant water system for the 4.6 formulation. The 1.6 formulation is rarely used due to expense.
- **Thiamethoxam** (Actara 25WG, Plantinum 2SC) has Caution listed as the signal word, has a 12-hr REI and a 14-day PHI. The 2SC formulation is applied at the rate of 0.5 fl.oz per 1,000 plants for aphid control or 0.8 fl.oz for thrips suppression. The Actara formulation is applied at the formulation rate range of 2 to 3 oz or 0.03125 to 0.0469 lbs ai per acre. The Actara formulation is labeled for field control of aphids, flea beetles and Japanese beetles. Cost would be approximately $5.92 for the 2SC formulation per 1,000 plants treated.

Microbial insecticides

- **Bacillus thuringiensis** (Dipel 2XWP) has Caution listed as the signal word and has a 0-day PHI. Applied at the formulation rate range of 2 to 5 oz per acre. Used to control hornworms.

Calcium insecticides

- **Calcium Hydroxide** (Slaked lime, hydrated lime): used in plant beds when plants are dry. Product may cause burning of foliage when leaves are wet. Applied at the rate of 4 lbs per 100 sq. yard bed. Cost of $3.00 per bed.

Avermectin insecticides

- **Emamectin benzoate** (Denim 0.16EC) has Danger listed as the signal word, has a 48-hr REI, has a 14-day PHI and is a Restricted Use Pesticide. Applied at the formulation rate range of 6 to 12 oz or 0.0075 to 0.015 lbs ai per acre. No more than two sequential applications before switching to another insecticide with a different mode of action. No more than 36 fl. oz. formulation per acre per season. Labeled to control hornworms, budworms, armyworms, and loopers. This product is relatively new and has been difficult to obtain. Cost was not available.

Pymetrozine insecticides

- **Pymetrozine** (Fulfill 50WDG) has Caution listed as the signal word, has a 12-hr REI and has a 14-day PHI. Applied at the rate of 2.75 fl.oz. per acre per application, not to exceed 5.5 oz formulation per acre per season. Used to control the green peach aphid and tobacco aphids. This product is relatively new and has been difficult to obtain. Cost was not available.

Spinosyns insecticides

- **Spinosad** (Tracer 4EC) has Caution listed as the signal word, has a 4-hr REI, and a 3-day PHI. Applied at the formulation rate ranging from 1.4 to 2.9 fl.oz. per acre. Use for control of the tobacco budworm, hornworm and thrips. Cost would range from $7.34 to $15.19 depending on rate selected.

Other pesticides

- **Metaldehyde** (Deadline Bullets 4G) has Caution listed as the signal word and has a 12-hr REI. Applied at the rate of 1 lb per 1,100 to 3,600 sq. ft. Generally applied in the evening. Applied during the growing season when plants are small on an as needed basis every 3 to 4 weeks. Used to control slugs in float bed and greenhouses. Cost is approximately $1.88 per lb of formulation.

Diseases and Disease Control

There are several diseases which occur in tobacco production in Tennessee and the production of healthy tobacco transplants is the first step toward the production of high quality tobacco in the field. In Tennessee approximately 98% of the transplants are produced in greenhouses using the float tray system. Many transplants are started off the farm and are transported to the farm within a few weeks to one month prior to transplanting into the field. One of the most common diseases of tobacco seedlings in greenhouses is damping off caused by *Pythium* spp. Other diseases include; *Rhizoctonia solani*, and *Sclerotinia* spp. Estimated losses from these pathogens in the production of tobacco seedlings vary from year to year and usually average around 0.8%.

Listed are diseases which occurred in Tennessee during 2007 with an estimated percent loss. Black shank (*Phytophthora parasitica*) caused an estimated 10.00% loss, blue mold (*Peronospora tabacina*) <0.25% loss, black root rot (*Thielaviopsis basicola*) trace loss,

brown spot (*Alternaria alternata*) 0.10%, Tomato Spotted Wilt Virus (TSWV) 5% loss, aphid borne virus complex (several viruses) trace loss, angular leaf spot (*Pseudomonas tabaci*) trace damage, target spot (*Thanatephorus cucumeris*) 0.50%, and other disease organisms (*Rhizoctonia* spp. , *Cercospora* spp.) with trace loss. Other factors which caused loss in 2007 tobacco production included: drought 20.00% loss, low pH 1.00%, and herbicide injury with 0.02% loss. Spartan herbicide has caused some problems in areas where rainfall occurred after application and/or transplanting, however loss was minor.

Plant Bed Diseases

Disease Control in Plant Beds

There are numerous diseases observed in tobacco plant beds. Most diseases are soil borne diseases where other diseases may be spread by wind and arthropods and occasionally by animals or humans. Diseases commonly found in plant beds which are considered soil borne diseases which include; algae, wildfire, angular leaf spot, anthracnose, rhizoctonia, target spot (also spread by wind and rain), Sclerotinia root rot, bacterial soft rot, Pythium root rot and black shank. Other diseases are transported by wind include; blue mold, and target spot. A few diseases are spread by insect vectors such as tomato spotted wilt virus (TSWV) which is spread by thrips and many other viruses are spread by aphids. Due to lack of limited chemical control options, disease management is usually centered around cultural control practices.

Location: it is recommended to locate transplant production away from tobacco fields and other areas where tobacco may be worked (barns, stripping areas, etc.)

Water source: Use clean water. Water from creeks, streams, ponds and lakes may contain spores of *Pythium* spp and/or *Phytophthora* spp.

Sanitation: use clean equipment, tools, plastic covers, trays, washing hands, remove any unhealthy or diseased plants.

Plants: grow your own, purchase healthy plants or plugs, buy locally grown plants.

Aeration: provide an environment which has good aeration. Do not direct fans towards plants, it could cause wicking of water in tray cells, leaving high salt residues at the soil-less mix line, resulting in injury.

Media mix: Not all media mixes are pathogen free. If problems have occurred in the past, growers may want to use another source of soil-less mix.

Fertilization: over fertilization creates lush, tender plants and excessive canopy growth which may promote disease development.

Plant removal: removing old unused plants, reduces sites for diseases to develop. This method can be effective in reducing blue mold spread.

Clipping: using a mower to even growth of plants and to reduce plant size can be highly beneficial, however clippings must be removed from float trays to reduce possible disease incidence.

Field Diseases

Blue mold (*Peronospora tabacina*)

Blue mold is caused by a fungus which commonly affects tobacco in Tennessee. Blue mold had been considered to be primarily a problem in the plant bed where total loss of plants has occurred when not controlled. However, during extremely wet and cool conditions provides a conducive environment for the fungus to develop, spread, and infect plants. Spore production can occur from 46-86°F. Temperatures above 86°F or below 46°F restrict spore production. The time from infection to sporulation is typically from 4 to 15 days, but can be considerably longer depending upon day and night temperatures, variety, and strain of the fungus. Night temperatures from 50 to 65°F and daytime temperatures from 70-85°F are ideal for disease development. During most years, from May to early June temperatures are ideal for development of blue mold. Thus, any rainfall and irrigation would tend to strongly influence blue mold development. Blue mold causes variable symptoms. In young plants, leaf yellowing and cupping occurs. Eventually leaves will turn brown and the plant may die. In the plant bed somewhat circular patches of plants will be infected, with disease spread away from these areas. As plants get larger, various degrees of systemic infection may occur and depending on time of infection, may kill or severely stunt infected plants. Approximately, 500 acres were treated for blue mold control in the field during 2007. Products containing mancozeb were applied to approximately, 20% of the tobacco produced, to aid in early season (ground beds and float beds) blue mold control.

Chemical Controls:

- **Acibenzolar** (Actigard 50WG): may only be used when plants are 18 inches in height or larger and are actively growing. Fairly expensive, must be applied prior to the onset of blue mold to achieve effective control. Does not require special nozzles or total plant coverage to be effective.
- **Azoxystrobin** (Quadris 2.08): for field use only. Product is slightly systemic. Thorough coverage provides more effective control.
- **Dimethomorph** (Forum): must be mixed with mancozeb products to obtain effective control of blue mold. For field use only. Product is locally systemic.
- **Fosteyl-Al** (Aliette WDG): must be used at high rates to be effective. This product is slightly systemic and thorough coverage provides more effective control.
- **Mancozeb** (Dithane DF rainshield): commonly mixed with dimethomorph to obtain greater control. May be used in ground bed, field and float bed production. This product is a protectant and thorough coverage is critical for effective control.
- **Mefenoxam** (Ridomil Gold SL, Ultra Flourish): will not control resistant fungal strains. For field use only. Product is highly systemic and should be applied to soil for effective plant uptake.

- **Streptomycin sulfate** (AgriMycin): recommended for use only in ground beds and is poorly effective.

Alternative Controls:

- Plant and row spacing can aid in reducing humidity levels.

Cultural Controls:

- Several **new varieties** have greater tolerance to this disease. TN90 has been reported to have some resistance.

Biological Controls:

- None

Post Harvest Control Practices:

- Rouge out any remaining plants and/or stalks. Extremely warm winters it would be possible for infected plants to overwinter. This is usually not the case in Tennessee.

Other Issues:

Black shank (*Phytophthora parasitica* var. *nicotiana*)

Black shank is caused by a fungus which lives in the soil. This pathogen belongs to a group of fungi that occurs commonly in areas of high soil moisture. The fungus produces microscopic spores which swim in water surrounding roots and/or soil particles. These swimming spores are attracted to tobacco, their only natural host, by root exudates produced primarily at growing points and wounds. Whereas wounds are not required for penetration, they do favor more rapid disease build-up. The fungus forms thick-walled, resistant spores, some of which may survive for years during unfavorable conditions. Once conditions are favorable, the resistant spores germinate and motile spores are produced. During favorable conditions for the fungus, a new generation of motile spores is produced every 72 hours. The black shank fungus is spread when infested soil is moved from one place to another. Contaminated irrigation or runoff water may also aid in its movement within a field or from one field to another. Although roots are the most commonly affected plant parts, occasionally the fungus infects leaves and forms circular, yellowish-to-brown lesions up to 3 inches in diameter. Leaf infection may occur as a result of zoospores in splashing water or contact with infested soil. Approximately 25% of the acreage grown was treated with mefenoxam products to aid in black shank control.

Chemical Controls:

- **Mefenoxam** (Ridomil Gold SL, Ultra Flourish): need to use a resistant variety with a medium to high level of resistance to obtain economic returns. Product should be applied to the soil prior to planting to obtain effective control.

Alternative Controls:

- None

Cultural Controls:

- **Rotation** into sod for two or more years.
- **Resistant varieties**; varieties with a level of 4 or greater have demonstrated the greatest yield improvements when mefenoxam was used.
- **Sanitation** - Elimination of the host by destroying stalks and roots immediately following harvest will help reduce populations of the fungus and nematodes, resulting in less damage in the next crop.

- **Irrigation** from areas other than creeks, streams, and ponds, to reduce chances of introduction of the pathogen.
- **Clean equipment** between fields.
- **Work non-infested areas prior to areas with known history of black shank.**

Biological Controls:

- None

Post Harvest Control Practices:

- Do not distribute old stalk residues in un-infested areas.

Other Issues:

- None

Target spot (*Thanatephorus cucumeris, Rhizoctonia spp.*)

Rhizoctonia solani causes two types of diseases on tobacco seedlings in greenhouse floatbed system: Target spot caused by *R. solani* strain AG3 is more common and causes stem rot, sore shin, and damping-off is caused by *R. solani* strain AG4. In the float bed system, target spot is usually observed as small transparent water soaked leaf spots, usually when the canopy is already formed (high humidity and high temperature). Symptoms on leaves begin as small, round, water-soaked spots about 2-3 mm in diameter. Under favorable conditions these lesions enlarge rapidly, becoming light green, almost transparent, with irregular margins and chlorotic halos. In infested areas, lower leaves turn brown and stick to the surface of the tray and the presence of brown spider-like webs (mycelium) may be observed attached to leaves and stems. When periods of high relative humidity, prolonged leaf wetness, and moderate temperature are present, cream color hyphae (hymenium) are formed on the soil surface, on infected stems, and on leaves. Then production of spores start which are wind dispersed all over the float bed system. When conditions are not favorable for basidiospore production (low moisture), leaf spot isolates may cause damping-off and sore shin of tobacco seedlings. This strain, in a few cases may kill the plant. Sore shin and target spot are both commonly observed in the field.

Chemical Controls:

- **Azoxystrobin** (Quadris 2.08): for field use only.

Alternative Controls:

- **Steam treatment** of plant trays prior to planting:
- **Steam treatment** of growing media.
- **Methyl bromide treatment** of plant trays.

Cultural Controls:

- **Rotation** in the field
- Adequate **aeration** within the greenhouse, helps reduce high humidity levels needed for fungal development.
- Use clean float trays.

Biological Controls:

- Gliocladium spp. GL-21 has been reported to aid in control when added to growing media. No state data is available concerning efficacy of this product.

Post Harvest Control Practices:

- If float trays are to be reused, thoroughly clean them prior to storage.

Other Issues:

Frogeye leaf spot (*Cercospora nicotianae*)

Frogeye can occur in leaves at any time during the season. Spots vary in size from a pinpoint to slightly over 1/2 in. Spots 1/8 to 1/4 inch are common. Frogeye leaf spots are sunken, somewhat round, white in the center when mature and delineated by a distinct brown-purple border ring. The ring may encompass most of an individual spot in some situations. High humidity aids in the development of the fungus.

Chemical Controls:

- **Azoxystrobin** (Quadris 2.08):

Alternative Controls:

- None

Cultural Controls:

- Rotation
- Increasing row and plant spacing at setting may aid in reducing humidity of leaf surface.

Biological Controls:

- None

Post Harvest Control Practices:

- Dispose of plant stalks after stripping in areas away from future plantings.

Other Issues:

- None

Anthracnose (*Colletotrichum nicotianae*)

Anthracnose is fungal disease which may be encountered in tobacco seed beds and occasionally in the field. Small gray-white, usually circular, spots develop on leaves. As lesions age and dry, they become papery and thin and are surrounded by a raised water-soaked border. Leaf tissues, especially veins and midribs, may appear "pitted" or sunken when viewed from the underside. The lesions often become brown. Larger spots may have a dark brown center. Lateral veins on the lower leaf surface may turn dark. Heavily affected leaves may become wrinkled and/or distorted. As the disease continues, the entire leaf may die. Small plants may be killed, resulting in large barren spots in plant beds. In the field, leaf lesions may be followed by cankers on midribs and stems. Anthracnose is favored by wet conditions and is sometimes confused with weather fleck. Symptoms of anthracnose are also similar to those of target spot. Target spot has more consistently circular, pin-head sized lesions which usually do not affect the major leaf veins until the whole leaf begins to die, whereas anthracnose often attacks leaf veins and petioles early in the disease development.

Chemical Controls:

- **Mancozeb** (Dithane DF Rainshield): thorough coverage is required to obtain effective control.

Alternative Controls:

- None

Cultural Controls:

- In plant beds, weeding frequently reduces humidity and spread of the fungus.
- Keep nitrogen levels at an optimum level.

Biological Controls:

- None

Post Harvest Control Practices:

- Dispose of plant stalks after stripping in areas away from future plantings.

Other Issues:

- None

Damping off (*Pythium* spp.)

This disease has become very important for tobacco seedlings because the mechanism of *Pythium* dissemination is very adapted to float systems used in tobacco production in greenhouses. Zoospores can easily move throughout the seedling bed in the water and reach epidemic levels in a short time. If infected plants live, their vigor is generally reduced, resulting in poor quality transplants. Once transplanted, plants are very slow to grow and are usually stunted. If infected in the field, plants have reduced vigor and have stunted growth.

Chemical Controls:

- **Terrazole** (Terramaster 4EC): **float bed use only**. Has some phytotoxicity issues which are occasionally observed from use of this product.
- **Mefenoxam** (Ridomil Gold SL): **field use only**. Must be applied prior to planting.

Alternative Controls:

- Steam sterilize growing media for float trays.

Cultural Controls:

- Use clean trays
- Use municipal water sources for float plants and ground beds, if available.
- Do not use water from ponds, creeks, or streams.
- Use plastic disposable boot covers when entering greenhouse area.

Biological Controls:

- None

Post Harvest Control Practices:

- Store trays in clean areas off of soil.

Other Issues:

- None

Wildfire angular leafspot (*Pseudomona syringae* pv. *angulata*)

Angular leaf spot is caused by a bacterium. Tobacco is considered to be the primary host for this bacterium, but numerous other plant species have been infected experimentally. This bacterium can survive in tobacco stubble, dry leaf, or manufactured tobacco. It survives also on roots of pasture, weed, and crop plants such as tobacco, wheat, rye, barley, vetch, chickweed, shepherds purse, lespedeza, clover, ragweed, and oxalis. Spread of the bacterium occurs primarily by wind-driven rain, rain splash, or irrigation. Infection of leaves occurs through wounds or natural plant openings such as stomates. Bacterial cells enter into such openings and within 2 – 7 days, leaf spots develop. The shorter incubation period of two days occurs when plants are exposed to excess rain or irrigation. Angular leaf spot can develop at any temperature suitable for growth of tobacco. Symptoms of angular

leaf spot are often diagnostic in the field. Distinct angular, dark, vein-limited spots occur on a leaf, often in an aggregated pattern. Laboratory diagnosis may be necessary in many situations.

Chemical controls:

- **Streptomycin sulfate** (AgriMycin): application is usually not necessary in the field unless wet overcast conditions prevail for several days.

Alternative Controls:

- None

Cultural Controls:

- Rotation
- Plowing plant beds after transplant and/or fields after harvest.
- Use disease free transplants
- Avoid high amounts of nitrogen or lime prior to planting.

Biological Controls:

- None

Post Harvest Control Practices:

- Remove old crop residue

Other Issues:

- None

Tomato Spotted Wilt Virus (TSWV)

Tomato Spotted Wilt Virus has been reported almost everywhere in the United States where tomatoes and ornamentals are grown. It is a very destructive disease of tomatoes and tobacco. One hundred sixty-three plant species are affected by TSWV, including many flowers and ornamentals. It can be especially severe problem in greenhouse plant production. Ring spots are often seen in developing of leaves. Often systemic infections may be observed. A necrotic vein may appear causing one half of the leaf to grow at a faster rate and the leaf will appear to bow. Infected plants may look as if it has a vascular wilt. The entire plant is usually dwarfed and if infected just after transplant, often dies. The virus is vectored by thrips.

Chemical Controls:

- Products containing **neonicotinoid** insecticides may provide some benefit.
- A systemic insecticide such as **acephate** may provide some benefit, if applied at transplant.

Alternative Controls:

- None

Cultural Controls:

- **Mow** weedy areas around plant beds, float beds, and field.
- **Reflective mulches** have been reported to aid in control of TSWV and resulted in less incidence of TSWV vs non-reflective mulches.

Biological Controls:

- None

Post Harvest Control Practices:

- Mow weedy areas around field may reduce food sources for thrips.

Other Issues:

- Usually observed more often during dry springs.

Algae

Like all plants, algae require nutrients to grow and reproduce. In the float system, algae are free-floating, so they must get their nutrients from the water and sunlight. They do not have the ability to obtain nutrients from the solids found on the float bed bottom, however in plant beds could obtain nutrients directly from the soil. The higher the nutrient level in the float bed or soil, the more algae you will have. Also, the older the float bed, the more nutrients will have accumulated and the more susceptible it will be to algae problems. The leaching of nutrients from tray cells will accelerate algae growth in the float bed.

Chemical Controls:

- **Terrazole** (Terramaster 4EC): may be phytotoxic in some situations. Float bed use only.
- **Lime** (various): for ground beds.

Alternative Controls:

- Steam sterilized growing media. Difficult to do and can be costly.

Cultural Controls:

- Trays tightly packed within the float system will help reduce algae growth on the water.

Biological Controls:

- None

Post Harvest Control Practices:

- None

Other Issues:

- None

Fungicides

- **Acibenzolar** (Actigard 50WG): has Caution listed as the signal word, has a 12-hr REI and a 21-day PHI. Applied at the rate of 0.5 oz. or 0.0156 lbs ai per acre per application. Not to exceed 4 oz per acre per season. Applications to should begin prior to the onset of blue mold. Applications to burley tobacco should be made when plants are actively growing and have reached at least 18 inches in height and dark varieties must be actively growing and at least 12 inches in height. Labeled for control of blue mold. **NOTE**: product should be applied prior to the onset of blue mold to obtain effective control. Cost is approximately $30.25 per acre per application.
- **Azoxystrobin** (Quadris 2.08): has Caution listed as the signal word, has a 4-hr REI and a 0-day PHI. Applied at the formulation rate range of 6 to 12 fl.oz. or 0.1 to 0.2 lbs ai per acre. No more than 0.52 lbs ai per acre per season may be applied. This product should not be tank mixed with endosulfan or other EC formulated products. Labeled to control blue mold, target spot and frogeye leaf spot. Cost would range

from $13.50 to $27.00 per acre per application. No more than two sequential applications without changing to another product with a different mode of action.

- **Copper** and **hydrated lime** (Bordeaux mixture) the mixture contains 1.5 lbs bluestone copper and 2 lbs of hydrated lime mixed in 25 gallons of water. Material is passed through a 400 mesh screen and added to the water with constant agitation. Young plants and the soil surface are thoroughly wetted down. Used to control algae in ground beds. Cost of approximately $5.00 per ground bed.
- **Dimethomorph** (Forum 4.18): has Caution listed as the signal word, has a 12-hr REI and a 0-day PHI. Applied at the formulation rate of 2 to 8 fl.oz. or 0.065 to 0.26 lbs ai per acre. No more than 8 fl.oz. per application or 30 fl.oz. per season. This product must be mixed with mancozeb containing products to obtain effective control of blue mold. Cost would range from $3.17 to $12.69 per acre per application.
- **Fosteyl-Al** (Aliette WDG) has Caution listed as the signal word, has a 12-hr REI and a 3-day PHI. In the greenhouse or transplant beds applied at the rate of 0.5 lbs per 50 gallons of water. No more than two applications per season in the greenhouse or transplant beds due to leaf burn issues. No more than 0.6 lbs formulation per 1,000 sq ft per greenhouse or transplant bed application. For field applications applied at the formulation rate of 2.5 to 4 lbs or 2 to 3.2 lbs ai per acre. No more than 2 greenhouse/transplant bed applications and no more than 5 field applications. Labeled for control of blue mold. Cost would range from $65.43 to $104.69 per acre per application.
- **Mancozeb** (Dithane DF rainshield): has Caution listed as the signal word, has a 24-hr REI and 30-day PHI. Applied at the formulation rate of 1.5 to 2.0 lbs per 100 gallons of spray solution per acre. Product should not be applied after a sucker control material has been applied. Labeled for control of blue mold, anthracnose, and Rhizoctonia and Fusarium damping off in the plant bed. Cost ranges from $4.20 to $5.60 per acre per field application.
- **Mefenoxam** (Ridomil Gold SL, Ultra Flourish): has Caution listed as the signal word and a 48-hr REI. The SL formulation contains 4 lbs ai per gallon of formulation. Applied at the SL formulation rate of 0.5 to 3 pints or 0.25 to 1.5 lbs ai per acre. Labeled to control black shank, blue mold and Pythium damping off. For effective control of black shank a variety with a level of 4 or greater resistance for black shank must be used. Cost would range from $107.80 to $323.40 per acre depending on rate and number of applications made.
- **Methyl bromide** and **chloropicrin** (Bromo-gas) is formulated at 98% MB and 2% C. Applied at the rate of 9 lbs per 100 sq. yard for ground beds. Beds are prepared just as producers do for seeding (adequate soil moisture and tilth). A tight air cover must be used to seal the treated area. Areas are normally treated in the fall when soil temperature is above 50F. Treated areas must be exposed to the fumigant for 24-48 hours, then the area is aerated for one week prior to seeding. Seeding occurs in late January. Used to control various soil-borne diseases, weeds and insect pests.
- **Streptomycin sulfate** (AgriMycin) has Caution listed as the signal word and has a 12-hr REI. Applied at the rate of 100ppm solution or 0.5 lbs per 100 gallons of water. If the disease is present a 200ppm solution is used. The solution is then applied thoroughly to wet the foliage of plants. Used to control wild fire and

angular leaf spot in ground beds. Also labeled to control blue mold. Cost would be approximately $8.00 per 100 gallons of prepared solution.

- **Terrazole** (Terramaster 4EC) has Danger listed as the signal word and depending on the area conditions the REI ranges from 12 to 24 hr REI. There are two methods for application. A preventative method which includes 1 fl.oz. per 100 gallons of float water, followed by another 1 fl.oz. per 100 gallons of float water three weeks after the first application. For curative control 1.4fl.oz per 100 gallons of float water is used when disease symptoms first appear followed by a second application of 1 to 1.4 fl.oz per 100 gallons of float water, if symptoms recur. Product should not be applied sooner than three weeks after seeding and no later than 8 weeks after seeding. Even distribution of this material is critical, so the material should be mixed in a bucket with water then distributed to the treated area and mixed thoroughly within the float bed. Used to control *Pythium* spp. and will aid in the control of algae. Cost would range from $2.75 to $3.85 per 100 gallons of treated water.

Weed Control

There are several weeds which occur in tobacco production. These include; crabgrass , fall panicum, foxtail, goosegrass, johnsongrass, yellow nutsedge, cocklebur, groundcherry, hairy galinsoga, horsenettle, jimsonweed, lambsquarter, morningglory (several species), pigweed, purslane, ragweed, smartweed, and spiny amaranth. Yellow nutsedge is an occasional problem in lowers areas of the field which tend to retain greater amounts of soil moisture. Command, Spartan and Prowl are the most commonly used herbicides for weed control.

Herbicides

- **Clomazone** (Command 3ME): has Caution listed as the signal word, has a 12-hr REI and a 0-day PHI. Applied at the formulation rate range of 2 to 2.67 pints or 0.75 to 1 lb ai per acre. Provides control of several broadleaf weeds and grasses. Application cost would range from $25.63 to $34.21 per acre depending on rate used. **NOTE**: Clomazone is a persistent herbicide which may injure crops planted after tobacco has been harvested.
- **Napropamide** (Devrinol 50DF, 2E): the 50DF formulation has Warning listed as the signal word since it is an eye irritant. The 2E formulation has Danger listed as the signal word. Both formulations have 12-hr REIs. Applied at the rate range of 1 to 2 lbs ai per acre. Areas treated with this product, the soil should be worked to reduce any possible crop injury due to remaining residues. Napropamide is used for control of hairy galinsoga, however the maximum rate must be used to get effective control. Cost would range from $16.80 to 33.60 for the DF formulation and $36.50 to $73.00 for the EC formulation. **NOTE**: Napropamide is a persistent herbicide which may injure crops planted after tobacco has been harvested.
- **Pendimethalin** (Prowl 3.8CS): has Caution listed as the signal word and has a 24-hr REI. Applied at the formulation rate of 1.5 to 3 pints or 0.71 to 1.42 lbs ai per acre depending on soil type. This product should not be applied as a broadcast spray. Cost would range from $6.30 to $12.60 per acre depending on rate used.

NOTE: Pendimethalin is a persistent herbicide which may injure crops planted after tobacco has been harvested.

- **Sulfentrazone** (Spartan 4F): has Caution listed as the signal word and has a 12-hr REI and a 0-day PHI. Applied at the formulation rate range of 8 to 10.1 fl.oz. or 0.25 to 0.31 lbs per acre. Sulfentrazone is the only product which gives satisfactory control of morning glories. Caution should be used when applying this product due to some phytotoxicity issues. Cost would range from $57 to 72 per acre depending rate used. **NOTE**: This product should not be applied over the top after transplanting, as severe crop injury will occur.
- **Sethoxydim** (Poast 1.5E): has Warning listed as the signal word, has a 12-hr REI and a 42-day PHI. Applied at the formulation rate of 1.5 pints or 0.28 lbs ai per acre. Used to control various grasses. Cost would be around $14.29 per acre.
- **Glyphosate** (various 4EC, 5.5EC): has Caution listed as the signal word, has a 4-hr REI and a 0-day PHI. Generally, applied at the rate of 4lbs ai per acre. This product is commonly used in the fall prior to planting to aid in weed control for the following season. Depending on formulation or rate used cost may range from $25 to $37 per acre per application.
- **Paraquat** (Gramoxone 2E): has Danger listed as the signal word, has a 24-hr REI and a 0-day PHI. This is a Restricted-Use-Pesticide. Applied at the rate of 0.5 to 1 gallon formulation or 1 to 2 lbs ai per acre. This product may be used several weeks prior to planting to burn down weeds, if no-till tobacco production methods are selected. Less than 1% of tobacco production utilizes no-till production methods. Cost would range from $16.10 to 32.20 per acre.

Sucker Control Products

Removing the tops of tobacco plants removes the dominant influence of the terminal shoot over lateral shoots or "suckers." If left unchecked, suckers can severely reduce yield and quality of tobacco. Research has shown that tobacco topped at bud-elongation stage will yield 300 or more pounds per acre compared to tobacco that is topped at full bloom. In general, for burley and dark types of tobacco, plants are topped when 50% or more of the plants have developed flowers. Tops are removed by hand by breaking out tops or cut off using a knife. Hand suckering has been replaced with more efficient and effective chemical control programs.

Three types of chemical sprays for controlling sucker growth on tobacco plants are:

- Systemic--These chemicals are absorbed by plants and move inside the plant to active growth sites,
- Contact--These chemicals are not absorbed by plants and must be used so as to contact the suckers directly.
- Local systemic--This chemical runs down the stalk and is absorbed by the suckers.

- **Butralin** (Butralin 3EC): has Danger listed as the signal word, has a 12-hr REI. Applied at the formulation rate of 3 to 4 quarts alone or 2 to 4 quarts with maleic

hydrazide products. Must be applied within 24 hours of topping. Sequential treatments may be made after initial treatment, however these treatments are rarely needed. Is a local systemic sucker control agent. Cost would vary from $33.93 to $67.85 depending on rate used.

- **Maleic hydrazide** (Royal MH30): has Caution listed as the signal word and has a 12-hr REI. Applied at the formulation rate of 2 gallons or less per acre depending if product is spray alone or mixed with other products. One gallon of formulation contains 1.5 lbs active ingredient. When a systemic sucker control chemical is to be used, plants should be topped when 50% or fewer plants in the field have at least one flower open. Any suckers present should be removed when the plants are topped. Sucker control effectiveness is not reduced when untopped plants are sprayed with MH, then topped within two days. This product is a systemic sucker control product. **NOTE**: **industry has been requesting that growers apply MH products as directed by the label or use other products due to high levels of MH residues found after curing.** Cost would range from $23.93 to $31.90 per acre depending on rate used. More MH is used in burley production than in dark types.
- **Flumetralin** (Prime +, Flupro): has Danger listed as the signal word, has a 24-hr REI. The formulation contains 1.2 lbs ai per gallon of formulation. Applied at the rate of 1 gallon per acre. This product is often mixed with maleic hydrazide to improve efficacy. Is a local systemic sucker control chemical. This material is applied to the top of the plant so that it runs down the stalk and into each leaf axil where it systemically controls the suckers. The method of application is similar to that used for contacts, and Prime+ has, therefore, been used more extensively in dark tobacco regions where contact use is common. Prime+ should be applied when most tobacco plants are in the elongated button to early flowering stage. That's important because the number and size of suckers should be small. Suckers more than one inch long must be removed at topping. If flowering is uneven, early flowering plants should be topped and treated with Prime+. If suckers are present, they should be removed before application. Cost would be approximately $73.00 per acre. **NOTE**: Poor stands and/or growth of rotational or cover crops have been observed in some fields where flumetralin materials have been used in conjunction with dinitroanalin herbicides (Prowl).
- **Fatty Alcohol** (Royal-TacM 6.04): has Danger listed as the signal word, has a 24-hr REI and a 7-day PHI. Applied at the rate of 1.75 to 2. gallons per 50 gallons of water, which should treat approximately 130 to 190 plants. For dark types applied at the rate of 2 to 3 gallons formulation per 50 gallons of water. This product is a contact sucker control agent. Pricing not available from vendors.

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References:

Tobacco Pest Control, University of Tennessee Extension Service, Extension Service. SP91.

Weed Control Manual for Tennessee, University of Tennessee, Extension Service, PB 1580.

Burley Tobacco Production in Tennessee, University of Tennessee, Extension Service, PB1657.

Estimated Insecticide Use in 2007 Tobacco Production

Active ingredient	Tradename / formulation	Avg. number of applications	Percent acreage treated
Chlorpyrifos	Lorsban 4EC	1	0.1%
	Lorsban 15G	1	0%
Acephate	Orthene 97PE	2	35%
Carbaryl	Sevin 80S	1	0.75%
	Sevin XLR	1	0.25%
Methomyl	Lannate 90SP	1	2%
Oxamyl	Vydate 2L	1	0.1%
Lambda-cyhalothrin	Warrior 1CS	1	10%
Endosulfan	Thionex 3 EC	1	5%
Acetamiprid	Assail 70WP	1	0.01%
	Assail 30SG	1	0%
Clothianidin	Belay 16WSG	1	0%
Imidacloprid	Admire 2F	1	0.3%
	Admire Pro 4.6	1	58%
Thiamethoxam	Platinum 2SC	1	8%
	Actara 25WG	1	0%
Bacillus thuringiensis	Dipel 2XWP	1	0.5%
Calcium hydroxide*		1	0.5%
Emamectin benzoate	Denim 0.16EC	1	0.5%
Pymetozine	Fulfill 50WDG	1	0.5%
Spinosad	Tracer 4EC	1	0.5%
Metaldehyde**	Deadline Bullets 4G	1.5	3%

* primarily used for disease control

** generally, this product is used around float beds, ground beds and greenhouses and not in the field. Amount listed would suggest percent of **production area** treated.

Estimated Fungicide Use in 2007 Tobacco Production

Active Ingredient	Tradename / Formulation	Est.number of applications	Percent acreage treated
Acibenzolar	Actigard 50WG	1	0.5
Azoxystrobin	Quadris 2.08	1	3
Copper-hydrated lime*	Bordeaux mixture	1	trace
Dimethomorph	Forum	1	1.5
Fosteyl-al	Aliette 80WDG	1	trace
Mancozeb	Dithane DF 75	2	2
Mefenoxam	Ridomil Gold SL	1	25
	Ultra Flourish	1	1
Methyl bromide / Chloropicrin	Bromogas	1	Trace
Streptomycin sulfate*	AgriMycin	1	trace
Terrazole*	Terramaster 4EC	1	5

Estimates provided by Darrell Hensley

* percent total tobacco crop treated in plant bed system or float bed system

Estimated Herbicide Use in 2007 Tobacco Production

Active Ingredient	Tradename / Formulation	Est. number of applications	Percent acreage treated
Clomazone	Command 3ME	1	40
Pendimethalin	Prowl 3.8EC	1	25
Sulfentrazone	Spartan 4F	1	70
Sethoxydim	Poast 1.5EC	1	15
Paraquat	Gramoxone	1	3
Napropamide	Devrinol 50DF	1	5
	Devrinol 2EC	1	5
Glyphosate	Various	1	2

Estimates provided by Paul Denton

Estimated Growth Regulator Use in 2007 Tobacco Production

	Percent Acreage Treated	
Active Ingredient*	**Burley**	**Dark**
Butralin	25	40
Maleic hydrazide	90	20
Flumetralin	35	60
Fatty alcohols	30	70

* Products containing butralin or flumetralin are often used in conjunction with maleic hydrazide.
Estimates provided by Andy Bailey.

Expected Herbicide Response of Common Weeds in Tobacco

Weed	Herbicide				
	Command	**Devrinol**	**Prowl**	**Spartan**	**Poast**
Cocklebur	5	0	0	6	0
Common ragweed	6	7	0	2	0
Crabgrass	9	8	9	7	9
Fall panicum	9	8	9	7	9
Foxtail	9	8	9	7	9
Goosegrass	9	8	9	7	9
Groundcherry	3	0	0	--	0
Hairy galinsoga	9	7*	0	5	0
Horsenettle**	0	1	0	0	0
Jimsonweed	5	0	0	7	0
Johnsongrass, rhizome	1	0	2	1	7
Johnsongrass, seedling	8	7	8	6	8
Lambsquarters	7	8	7	8	0
Morningglories	3	1	5	9	0
Pigweed	2	9	8	9	0
Purslane	--	9	7	--	0
Smartweed	6	6	2	7	0
Spiny Amaranth	2	9	8	9	0
Yellow nutsedge	0	0	0	8	0

* 2 lb. a.i./acre required for this level of control.

** Horsenettle is a deep-rooted perennial. For best results, spray mature weeds after tobacco harvest with a cupful of Roundup mixed with two gallons of water. Wet foliage thoroughly and wait seven days before disking or turning. This application will also give excellent control of rhizome johnsongrass.

RATING SCALE: 0=No Control; 9=90% Control or Greater; -----=Data not available. The above ratings are based on labeled herbicide rates and proper application methods.

2007 Disease Loss Estimate for Tobacco

Cause	**Estimated loss**
Drought	15%
Black shank	5%
Blue mold	0.5%
Target spot	Trace
Frogeye leaf spot	Trace
Pythium root rot	1%
Soil pH related	3%
Others	Trace

Burley Tobacco Variety Disease Ratings

		Disease Resistance Ratings						
Variety	***Yield potential[1]***	***Black[2] Shank Races*** 0	1	*Black Root Rot*	*Wildfire*	*Tobacco Mosaic Virus (TMV)*	*Tobacco Vein Mottling Virus (TVMV)*	*Tobacco Etch Virus (TEV)*
Black Shank Susceptible								
MS KY 14xL8[2]	7	10	0	Medium	High	High	None	None
NC 3	7	2	2	High	High	High	High	Medium
N 126	8	0	0	Medium	High	High	None	None
R 7-12	8	0	0	High	High	High	None	None
Hybrid 403	9	0	0	High	-	High	None	None
NC BH 129	7	1	1	High	High	High	None	None
HB 04P	9	0	0	High	High	High	None	None
NC 2000	2	0	0	Low	High	High	None	None
NC 2002*	3	0	0	Low	-	High	None	None
Black Shank Resistant								
TN 86 LC	7	4	4	High	High	None	High	Medium
TN 90 LC	5	4	4	High	High	High	High	Medium
TN 97 LC	6	5	5	High	High	High	High	Medium
NC 5	7	10	4	High	-	High	High	Medium
KT 204 LC	9	7	7	High	High	High	High	Medium

[1] Rating of 1 - 10, with 10 being highest potential yield.
[2] Scale of 0-10, with 10 having the greatest resistance in burley varieties.
"-" = resistance not evaluated or data limited.
* NC 2002 is blue mold resistant, but susceptible to black root rot and many viruses. It is recommended only in situations if severe blue mold is expected, where black shank or black root rot are not present and where chemical control would not be feasible for control.

DARK TOBACCO DISEASE RATINGS

	Black Shank Race 0	*Black Shank Race 1*	*Black Root Rot*	*Fusarium Wilt*	*Tobacco Mosaic Virus*	*Wildfire*
N.L. Madole	None	None	None	None	None	None
T.R. Madole	None	None	None	None	None	None
Little Crittenden	None	None	None	None	None	None
DF 911	None	None	High	None	High	High
KY 160	None	None	None	None	High	None
KY 171	None	None	High	Moderate	High	None
VA 309	Moderate	Low	Low	-	None	-
VA 359	Low	Low	Low	-	None	-
TN D950	Moderate	Moderate	High	None	High	High
KT D4 LC	Moderate	Moderate	None	-	None	None

For an extensive list of dark tobacco varieties, visit: http://ces.ca.uky.edu/darktobacco