Crop Profile for Soybeans in Tennessee

Prepared: August, 1999
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General Production Information

- The average yield was 38 bushels per acre in 2005.
- Approximately 1,130,000 acres were planted and 1,100,000 acres were harvested, with a total of 41,800,000 bushels produced.
- Tennessee soybean crop was valued at $232,000,000 for 2005 (Tennessee Agricultural Statistics Service).
- The top five soybean producing counties for 2005 included: Dyer, Gibson, Obion, Weakley and Lauderdale. These counties are located in West Tennessee.

Worker Activities

Field Preparation:
- Conventional tillage:
  - Conventional tillage systems were once the main type of production system of soybeans. This type of system is prone to great soil loss during heavy rains. This system has 100 percent of the surface layer mixed or inverted by plowing, power tilling or multiple disking.
- No-till:
  - In no-till production systems, fields are prepared by using burndown herbicides. These are normally applied one month to two weeks prior to planting. Herbicides are applied using an opened or enclosed cab tractor. No-till production is a procedure whereby a crop is planted directly into a seed bed not tilled since harvest of a previous crop, or the planting of a crop into sod, previous crop stubble, or a cover where only the intermediate seed zone is disturbed. This method helps prevent erosion and increases soil moisture and organic matter. The majority of Tennessee’s soybean acreage is now planted using no-till systems.
- Conservation tillage:
  - This form of tillage minimizes soil disturbance, some areas may be slightly disturbed where others are not. This is another form of tillage, which helps prevent soil erosion.

Planting:
- Planting generally begins in mid-May and may run as late as the first week of July. However, due to the perceived threat of Asian soybean rust producers were advised to plant as soon as warm weather permitted...
during 2005. The majority of soybeans grown in 2005 were planted within the first two weeks of May. The suggested planting dates for all soybean varieties in Tennessee are April 25 until to June 15. Depending on seed size, row width, germination rate and production method selected, seeding rate ranges from 104 to 300 thousand seeds per acre or 40 to 60 lbs of seed per acre if broadcast.

Cultivation:
- No cultivation occurs in no-till plantings
- Cultivation in conventionally planted soybeans that are planted in rows spaced at 24 to 36 inches. Usually cultivation begins two to three weeks after planting and ends when plants reach 18” in height. Time to reach the 18” height (5 weeks) varies depending on soil type, weather and other environmental factors.

Pest Control:
- Insecticide applications:
  - Most insecticides are applied after planting and are usually mid-season applications.
  - Few if any insecticides are applied directly on seed. No data is available showing a consistent economic return when using insecticide seed treatments in Tennessee. However, seed treatment use may aid in control of various seedling pests.
- Herbicide applications:
  - Products containing glyphosate are the predominate products used on Roundup Ready soybean varieties. They are often applied prior to planting and several weeks after soybean emergence.
  - Herbicides applied to non-Roundup Ready soybeans are applied as pre-plant incorporated (PPI) and with additional weed control products applied at post emergence.
- Fungicide applications:
  - Approximately 45% of the soybeans grown in Tennessee are treated with a fungicide seed treatment. Most certified seeds are treated by seed companies, where the remainder are treated by producers. Producers most often treat seeds in the field the day of planting.
  - Approximately 15% of the soybean acreage is treated with a foliar fungicide each year. During 2005, foliar applications of fungicides increased by 26% due to the threat of Asian soybean rust. Foliar fungicide applications are made using a boom sprayer, using an open or enclosed cab tractor. When soybean plants are taller, high-boy type boom sprayers may be used. Occasionally, foliar fungicides may be applied aerially. Fungicide applications are applied from R1 (beginning bloom) to the R6 (full seed) stage of plant development. Applications would begin around 30 days after planting and may continue up to an additional 30 days depending on plant development.

Harvest:
Soybeans are harvested beginning in late September and depending on the weather may be harvested as late as December. Soybeans are harvested using an enclosed combine, seed is thrashed to remove plant hulls, seed is then transferred by auger from the combine to trucks when the combine storage bin is full. During the 2005 season, most soybeans were harvested by late October. Remaining stubble is often turned under to reduce over-wintering habitats for various insects. Turning of stubble may occur the day of harvest or when it is convenient for the producer (usually within one to two months after harvest).
Production and Costs

During 2004, approximately 67.8% of the total acreage planted of soybeans was planted in no-till, 22% planted in other conservation tillage systems, and the remaining 10.2% was planted in conventional tillage system. Approximately 25.4% of the total soybean acreage in 2004 was double-cropped (USDA / NASS). The estimated cost of producing one acre of soybeans during 2005 was approximately $203 per acre excluding costs for pesticide application (http://economics.ag.utk.edu/beans3.html).

There are many varieties of soybeans available to soybean producers. During 2005, most producers selected varieties that were early maturing to aid in escaping the threat of Asian soybean rust. The majority of growers also selected varieties which were Roundup Ready for weed management purposes. Harvest occurred slightly earlier in 2005 due to earlier planting dates and warm dry harvest season.

Growers are encouraged to plant only high quality seed known for varietal purity, high germination and mechanical purity. Soybean seeds should be free of weed seeds and germination should be 80 percent or above. Seed treatments containing one or more fungicides help protect seeds until the plant emerges and may provide extended disease control when the plant is most susceptible to damping off pathogens. High quality seed helps provide maximum production.

The University of Tennessee recommends growers to plant soybeans in 20-inch rows or less to provide maximum returns. Seeding rate depends on size of seed and width of row. Seeding rate is often increased if seed germination is below 80 percent, if soil crusting is expected or if planting conventional soybeans after June 15.

Insect Pests

**Soybean Insects, Control and Insecticides**

Tennessee recommends that soybeans producers check once a week, from the time plants begin emerging until the leaves begin to turn yellow and fall from the plants (usually until about the first or second week in October, however it was earlier in 2005) for insects. A good sampling plan is to check three feet of row at each of 10 different locations in average sized fields (about 50 acres). Sample points should be increased or decreased proportionally to the acreage in a field. Producers should scatter sample points over the entire field. This helps identify if and when any pesticide application is necessary to obtain economic returns from the crop. Producers are urged to be looking for, seedling pests, foliage feeders and pod feeders. During 2005, few arthropod pest exhibited serious problems in soybean product. Approximately 5% loss was attributed to insect pest damage during 2005. This damage was evenly distributed between several pest complexes, such as stem feeding pests, foliar feeders and pod feeding pests.

**Suggested threshold levels (when to treat) for insect control:**

- **Stem feeding pests**
  - If 10% of plants (up to 10-12”) are infested with adults and/or nymphs treatment is recommended.
- **Foliar feeding pests**
If 30% defoliation of foliage
- If 20% bloom

Pod feeding pests
- If four corn earworms per row foot.
- If one stink bug per three row feet from bloom through mid-pod fill and one stink bug per one row foot from mid-pod fill to maturity.
- If four fall armyworms per row foot are observed.

Cutworms
*Agrotis ipsilon*

Cutworms occur sporadically across Tennessee. Damage may be reduced if weeded border areas near soybeans are removed by mowing, however using an insecticide is often required if fields become highly infested. An entire crop can be lost from infestation by this pest.

**Recommended chemical pest management tools:**

**Organophosphate insecticides:**
- **Chlorpyrifos (Lorsban 4E)** 28 days PHI and has “Caution” listed as the signal word. Moderate cost associated with treatment. Long residual and effective.
- **Methyl parathion (Methyl Parathion 4EC)** rate range of 0.375 to 0.50 lbs active ingredient per acre. This product is now difficult to obtain, has a moderate to high cost for application. Product is fairly toxic to applicator.

**Carbamate insecticides:**
- **Carbaryl (Sevin 80S or XLR)** 21 days PHI. Depending on formulation used has Warning or Caution listed as the signal word. Depending on rate used has a moderate to high cost associated with application.
- **Thiodicarb (Larvin 3.2)** 28 days PHI. Product has a moderate to high cost associated with application.

**Pyrethroid insecticides:**
- **Permethrin (Pounce 3.2EC, Ambush 2EC)** 0.05 to 0.10 lbs active ingredient per acre.
- **Cyfluthrin (Baythroid 2)** has a low rate range of 0.013 to 0.025 lbs active ingredient per acre. Has a low to moderate cost depending on formulation rate selected.
- **Zetamethrin (Mustang Max 0.8E)** Low rate range of 0.008 to 0.025 lbs active ingredient per acre. Product is fairly inexpensive.
- **Lambda-cyhalothrin (Karate 2.08EC)** 45 days PHI. Low rate range of 0.015-0.025 lb. active ingredient per acre. Moderate cost for application.
- **Esfenvalerate (Asana XL .66EC)** 21 days PHI. Has a low rate range of 0.03-0.05 lb. of active ingredient per acre. Low cost associated with application.

**Possible alternative chemical pest management tools:**
- **Aldicarb (Temik 15G):** has a 90-day PHI. It may provide control of this pest, however may be expensive. Currently, this pest is not included on the label. Is a Restricted Use Pesticide which has “Danger” as the signal word. This product is packaged in a “Lock & Load” system which reduces applicator and handler exposure. Current cost of product and low commodity pricing would prevent usage.
- **Gamma-cyhalothrin (Prolex):** has a 45-day PHI and is a pyrethroid insecticide that is restricted use
pesticide. Product is difficult to obtain.

Non-chemical pest management tools:

- Do not plant in areas with history of cutworm damage
- Mow weedy perimeter areas several weeks prior to planting
- Scout fields to determine if control is needed.

Three cornered alfalfa hopper
Spissistilus festinus

Alfalfa hopper damage may be detected from the seedling stage and into mid-season. Both the adults and nymphs feed on the soybean plant by piercing the main stem, branches, and leaf petioles and sucking sap. Typically, hoppers will repeatedly feed at the same location on the stem, which causes ringing of the stem or petiole. This feeding cause a swollen, callused spot which is weak and will break during windy conditions. Lodging of the main stem or aerial stems is what causes the farmer to be concerned. Usually, this insect does not cause severe losses in Tennessee.

Recommended chemical pest management tools:
Organophosphate insecticides:
  - Methyl parathion (Methyl Parathion 4EC) rate range of 0.375 to 0.50 lbs active ingredient per acre. Effective, however has Warning as the signal word and may be extremely dangerous if used correctly.
Carbamate insecticides:
  - Carbaryl (Sevin 80S, XLR) has a 21-day PHI. Rate of 1.0 lb. active ingredient per acre. Cost is relatively high compared to other available products.
Pyrethroid insecticides:
  - Esfenvalerate (Asana XL .66EC) 21 days PHI. Rate range of 0.03-0.05 lb. active ingredient per acre. Cost is relatively low for product.
  - Lambda-cyhalothrin (Karate 2.08EC) has a long PHI of 45 days. Has a low rate range of 0.015-0.025 lb. active ingredient per acre. This product is most often used for this particular pest due to low cost of the product.
  - Cyfluthrin (Baythroid 2) has a low active ingredient applied to the acre ranging from 0.025 to 0.044 lbs active. Cost may be low to moderate depending on rate used.
  - Zetamethrin (Mustang Max 0.8E) applied at the rate range of 0.0175 to 0.025 lbs active ingredient per acre. Very cost effective pest management tool.

Possible alternative pest management tools:

- Potassium salts (M-Pede): labeled to control leafhoppers, thrips, plantbugs, and aphids. Labeled for 4 pints per acre formulation rate. Product is fairly safe for applicator and handler. Would require multiple treatments for optimum control.
- Aldicarb (Temik 15G): has a 90-day PHI. It may provide suppression of this pest, however may be expensive. Is a Restricted Use Pesticide which has “Danger” as the signal word. This product is packaged in a “Lock &
Load” system which greatly reduces applicator and handler exposure. Current cost of product and commodity pricing may prevent usage.

- **Gamma-cyhalothrin (Prolex)**: Product is labeled however, difficult to obtain from local vendors. Product is very similar to Lambda-cyhalothrin. Is a restricted use pesticide with a low ai per acre rate.

Non-chemical pest management tools:

- Scout field to determine level of infestation and if treatment is needed

**Bean leaf beetle**

*Cerotoma trifurcata*

Hosts of the bean leaf beetle include bean, clover, corn, cowpea, soybean, peanut, and several leguminous weeds. Adults over-winter in leaf litter or other vegetation, primarily in wooded areas. They become active in April and move to the earliest host plants available. Adult beetles do not usually attack soybeans until early May. They feed voraciously for several days and then mate. Peak periods of adult activity generally occur the last of May, the last of July, the second and third weeks in August, and the second and third weeks of September. Damage to soybeans appears to be due primarily to the foliar-feeding adults. Bean leaf beetles prefer the youngest plant tissue available; when vegetative growth terminates, they will consume tender pod tissue. Pod damage is usually limited to the outer layers of the pod, the developing seeds being infrequently attacked. In Tennessee, damage is normally observed from July through September and some seedling damage may occur on early planted soybeans. In addition to the beetles’ direct attack, the adults are also known vectors of the bean pod mottle, cowpea mosaic, and southern bean mosaic viruses.

**Recommended chemical pest management tools:**

**Organophosphate insecticides:**

- **Chlorpyriphos (Lorsban 4E)**: Formulation is applied at the 1-2 pint per acre rate. Cost is moderate to high depending on rate used.
- **Methyl parathion (Methyl Parathion 4EC)**: applied at the rate range of 0.5 to 1.5 lbs ai per acre. Cost of product is moderate to high depending on rate used. Effective, highly toxic to user and beneficials.

**Carbamate insecticides:**

- **Carbaryl (Sevin 80S, Sevin XLR)** 21 days PHI. Rate range is 0.5-1.0 lb. active ingredient per acre. Product is fairly safe to use.
- **Methomyl (Lannate 2.4LV)**: Product is highly toxic with “Danger” listed as the signal word. Pricing ranges from low to high depending on rate used. Has a short PHI – 14-days.

**Pyrethroid insecticides:**

- **Esfenvalerate (Asana XL 0.66EC)** 21 days PHI. Rate range is 0.03-0.05 lb. active ingredient per acre. Relatively inexpensive cost.
- **Lambda-cyhalothrin (Karate 2.08EC)** 45 days PHI. Rate range is 0.015-0.025 lb. active ingredient per acre.
- **Permethrin (Ambush 2EC or Pounce 3.2EC)** 60 days PHI. Rate range is 0.05-0.1 lb. active ingredient per acre.
- **Cyfluthrin** (Baythroid 2): has a long PHI of 45-days. Danger is listed as the signal word. Cost is low to
moderately priced depending on rate used.

- **Zetamethrin (Mustang Max 0.8E):** Very economical, and low ai use rates. Has a fairly short PHI of 21-days.
- **NOTES:** Permethrin, Carbaryl, lambda cyhalothrin or zetamethrin are more commonly used to control this pest due to low to moderate cost of the products.

**Alternative chemical pest management tools:**

- **Diflubenzuron (Dimilin 2L):** is an insect growth regulator which is a Restricted Use Pesticide. It has “Caution” listed as the signal word.
- **Gamma-cyhalothrin (Prolex):** Product is labeled however, difficult to obtain from local vendors. Product is very similar to Lambda-cyhalothrin. Is a restricted use pesticide with a low ai per acre rate.

**Non-chemical pest management tools:**

- Scouting

**Grasshoppers**

*Melanoplus* spp.

Grasshopper populations vary from year to year and field to field. In most situations where grasshopper populations are generally at high numbers is when soybeans are adjacent to weedy areas. To reduce problems from grasshopper infestations growers are encouraged to mow or remove weedy areas adjacent to the crop. This often eliminates the problem, if weeds are removed prior to high levels of crop infestation and will minimize the risk of crop loss due to this pest.

**Recommended chemical pest management tools:**

**Organophosphate insecticides:**

- **Chlorpyrifos (Lorsban 4E):** has a 28-day PHI. Product is highly effective, long residual, moderate cost.
- **Methyl parathion (Methyl Parathion 4E):** highly effective, product is extremely dangerous to user if not applied correctly. An enclosed cab tractor should be used when applying this product.

**Carbamate insecticides:**

- **Carbaryl (Sevin 80S or XLR) 21 days PHI. Rate range of 0.5-1.5 lbs. active ingredient per acre. Product cost is moderate to high depending on formulation used.
- **Carbofuran (Furadan 4F) 21 days PHI. Rate range of 0.125-0.25lbs. active ingredient per acre. Product only lists grasshoppers for control however may provide suppression of other pests.

**Pyrethroid insecticides:**

- **Esfenvalerate (Asana XL 0.66EC) 21 days PHI. Rate range of 0.03-0.05 lbs. active ingredient per acre. Cost per acre is low to moderate depending on rate selected.
- **Lambda-cyhalothrin (Karate 2.08EC) has a 45-day PHI. Low rate range of 0.025-0.030 lbs. active ingredient per acre. Cost is moderate for this product.
- **Cyfluthrin (Baythroid 2):** has a long PHI of 45 days, however is highly effective and low use rates. Cost is low to moderate depending on rate used.
Zetamethrin (Mustang Max 0.8E): has a 21-day PHI, highly effective, low cost and low ai per acre rate of use.

Non-chemical pest management tools:

- Mow weedy areas around field edges.
- Control weeds within field.
- Scout to determine infestation levels.

**Mexican bean beetle**

*Epilachna varivestis*

The Mexican bean beetle is rarely a problem in Tennessee soybean production, however out breaks are observed in localized areas. When this pest reaches economic thresholds, methyl parathion, permethrin or carbaryl are most commonly used for control of this pest.

**Recommended chemical pest management tools:**

**Organophosphate insecticides:**

- **Chlorpyrifos (Lorsban 4E):** has a 28-day PHI and Caution as the signal word. Has a fairly long residual. Cost ranges from moderate to high per application depending on rate used.
- **Dimethoate (dimethoate 4):** 21-day PHI and has Danger listed as the signal word. Also has a higher rate of active ingredient per acre at 0.5 lbs. Cost is moderate for this product.
- **Methyl parathion (methyl-parathion 4):** has a short PHI of 15 days. Rate of 0.47 lb. active ingredient per acre. Enclosed cab tractor should be used when applying this product.

**Carbamate insecticides:**

- **Carbaryl (Sevin 80S and XLR):** 21 days PHI. Has a higher rate range of 0.5-1.0 lb. active ingredient per acre than other materials. Cost per application ranges from moderate to high depending on rate selected.
- **Methomyl (Lannate 2.4LV):** has a relatively low PHI of 14 days. Rate range of 0.23-0.45 active ingredient per acre per application.

**Pyrethroid insecticides:**

- **Esfenvalerate (Asana XL 0.66EC):** 21 days PHI. Rate range of 0.015-0.03 lb. active ingredient per acre.
- **Permethrin (Ambush 2EC or Pounce 3.2 EC):** has a long PHI of 60 days. Rate range of 0.05-0.1lb. active ingredient per acre. Controls a wide range of insect pests.
- **Cyhalothrin (Karate 2.08EC):** has a 45-day PHI and has a low ai per acre (0.015 to 0.030) use rate. Has Warning listed as the signal word. Cost per application is low to moderate depending on rate selected.
- **Cyfluthrin (Baythroid 2):** has a 45-day PHI and a low ai per acre (0.013 to 0.044 lb) use rate. Cost is low to moderate depending on rate used.
- **Zetamethrin (Mustang Max 0.8E):** relatively inexpensive, has a 21-day PHI and had a low use rate (0.008 to 0.025 lb) ai per acre.

Non-chemical pest management tools:

- Scout for presence of pest
Blister beetle
_Epicauta_ spp.

Blister beetles are commonly found in soybean production and may cause severe problems if high populations are reached. Carbaryl is one product commonly selected by producers for used of control of this pest. Sevin 80S is the most common formulation of carbaryl used due to the cost of the product, however Sevin XLR is preferred because this product mixes better in water and needs less agitation.

**Recommended chemical pest management tools:**

**Organophosphate insecticides:**
- **Methyl Parathion (Methyl Parathion 4EC):** product is very effective, however, has Warning as the signal word. Harsh on beneficial insects. Dangerous to applicator.

**Carbamate insecticides:**
- **Carbaryl (Sevin 80S and XLR):** 21 days PHI. Rate range of 0.5 - 1.0 lb. active ingredient per acre. Sevin 80S is the most common formulation of carbaryl used due to the cost of the product, however Sevin XLR is preferred because this product mixes better in water and needs less agitation. Product is fairly safe for use.

**Pyrethroid insecticides:**
- **Cyhalothrin (Karate 2.08EC):** has a long PHI of 45 days, however relatively inexpensive when using lower rates and moderately priced at higher use rates.
- **Cyfluthrin (Baythroid 2):** has a long PHI of 45 days and is relatively inexpensive. Has Danger listed as the signal word.
- **Zetamethrin (Mustang Max 0.8E):** very cost effective product and low use rate.

**Non-chemical pest management tools:**
- Control weeds
- Mow weedy field borders often

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Japanese beetle
_Popillia japonica_

Adults emerge as early as mid May in eastern Tennessee. Peak emergence occurs in July. Throughout summer, the beetles attack the fruit and foliage of many plants. Soon after emerging, females deposit 40 to 60 eggs in small batches 2 to 3 inches deep especially in damp soil. During dry periods, adults may be more attracted to low lying and irrigated areas to lay eggs. In extremely dry weather, many eggs and larvae perish. In warm, wet summers, eggs hatch in about two weeks. The newly emerged larvae feed until cold weather forces them into hibernation. One generation occurs each year.

**Recommended chemical pest management tools:**
Carbamate insecticides:
- Carbaryl (Sevin 80S and XLR): 21 days PHI. Rate range of 0.5 - 1.0 lb. active ingredient per acre.

Pyrethroid insecticides:
- Cyhalothrin (Karate 2.08EC): has 45-day PHI and Warning listed as the signal word. Labeled to control various species of pests. Cost per application is low to moderate depending on rate used.
- Esfenvalerate (Asana XL 0.66EC): has a 21-day PHI. Rate range of 0.015-0.03 lbs. active ingredient per acre. This product has a low to moderate cost depending on rate used.
- Permethrin (Ambush 2EC or Pounce 3.2 EC): has a long PHI of 60 days. Rate range of 0.05-0.1lb. active ingredient per acre.
- Cyfluthrin (Baythroid): has Danger listed as the signal word. Is low to moderately priced depending on rate selected.
- Zetamethrin (Mustang Max 0.8E): relatively inexpensive has a low use rate range of 0.008 to 0.025 lbs ai per acre.

Non-chemical pest management tools:
- Use of pheromone traps rarely reduces adult populations and may attract beetles into area.
- Plant away from pastures or sod areas.

**Green cloverworm**
*Plathypena scabra*

Green cloverworms only eat foliage. They make holes in the leaves and are damaging only under very high populations or in combination with other defoliators. They are present throughout most of the growing season. Damage causes reduced photosynthesis therefore reducing pod development.

**Recommended pest management tools:**
**Organophosphate insecticides:**
- Chlorpyrifos (Lorsban 4E) 28 days PHI. Rate range of 0.25-0.5 lb. active ingredient per acre. Has a long residual.
- Methyl parathion (Methyl Parathion 4EC): Product is hazardous to applicator and beneficals. Has a long REI of 5-days however has a 20-day PHI. Product costs are moderate to high depending on rate used.

**Carbamate insecticides:**
- Carbaryl (Sevin 80S or XLR): 21 days PHI. Rate range of 0.5-1.0 lb. active ingredient per acre.
- Methomyl (Lannate 2.4LV): 14 days PHI. Rate range of 0.23-0.45 lb. active ingredient per acre.
- Thiodicarb (Larvin 3.2): 28 days PHI. Rate range of 0.25-0.4 lb. active ingredient per acre.

**Pyrethroid insecticides:**
- Esfenvalerate (Asana XL .66EC): 21 days PHI. Rate range of 0.015-0.03 lb. active ingredient per acre.
- Lambda-cyhalothrin (Karate 2.08EC): 45 days PHI. Rate range of 0.015-0.025 lb. active ingredient per acre.
- Permethrin (Pounce 3.2EC or Ambush 2EC): has a long PHI of 60 days. Rate range of 0.05-0.1 lb. active ingredient per acre.
- Zetamethrin (Mustang Max 0.8E): fairly inexpensive and has a low use rate range of 0.008 to 0.025 lbs ai per acre.
- Cyfluthrin (Baythroid): has a 45-day PHI, rate range of 0.013 to 0.044 lbs ai per acre per treatment and Danger is listed as the signal word.
Biological controls:

- **Bacillus thuringiensis (Javelin WG or Dipel ES):** has a 0-day PHI. Is safe and no adverse effects to non-targeted organisms. Product has a moderate to high cost depending on rate selected.

Products with various modes of action:

- **Spinosad (Tracer):** product is fairly safe to use however is fairly expensive. It has a 4-hr REI and a 28-day PHI.
- **Indoxacarb (Steward 1.25):** has a 28-day PHI and a 4-hr REI. Product costs are moderate to high depending on rate used.

**NOTES:** Permethrin and chlorpyrifos are commonly used for control of this pest, due to efficacy of these products.

Alternative chemical pest management tools:

- **Diflubenzuron (Dimilin 2L):** is an insect growth regulator which is a Restricted Use Pesticide. It has “Caution” listed as the signal word. Would be safe on beneficials.

_Soybean looper_  
_Pseudoplusia includens_

The preferred hosts of the soybean looper are soybeans, sweet potatoes, and peanuts. Other hosts include cotton, tomato, crucifers, pea, tobacco, and cocklebur. In Tennessee, soybeans are attacked by both cabbage loopers and soybean loopers, but over 90 percent of these are usually soybean loopers. Although loopers infrequently cause pod damage, they are capable of inflicting heavy foliage losses. Defoliation by these pests leaves the plants with a ragged appearance. Damage usually results after a prebloom insecticide application removes most of the looper's natural enemies. Soybean loopers are difficult to control with insecticides. Soybean loopers have three or four generations a year. They overwinter as pupae within loosely spun cocoons which are usually attached to plant debris. Soon after adults emerge in the spring, each mated female begins laying an average of 640 eggs, singly, on the upper surface of the host plant leaf. Soybean looper populations reach a peak in August or September.

**Recommended chemical pest management tools:**

- **Thiodicarb (Larvin 3.2)** 28 days PHI. Rate range of 0.45-0.75 lb. active ingredient per acre. Cost is moderate to high depending on rate selected for use.
- **Bacillus thuringiensis (Dipel ES, Javelin WG, Condor XL)** 0 days PHI. Rate of use of active ingredient is variable depending on product used. More than one application may be needed of this product to obtain effective control. These products are extremely safe to the applicator and environment.
- **Spinosad (Tracer 4):** This product is safe to the applicator and the environment. Fairly expensive cost for an application.
- **Indoxacarb (Steward 1.25):** This product is safe to the applicator and the environment. Fairly expensive for an application.

**Non-chemical pest management tools:**
Control weeds such as cocklebur within the field

**Corn earworm**

*Helicoverpa zea*

This caterpillar can be a serious insect pest of soybeans. Soybean field infestation normally occurs in later July and into August, following several build-up generations in other crops. Corn earworm overwinters as pupa in the soil. The pupa change to moths in the April/May period and fly to whorl stage corn, or wild hosts, and lay eggs for the first generation. Following several weeks of development, first generation moths emerge around corn pollination time and are strongly attracted to fresh corn silks for laying the second generation eggs. Corn ears provide protection and a good food source and a large increase in population is realized during the second generation. After developing in the ears, larva eat through the husk and drop to the ground and pupate in the soil. Moths of the second generation emerge from corn fields, from mid-July and into early/mid August, and seek soybean, cotton, peanut, sorghum, and other crop and wild host plants. There is also a September moth flight and very late planted soybeans are sometimes suitable (not past blooming and early podding) for egg laying and small caterpillar survival. Yearly fluctuations in population may be great, with high populations often occurring in seasons of early warm and dry weather. This insect is usually called the cotton bollworm when it occurs in cotton. The July/August moth flight may be monitored throughout the state each year and presented in extension reports as corn earworm or bollworm moth trap catches. This information can be very helpful for determining when to scout soybeans. Black light insect traps and sex pheromone traps can be used to monitor flight periods.

**Recommended chemical pest management tools:**

**Carbamate insecticides:**

- **Carbaryl (Sevin 80S, XLR)** 21 days PHI. Rate range of 0.5-1.5 lbs. active ingredient per acre. Cost is moderate to high depending on rate used.
- **Methomyl (Lannate 2.4LV)** 14 days PHI. Rate range of 0.23-0.45 lb. active ingredient per acre. Product has Danger listed as the signal word. Cost is low to moderate depending on rate selected.
- **Thiodicarb (Larvin 3.2)** 28 days PHI. Rate range of 0.25-0.4 lb. active ingredient per acre. Product has Warning listed on the label and has a moderate to high cost depending on rate used.

**Pyrethroid insecticides:**

- **Esfenvalerate (Asana XL .66EC)** 21 days PHI. Rate range of 0.03-0.05 lb. active ingredient per acre.
- **Lambda-cyhalothrin (Karate 2.08EC)** 45 days PHI. Rate range of 0.015-0.025 lb. active ingredient per acre.
- **Permethrin (Ambush 2EC or Pounce 3.2EC)** 60 days PHI. Rate range of 0.1-0.2 lb. active ingredient per acre.
- **Cyfluthrin (Baythroid 2)**: has a long PHI of 45-days and Danger is listed as the signal word. It is labeled for use at the rate range of 0.013 to 0.044 lbs ai per acre per treatment.
- **Zetamethrin (Mustang Max 0.8E)**: Product is fairly inexpensive has a 21-day PHI and a low use rate range of 0.008 to 0.025 lbs ai per acre per treatment.

**NOTE:** Pyrethroid and carbamate insecticides are most commonly used to reduce corn earworm numbers below the economic threshold. Ideally, treatment should be directed to mid-size larvae since control of small larvae is sometimes difficult (they are within flower clusters, terminals, etc) and large larvae may have already caused economic loss. Recently, growers have been encouraged to avoid using pyrethroid insecticides for
corn earworm control in soybean. During recent seasons this insect has shown early signs of becoming resistant to pyrethroids. By using alternate insecticides (e.g. Larvin) against corn earworm in soybeans this crop can act as a resistance management refuge. Thus, growers may help increase the useful life of pyrethroids for use in cotton, where their value for bollworm (corn earworm) is greatest.

Non-chemical pest management tools:

- Scout for the presences of adults
- Use black light traps to detect presence of pest
- Use pheromone traps to detect presence of pest. This is fairly costly.

**Fall armyworm**

*Spodoptera frugiperda*

It normally overwinters successfully in the United States only in southern Florida and southern Texas. The fall armyworm is a strong flier, and disperses long distances annually during the summer months. However, as a regular and serious pest of various plants, its range tends to be mostly the southeastern states.

Larvae cause damage by consuming foliage. Young larvae initially consume leaf tissue from one side, leaving the opposite epidermal layer intact. By the second or third instar, larvae begin to make holes in leaves, and eat from the edge of the leaves inward. Feeding in the whorl of corn often produces a characteristic row of perforations in the leaves. Larval densities are usually reduced to one to two per plant when larvae feed in close proximity to one another, due to cannibalistic behavior. Older larvae cause extensive defoliation, often leaving only the ribs and stalks of corn plants, or a ragged, torn appearance.

Recommended chemical pest management tools:

Carbamate insecticides:
- **Carbaryl (Sevin 80S, XLR)** 21 days PHI. Rate range of 1.0-1.5 lbs. active ingredient per acre. Depending on formulation selected has Warning or Caution listed as the signal word.
- **Methomyl (Lannate LV)** 14 days PHI. Rate range of 0.23-0.45 lb. active ingredient per acre. Has Danger listed as the signal word.
- **Thiodicarb (Larvin 3.2)** 28 days PHI. Rate range of 0.25-0.40 lb. active ingredient per acre. Has Warning listed as the signal word.

Pyrethroid insecticides:
- **Cyfluthrin (Baythroid)**: has a long PHI of 45-days and Danger is listed as the signal word. It is labeled for used at the rate range of 0.013 to 0.044 lbs ai per acre per treatment.
- **Zetamethrin (Mustang Max 0.8E)** Product is fairly inexpensive has a 21-day PHI and a low use rate range of 0.008 to 0.025 lbs ai per acre per treatment.

Non-organophosphate, non-carbamate, non-pyrethroid insecticides:
- **Spinosad (Tracer 4)**: has a 12-hour REI
- **Indoxacarb (Steward 1.25)**: has a 4-hour REI. Expensive product.
Non-chemical pest management tools:

- Pheromone traps (must weed through various other non-targets, expensive)
- Black light traps help determine presence (usually not used by growers)
- Scout field and grassy field perimeters for presence

Stinkbugs

*Acrosternum* spp.

Stink bugs are important late season insect pests of the soybean seed and reduce both yield and quality by their feeding. Stink bugs have piercing mouth parts and feed on tender terminals, blooms, pods, and developing seeds within pods. When feeding, both adults and nymphs (immatures) inject a digestive saliva into the plant which helps liquify plant tissues for easy extraction by the bug. The salivary fluid causes direct tissue damage and also can carry yeast organisms that grow within the seeds. Feeding may also create an avenue for pathogen entry into the plant. Germination and general seed quality can be affected by stink bug feeding. Additionally, feeding injury during early seed formation can result in aborted seeds and undersized, deformed seeds.

Recommended chemical pest management tools:

Organophosphate insecticide:
- **Methyl parathion (methyl parathion 4EC)** Rate range of 0.31-0.94 lb. active ingredient per acre.

Pyrethroid insecticides:
- **Lambda-cyhalothrin (Karate 2.08EC)** Rate range of 0.025-0.030 lb. active ingredient per acre.
- **Cyfluthrin (Baythroid 2):** has Danger listed as the signal word.
- **Zetamethrin (Mustang Max):** fairly inexpensive. Low use rate ranges used.
- **Gamma Cyhalothrin (Prolex 1.25):** Difficult to find product.
- **NOTES:** Methyl parathion is most commonly used to control this pest, due to it effect control and low cost.

Alternative chemical pest management tools

- None

Spider mites

*Tetranychus* spp.

Spider mites are common mites which may be found attacking soybeans most often during hot dry weather. The twospotted spider mite is considered to be one of the most economically important spider mites. This mite has been reported infesting over 200 species of plants. The mites generally feed underneath the leaves and cause graying of the leaves due to mesophyll collapse and yellowing. Necrotic spots occur in the advanced stages of leaf damage. Mite damage to the open flower causes a browning and withering of the petals that resembles spray burn. All mites have needle-like piercing-sucking mouthparts. Spider mites feed by penetrating the plant tissue with their mouthparts and are found primarily on the underside of the leaf. All spider mites spin fine strands of webbing on the host plant—hence their name.
**Recommended chemical pest management tools:**
Organophosphate insecticides:
- **Chlorpyrifos (Lorsban 4E)**: 28 days PHI. Rate range of 0.25-0.5 lb. active ingredient per acre. When this pest becomes a serious threat, chlorpyrifos is used due to the low cost of the product.
- **Dimethoate (Dimethoate 4)**: 28 days PHI. Rate of 0.5 lb. active ingredient per acre.

**Alternative chemical pest management tools:**

- **Sulfur (Kumulus)**: may only suppress spider mite populations. May be phytotoxic if sprayed when temperatures exceed 80F.

**Non-chemical pest management tools:**

- In areas where over head irrigation may be used, it may provide control

**Soybean Aphid**
*Aphis glycines*

The soybean aphid is an eastern Asian soybean pest that has rapidly invaded the U.S. It was first detected in U.S. in the summer of 2000, the aphid is now well established through northern soybean growing areas and has recently become established in Tennessee. Economic infestations of soybean aphid have not been observed in Tennessee to date, however this pest has the potential to devastate soybean production.

**Recommended chemical pest management tools:**
Organophosphate insecticides:
- **Chlorpyrifos** (Lorsban 4E): has a 28-day PHI and a 0.5 to 1 lb ai per acre use rate. Product is moderately priced.

Pyrethroid insecticides:
- **Zetamethrin** (Mustang Max 0.8E): inexpensive and low use rates used for control.
- **Cyhalothrin** (Karate 2.08EC): has a long PHI of 45-days. No more than 0.06 lbs ai per acre per season may be allowed.

**Non-chemical pest management tools:**

- In areas where over head irrigation may be used, it may provide control

**Dectes stem borer**
*Dectes texanus texanus*

The Dectes stem borer overwinters as mature larvae within the stem of its host plants, and the adult beetles begin emerging sometime in late June or early July. After mating, the female beetle chews a small hole in the leaf petiole or the stem and then typically lays a single egg inside. After hatching, the larvae feed for several days
on the outer stem before they bore into the main stem. Typically, the petiole wilts and falls off the plant, leaving behind a reddish scar around the entrance hole. As the larva tunnels within the main stem, it feeds on the pith tissue. This damage can reduce the plant’s ability to obtain water and soil nutrients to the developing pods and seeds, and yield losses may occur in heavily infested fields.

In late summer, the larvae move to the base of the plant and girdle the interior of the stem approximately two inches above the soil surface. The larvae then plug the stem with their frass, creating a cell where they overwinter. This girdling stage can increase lodging during windy days or heavy rains as heavily damaged soybean plants mature. Damage from this insect may coincide with increased no-till soybean plantings, which provide undistributed overwintering sites for the larval stage. Since the Dectes stem borer also feeds on important weed hosts (e.g., cocklebur, giant ragweed), the presence of these weeds in and around soybean fields can further increase the risk of Dectes stem borer infestations.

**Recommended chemical pest management tools:**
- None

**Non-chemical pest management tools:**
- Turn under crop residue just after harvest.
- Mow down any remaining stubble from the previous season.
- Rotation

---

**Estimated acreage treated with insecticides commonly available in Tennessee during 2005.**

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Estimated acreage treated</th>
<th>Avg. no. apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacillus thuringiensis</td>
<td>trace</td>
<td>1</td>
</tr>
<tr>
<td>Carbaryl (Sevin XLR)</td>
<td>600</td>
<td>1</td>
</tr>
<tr>
<td>Carbaryl (Sevin 80S)</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Carbofuran (Furadan 4F)</td>
<td>250</td>
<td>1</td>
</tr>
<tr>
<td>Chlorpyrifos (Lorsban 4E)</td>
<td>2,000</td>
<td>1</td>
</tr>
<tr>
<td>Cyfluthrin (Baythroid 2)</td>
<td>125,000</td>
<td>1.1</td>
</tr>
<tr>
<td>Cyhalothrin (Karate 2.08EC)</td>
<td>150,000</td>
<td>1.1</td>
</tr>
<tr>
<td>Esfenvalerate (Asana XL)</td>
<td>50,000</td>
<td>1.1</td>
</tr>
<tr>
<td>Indoxacarb (Steward 1.25)</td>
<td>400</td>
<td>1</td>
</tr>
<tr>
<td>Methyl Parathion</td>
<td>2,000</td>
<td>1</td>
</tr>
<tr>
<td>Methomyl (Lannate )</td>
<td>2,000</td>
<td>1</td>
</tr>
<tr>
<td>Permethrin (Pounce )</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Spinosad (Tracer 4)</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>Thiodicarb (Larvin )</td>
<td>400</td>
<td>1</td>
</tr>
<tr>
<td>Zetamethrin (Mustang Max)</td>
<td>150,000</td>
<td>1.1</td>
</tr>
</tbody>
</table>
### Estimated percent losses in 2005 due to insect infestation.

<table>
<thead>
<tr>
<th>Pest</th>
<th>Estimated % loss</th>
<th>Conventional tillage</th>
<th>No-tillage</th>
<th>Estimated average loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutworms</td>
<td>0.1</td>
<td>0.5</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Three-cornered alfalfa hopper</td>
<td>0.25</td>
<td>0.75</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Bean leaf beetle</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Grasshoppers</td>
<td>0.1</td>
<td>0.3</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Mexican bean beetle</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Blister beetle</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Japanese beetle</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Green cloverworm</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Soybean looper</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Corn earworm</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Stink bugs</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Dectes stem borer</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

### Insecticides available during 2005 soybean production season

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Tradename</th>
<th>Formulation rate/ acre</th>
<th>Lbs active rate / acre</th>
<th>PHI</th>
<th>REI</th>
<th>SW*</th>
<th>RUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esfenvalerate</td>
<td>Asana XL 0.66</td>
<td>2.9-5.8 fl oz</td>
<td>0.015-0.030</td>
<td>21-D</td>
<td>12-hr</td>
<td>W</td>
<td>Y</td>
</tr>
<tr>
<td>Cyfluthrin</td>
<td>Baythroid 2</td>
<td>0.80-2.8 fl oz</td>
<td>0.013-0.044</td>
<td>45-D</td>
<td>12-hr</td>
<td>D</td>
<td>Y</td>
</tr>
<tr>
<td>Methomyl</td>
<td>Lannate 2.4LV</td>
<td>6.4-24fl oz</td>
<td>0.17 – 0.45</td>
<td>14-D</td>
<td>48-hr</td>
<td>D</td>
<td>Y</td>
</tr>
<tr>
<td>Permethrin</td>
<td>Pounce 3.2</td>
<td>2-8fl oz</td>
<td>0.05 – 0.20</td>
<td>60-D</td>
<td>12-hr</td>
<td>C</td>
<td>Y</td>
</tr>
<tr>
<td>Carbaryl</td>
<td>Sevin 80WSP</td>
<td>10.67-30 oz</td>
<td>0.5335 – 1.5</td>
<td>21-D</td>
<td>12-hr</td>
<td>W</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>Sevin XLR</td>
<td>0.5 -1.5qts</td>
<td>0.5 – 1.5</td>
<td>21-D</td>
<td>12-hr</td>
<td>C</td>
<td>N</td>
</tr>
<tr>
<td>Bacillus thuringiensis</td>
<td>Condor</td>
<td>0.66 – 1.66 qts</td>
<td>0-D</td>
<td>4-hr</td>
<td>C</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dipel</td>
<td>0.5-1 lb</td>
<td>0-D</td>
<td>4-hr</td>
<td>C</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Javelin</td>
<td>0.25-1.50 lbs</td>
<td>0-D</td>
<td>4-hr</td>
<td>C</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Dimethoate</td>
<td>Dimethoate 4EC</td>
<td>1 pint</td>
<td>0.5</td>
<td>21-D</td>
<td>48-hr</td>
<td>D</td>
<td>N</td>
</tr>
<tr>
<td>Lambda-cyhalothrin</td>
<td>Karate 2.08</td>
<td>0.96 -1.92 fl oz</td>
<td>0.015 - 0.030</td>
<td>45-D</td>
<td>24-hr</td>
<td>W</td>
<td>Y</td>
</tr>
<tr>
<td>Thiodicarb</td>
<td>Larvin 3.2F</td>
<td>10 - 30 fl oz</td>
<td>0.25 - 0.75</td>
<td>28-D</td>
<td>48-hr</td>
<td>W</td>
<td>Y</td>
</tr>
<tr>
<td>S-cyano</td>
<td>Mustang Max 0.8</td>
<td>1.28 – 4 fl oz</td>
<td>0.008 – 0.025</td>
<td>21-D</td>
<td>12-hr</td>
<td>W</td>
<td>Y</td>
</tr>
<tr>
<td>Gamma-cyhalothrin</td>
<td>Prolex</td>
<td>0.77-1.54 fl oz</td>
<td>0.0075-0.015</td>
<td>45-D</td>
<td>24-hr</td>
<td>C</td>
<td>Y</td>
</tr>
<tr>
<td>Indoxacarb</td>
<td>Steward 1.25</td>
<td>8.6-11.3fl oz</td>
<td>0.055 - 0.110</td>
<td>21-D</td>
<td>12-hr</td>
<td>C</td>
<td>N</td>
</tr>
<tr>
<td>Spinosad</td>
<td>Tracer 4</td>
<td>1 - 2 fl oz</td>
<td>0.03125 – 0.0625</td>
<td>28-D</td>
<td>4-hr</td>
<td>C</td>
<td>N</td>
</tr>
<tr>
<td>Chlorpyrifos</td>
<td>Lorsban 4E</td>
<td>104.5 fl oz</td>
<td>3.267</td>
<td>7-D</td>
<td>24-hr</td>
<td>C</td>
<td>N</td>
</tr>
</tbody>
</table>
### Insecticides

#### Organophosphates:

- **Dimethoate (Dimethoate 4EC):** has a 21-day PHI and a 48-hour REI. It has “Danger” listed as the signal word. It is applied at the rate of 1 pint or 0.5 lb ai per acre per treatment. Cost would be $4.54 per acre per treatment. Livestock should not be allowed to graze or be fed within 5 days of last application. Labeled for control of Mexican bean beetle, leafhopper, spidermites, bean leaf beetle, grasshoppers, and three-cornered alfalfa hopper.

- **Chlorpyrifos (Lorsban 4E):** has a 28-day PHI and a 24-hour REI. It has “Caution” listed as a signal word. It is applied at the formulation rate of 1 – 2 pts or 0.5 to 1 lb ai per acre per treatment. No more than three applications per season of chlorpyrifos products. Labeled for control of armyworms, beanleaf beetle, cutworm spp., corn earworm, European corn borer, Mexican bean beetle, velvetbean caterpillar, southern green stink bug, salt marsh caterpillar, grasshoppers, soybean aphid, spider mites and suppression of fire ants (if applied to soil). Do not allow livestock to graze in treated areas or otherwise feed treated soybean products as hay, feed, or straw to meat or dairy animals.

- **Methyl parathion (Methyl-4):** has a 20-day PHI and a 5-day REI. The product has “Warning” listed as the signal word. Applied at the formulation rate range of 1-3 pints or 0.5 to 1.5 lbs ai per acre per application. Cost ranges from $3.63 to 10.88 per acre per application. No more than two applications per season or 6 pints per year. Do not apply within 20-days of grazing. Labeled for control of aphids, stinkbugs, bean leaf beetle, Japanese beetle, velvet bean caterpillar, thrips, three cornered alfalfa hopper, Mexican bean beetle, green cloverworm, soybean looper, potato leaf hopper, and stink bugs.

#### Carbamates:

- **Carbaryl (Sevin 80WSP, XLR):** has a 21-day PHI and a 12-hour REI. Depending on formulation may have “Warning” or “Caution” listed as the signal word. The WSP formulation is applied at the rate range of 10.67 to 30 oz and the XLR formulation is applied at the rate range of 0.5 to 1.5 qts. or 0.5335 to 1.5 lbs ai per acre per application. Cost ranges from $4.05 to 12.19 per acre per treatment. No more than 6 lbs ai per acre per crop allowed. Depending on harvest method, has a 3 to 21-day restriction for feeding livestock. Labeled for control of bean leaf beetle, blister beetle, green cloverworm, Mexican bean beetle, velvet bean caterpillar, corn earworm, leaf hoppers, three cornered alfalfa hopper, armyworms, cutworms, stinkbugs, and saltmarsh caterpillar.

- **Carbofuran (Furadan 4F):** has a 21-day PHI and a 48-hr REI. Applied at the rate range of 4 to 8 oz or 0.125 to 0.25 lbs ia per acre per application. Cost ranges from $2.65 to 5.31 per acre per application. No more than two applications per season allowed. This product is relatively dangerous and is a restricted use pesticide with
“Danger” listed as the signal word. Do not graze or feed foliar-treated forage to livestock or cut for silage or hay. Used to control grasshoppers.

- **Methomyl (Lannate 2.4LV):** has a 14-day PHI and a 48 hour REI. It has “Danger” listed as the signal word and is a Restricted Use Pesticide. Applied at the formulation rate range of 6.4 to 24 fl oz or 0.12 to 0.45 lbs ai per acre per treatment. Cost ranges from $2.77 to 10.39 per acre per application. No more than 1.35 lbs ai per acre per season. Labeled to control; thrips, green cloverworm, beet armyworm, bean leaf beetle, Fall armyworm, Mexican bean beetle, saltmarsh caterpillar, silverspotted skipper, velvetbean caterpillar, and corn earworm.

- **Thiodicarb (Larvin 3.2F):** has a 28-day PHI and a 48-hour REI. It has “Warning” listed as the signal word and is a Restricted Use Pesticide. Applied at the formulation rate range of 10 to 30 fl oz or 0.25 to 0.75 lbs ai per acre per application. No more than 3.0 lbs ai per acre per season allowed. Cost ranges from $4.84 to $14.53 per acre per treatment. Treated feed, forage, hay or straw should not be fed to livestock. Labeled to control corn earworms, army worms, green cloverworm, velvetbean caterpillar, woollybear caterpillar, soybean looper, cabbage looper, Mexican bean beetle, bean leaf beetle, stinkbugs, three-cornered alfalfa hopper, and cutworms.

- **Aldicarb (Temik 15G):** has a 90-day PHI and a 48-hour REI. It has “Danger” listed as the signal word. It is applied at the rate of 5 to 20 lbs or 0.75 to 3 lbs ai per acre. Cost would range from $18.50 to 74.00 per acre. Only one application is allowed at planting. The material is manufactured for use in a “lock n load” system which prevents applicator and handler contamination. This product is normally used for nematode control at the formulation rate of 10 to 20 lbs per acre when soybean pricing is above $8.50 per bushel. However due to low commodity pricing and availability of resistant varieties, it is not used. When applied at the 5 to 10 lb formulation rate it is labeled to provide control of Mexican bean beetle, thrips and provides suppression of the three-cornered alfalfa hopper.

**Pyrethroids:**

- **Cyfluthrin (Baythroid 2):** has a 45-day PHI and a 12-hr REI. It has “Danger” listed as the signal word and is a Restricted Use Pesticide. Applied at the formulation rate range of 0.80 to 2.8 fl oz or 0.013 to 0.044 lbs ai per acre per treatment. Cost ranges from $2.23 to $7.78 per acre per treatment. No more than 0.175 lbs ai per acre per season. Green forage may be fed 15-days after last application. Labeled to control; cutworms, potato leafhoppers, thrips, green cloverworm, armyworm, bean leaf beetle, beet armyworm, blister beetles, cabbage looper, adult corn rootworm, cucumber beetle, European corn borer, Fall armyworm, adult grape colaspis, adult Japanese beetle, adult green June beetle, lygus bug, masked chafer, Mexican bean beetle, saltmarsh caterpillar, silverspotted skipper, Southern armyworm, stinkbugs, tarnished plant bug, threecornered alfalfa hopper, tobacco budworm, velvetbean caterpillar, webworm, woollybear caterpillar, yellowstriped armyworm, grasshoppers, soybean aphid, lesser cornstalk borer, and soybean looper.

- **Esfenvalerate (Asana XL 0.66EC):** has a 21-day PHI and a 12-hr REI. It has “Warning” listed as the signal word and it is a Restricted Use Pesticide. It is applied at the formulation rate range of 2.9 to 5.8 fl oz or 0.015 to 0.30 lbs ai per acre per treatment. Cost ranges from $2.22 to 4.44 per acre per treatment. No more than 0.2 lbs ai per acre per season. Livestock should not be feed or allowed to graze treated areas. Used to control green clover worm, Mexican bean beetle, potato leafhopper, saltmarsh caterpillar, velvet bean caterpillar, woollybear caterpillar, bean leaf beetle, beet armyworm, cabbage looper, corn earworm, cutworm spp., grasshoppers, green stink bug, adult Japanese beetle, Southern green stink bug, Soybean aphid, and three-cornered alfalfa hopper.

- **Gamma-cyhalothrin (Prolex):** has a 45-day PHI and a 24-hour REI. It has “Caution” listed as the signal word and is a Restricted Use Pesticide. It is applied at the formulation rate range of 0.77 to 1.54 fl oz or 0.0075 to 0.015 lbs ai per acre per application. The label indicates not to graze or harvest treated forage, straw or hay for livestock feed.
No more than 0.03 lb ai per acre per season allowed. Labeled to control bean leaf beetle, cabbage looper, corn earworm, cutworm spp., green cloverworm, Mexican bean beetle, Mexican corn rootworm beetle adult, adult northern corn rootworm, potato leafhopper, saltmarsh caterpillar, adult southern corn root worm beetle, soybean aphid, three-cornered alfalfa hopper, thrips spp., velvet bean caterpillar, woollybear caterpillar, armyworms, blister beetle spp., European corn borer, fall armyworm, grasshopper spp., adult Japanese beetle, plant bug spp., stink bug spp., tobacco budworm, webworm spp., yellowstriped armyworm, beet armyworm, lesser corn stalk borer, soybean looper, and spider mite spp.

- **Lambda-cyhalothrin (Karate 2.08)**: has a 45-day PHI and a 24-hour REI. It has “Warning” listed as the signal word and is a Restricted Use Pesticide. It is applied at the formulation rate range of 0.96 to 1.92 fl.oz or 0.015 to 0.03 lb ai per acre per treatment. Do not apply more than 0.06 lbs ai per acre per season. Cost ranges from $3.05 to 6.11 per acre per application. Livestock should not be allowed to feed in treated areas, or be fed forage, straw or hay. Labeled for control of corn earworm, velvet bean caterpillar, cabbage looper, saltmarsh caterpillar, woollybear caterpillar, cutworms, bean leaf beetle, Mexican bean beetle, adult Western corn root worm, adult Northern corn rootworm, adult Southern corn rootworm, adult Mexican corn root worm, three-cornered alfalfa hopper, thrips, soybean aphids, armyworms, tobacco budworm, webworm spp., adult Japanese beetle, silverspotted skipper, European corn borer, grasshopper species, blister beetle species, stinkbug species, plant bug species, soybean looper, and various spider mite species.

- **Permethrin (Pounce 3.2)**: has a 60-day PHI and a 12-hour REI. It has “Caution” listed as the signal word and is a Restricted Use Pesticide. It is applied at the formulation rate range of 2 to 8 fl oz or 0.05 to 0.20 lbs ai per acre per application. Cost ranges from $2.52 to 10.06 per acre per application. No more than 0.4 lbs ai per acre per season. Livestock may not be allowed to feed on treated forage or hay. Labeled for control of; bean leaf beetle, cabbage looper, corn root worm beetles, cutworms, flea beetles, green cloverworm, Japanese beetle, Mexican bean beetle, potato leaf hopper, saltmarsh caterpillar, thistle caterpillar, velvetbean caterpillar, beet armyworm, corn earworm, soybean looper, and webworms.

- **S-cyano or Zetamethrin (Mustang Max 0.8)**: has a 21-day PHI and a 12-hour REI. It has “Warning” listed as the signal word and is a Restricted Use Pesticide. It is applied at the formulation rate range of 1.28 to 4 fl oz or 0.008 to 0.025 lbs ai per acre per application. It cost $2.14 to $6.68 per acre per application. No more than 0.15 lbs ai per acre per season allowed. Labeled for control of armyworms, European corn borer, corn earworm, leafhopper spp., cucumber beetle, flea beetle, plant bug spp., aphid spp., and stink bug spp.

**Other classifications:**

- **Bacillus thuringiensis (Condor, Dipel, Javelin)**: all formulations have a 0-day PHI and a 4-hour REI. Most formulations have “Caution” listed as the signal word. Condor is labeled for control of green cloverworm, soybean looper and velvetbean caterpillar. Dipel may provide additional control of small armyworms. Javelin is labeled to control various lepidopterous pests. Cost for the Dipel ES formulation would range from $4.67 to 9.35 per acre per treatment.

- **Indoxacarb (Steward 1.25)**: has a 21-day PHI and a 12-hour REI. It has “Caution” listed as the signal word. It is applied at the formulation rate range of 5.6 to 11.3 fl oz or 0.055 to 0.110 lbs ai per acre. No more than 0.44 lbs ai per acre per season. Cost would range from $8.31 to $16.77 per acre per application. Livestock should not be allowed to feed or grazed treated areas. Labeled to control; beet armyworm, cabbage looper, corn earworm, fall armyworm, green cloverworm, soybean looper, velvetbean caterpillar, and yellow striped armyworm.

- **Spinosad (Tracer 4)**: is a naturalyte insecticide which has a 28-day PHI and a 4-hour REI. It has “Caution” listed as the signal word. It is applied at the formulation rate range of 1 to 2 fl.oz or 0.03125 to 0.0625 lbs ai per acre.
per application. Cost ranges from $6.66 to 13.31 per application per acre. Labeled for control of soybean looper, velvet bean caterpillar, green cloverworms, true armyworms, corn earworm, saltmarsh caterpillar. Treated hay or forage should not be fed to meat or dairy animals.

- **Potassium salts** (M-Pede): has a 0-day PHI and a 12-hour REI. It has “Warning” listed as the signal word. Applied at the formulation rate of 4 pints per acre. Cost would be approximately $10.50 per application per acre. Labeled for control of aphids, thrips, plant bugs, spidermites, and leafhoppers.

- **Azadirachtin** (Neemix 4.5): has a 0-day PHI and a 12-hr REI. It has “Warning” listed as the signal word and contains 0.34 lbs ai per one gallon. It is applied at the formulation rate of 5 to 16 fl oz or 0.013 to 0.042 lbs ai per acre per application. It is labeled to control aphids, leafhoppers, loopers, armyworms and borers.

- **Sulfur** (Kumulus): has a 0-day PHI and a 24-hr REI. It has “Caution” listed as the signal word. It may provide suppression for spidermites. Applied at the rate of 6-15 lbs formulation. May be phytotoxic when sprayed at temperatures above 85F.

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### Diseases

Soybean producers encounter several problems, even during good growing conditions. Many of the pests of soybeans include diseases. Disease pressure varies from year to year and from location to location. Growing soybeans continuously on the same land increases the possibility of diseases, insect infestation and weed interference. Rotations with corn, grain sorghum, cotton, hay or pasture can be extremely beneficial to soybean production. Rotations help reduce the populations of soybean cyst nematodes, a commonly observed pest of soybeans. Listed below are diseases and an estimated percent loss encountered by these diseases during the 2005 production year.

The soybean cyst nematode (*Heterodera glycines*) caused approximately 4.00% loss due to infestation, seedling diseases (*Rhizoctonia* spp., *Fusarium* spp., *Pythium* spp.) caused 2.00% loss, charcoal rot (*Macrophomina phaseolina*) caused 2.00 % loss, anthracnose (*Colletotrichum truncatum*) caused 3.00 % loss, brown leaf spot (*Septoria glycines*) caused 3.00 % loss, sudden death syndrome (*Fusarium solani* form A) caused 2.0 % loss, frogeye leaf spot (*Cercospora sojina*) caused 5.0 % loss, stem canker (*Diaporthe phaseolorum* var. *caulivora*) caused 2.0 % loss, Diaporthe/phomopsis (*Diaporthe & Phomopsis* spp.) caused 2.0 % loss, downy mildew (*Peronospora manshurica*) was not observed, purple seed stain (*Cercospora kikuchii*) caused 0.5 % loss, Fusarium wilt and root rot (*Fusarium* spp.) was responsible for a trace loss and other diseases caused very insignificant loss. A total estimated loss of 25.8% from all diseases observed in the 2005 soybean production season.

### 2005 Soybean Disease Loss Estimate

<table>
<thead>
<tr>
<th>Disease (common name / Scientific name)</th>
<th>% Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Anthracnose (<em>Colletotrichum truncatum</em>)</td>
<td>3.0</td>
</tr>
<tr>
<td>2 Bacterial diseases (<em>Pseudomonas syringae, P. syringae pv. tabaci, Xanthomonas campestris</em>)</td>
<td>0.0</td>
</tr>
<tr>
<td>3 Brown leaf spot (<em>Septoria glycines</em>)</td>
<td>3.0</td>
</tr>
<tr>
<td>Disease Type</td>
<td>Percentage</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Charcoal rot (Macrophomina phaseolina)</td>
<td>2.0</td>
</tr>
<tr>
<td>Diaporthe / Phomopsis complex (Diaporthe &amp; Phomopsis spp.)</td>
<td>2.0</td>
</tr>
<tr>
<td>Downy mildew (Peronospora manshurica)</td>
<td>0.0</td>
</tr>
<tr>
<td>Frog eye leaf spot (Cercospora sojina)</td>
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</tr>
<tr>
<td>Fusarium wilt &amp; root rot (Fusarium spp.)</td>
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</tr>
<tr>
<td>Phytophthora root &amp; stem rot (Phytophthora sojae)</td>
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</tr>
<tr>
<td>Pod &amp; stem blight</td>
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</tr>
<tr>
<td>Purple seed stain (Cercospora kikuchii)</td>
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</tr>
<tr>
<td>Rhizoctonia aerial blight (Rhizoctonia solani)</td>
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</tr>
<tr>
<td>Sclerotinia stem rot (Sclerotinia sclerotiorum)</td>
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</tr>
<tr>
<td>Seedling disease (Rhizoctonia, Pythium &amp; Fusarium spp.)</td>
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</tr>
<tr>
<td>Southern blight (Sclerotium rolfsii)</td>
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</tr>
<tr>
<td>Soybean cyst nematode (Heterodera glycines)</td>
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<tr>
<td>Root-knot (Meloidogyne spp.)</td>
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</tr>
<tr>
<td>Other nematodes</td>
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</tr>
<tr>
<td>Stem canker (Diaporthe phaseolorum var. meridionalis)</td>
<td>2.0</td>
</tr>
<tr>
<td>Sudden death syndrome (Fusarium solani)</td>
<td>2.0</td>
</tr>
<tr>
<td>Viruses</td>
<td>0.1</td>
</tr>
<tr>
<td>Brown stem rot (Phialophora gregata)</td>
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</tr>
<tr>
<td>Soybean rust (Phakospora pachyrhizi)</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Total loss due to disease**: 25.8

Information provided by Melvin Newman, University of Tennessee.

**Soybean fungicides and usage**

**Soybean seed treatments**

There are several soybean seed treatments available to growers. Active ingredients of these treatments include; thiram, carboxin, metalaxyl or mefenoxam, captan, maneb, chloroneb, thiabendazole, pentachloronitrobenzene (PCNB), terraclor (etridiazole). Approximately 45% of seeds used for planting are treated with a seed treatment containing one or more of these listed active ingredients. However, the majority of soybeans treated during 2005, were treated with thiram and carboxin (Vitavax) mixtures. Many producers choose products that contain mixtures of molybdenum, a material that promotes plant growth.

**Soybean foliar fungicide usage**

Tennessee recommends growers to utilize the "Soybean Foliar Point System.” However, with the threat of
Asian soybean rust, many growers selected to use preventative foliar treatments during 2005. The point system helps identify if foliar fungicides can aid growers in obtaining an economic return by using foliar fungicides for the typical diseases observed in Tennessee. The Point System is not a guarantee for and economic return but a guide. The system reviews yield potential, planting dates, cropping history, variety, moisture and disease susceptibility of variety chosen. Approximately 280,000 acres of soybeans were treated with a foliar fungicide during the 2005 season due to the onset of late season disease development. Products recommended for control of several leaf spot diseases included several fungicides, however, the majority of acreage treated during 2005 was treated with pyraclostrobin or azoxystrobin.

**Foliar Fungicides**

*Class Benzonitrile*

- **Chlorothalonil** (Bravo WeatherStik, Echo): has a 42-day PHI and a 12-hr REI. It has “Caution” listed as the signal word. Product is used as a protectant fungicide. Bravo is applied at the formulation rate range of 1.5 to 2.25 pints or 1.125 to 1.7 lbs ai per acre per application. Cost ranges from $9.13 to $34.40 per acre per application. Soybean hay or threshing from treated fields should to be used for livestock feed. No more than 4.5 lbs ai per acre per season allowed. Normally applied at early pod set (R3) to the beginning of seed formation (R5). Labeled for control; anthracnose, Diaporthe pod and stem blight, Frogeye leaf spot, purple seed stain, Cercospora leaf blight, Septoria brown spot, stem canker and Asian soybean rust.

*Class Strobilurin*

- **Azoxystrobin** (Quadris 2.08): has a 14-day PHI and a 4-hr REI. This product has “Caution” listed as the signal word. Product is used as a protectant and has some locally systemic activity. Applied at the rate of 4 fl oz per acre per application. Cost would be $9.20 per acre per application. No more than two applications of strobilurin products per season and no more than 1.5 lbs ai per acre per season allowed. Used to control Asian soybean rust, aerial blight, anthracnose, alternaria leaf spot, Septoria brown spot, Cercospora blight and leaf spot, frogeye leaf spot, pod and stem blight, Southern blight, and *Rhizoctonia solani*. This product may be applied the day of harvest for soybean forage and hay.

- **Pyraclostrobin** (Headline, 2.09): has a 21-day PHI and a 12-hr REI. This product has “Warning” listed as the signal word. Product is used as a protectant and has some locally systemic activity. May be applied at the 6 to 12 fl oz formulation rate with no more than 12 fl oz or 0.195 lbs ai per acre per application and no more than 24 fl oz or 0.39 lbs ai per acre per season. Cost would range from $10.38 to 20.77 per acre per application. Labeled for control of ascochyta blight, Cercospora blight, Anthracnose, Alternaria leaf spot, Septoria brown spot, Frogeye leaf spot, Pod and stem blight, Rhizoctonia aerial blight, and Asian soybean rust. This product may provide suppression of Southern blight when applied a maximum rates.

*Class Strobilurin and Triazole*

- **Propiconazole / azoxystrobin** (Quilt): may not be applied after R-6 maturity and has a 24-hr REI. It has “Caution” listed as the signal word. May be applied until R6 growth stage at the formulation rate range of 14 to 20 fl oz per acre per application. The product contains 1.04 lb ai propiconazole and 0.62 lbs ai azoxystrobin per gallon formulation. No more than 2 applications or 40 fl oz formulation or per acre per season. Cost ranges from $11.06 to $18.44 per acre per application. Product is used as a protectant and is locally systemic and acts curatively. Used to control Asian soybean rust. Product is fairly toxic to apples, avoid drift in orchard
areas. Product may cause slight phytotoxicity in some varieties of soybeans.

- **Propiconazole / trifloxystrobin (Stratego):** May not be applied after R-6 maturity. One gallon of formulation contains 1.04 lbs ai of propiconazole and 1.04 lbs ai trifloxystrobin. It has a 24-hr REI and has “Warning” listed as the signal word. No more than two applications per season allowed. Applied at the rate of 5.5 to 10 fl oz per acre per application. No more than 0.339 lbs ai of propiconazole products allowed per acre per season. No more than 0.162 lbs ai per acre per season of products containing trifloxystrobin. Cost ranges from $5.98 to $10.88 per acre per application. Product is used as a protectant, has post infection activity, and anti-sporulation activity. Applications may be made when environmental conditions are conducive for disease development up until R6 (full seed). Used to control Asian soybean rust.

- **Tebuconazole / Pyraclostrobin (Headline SBR):** has a 30-day PHI and a 12-hr REI. The signal word is “Warning”. Product is used as a preventative and has curative effects. Product contains 2.09 lbs ai pyraclostrobin and 3.6 lbs ai of tebuconazole per gallon formulation. Applied at the formulation rate of 7.8 fl oz per acre. No more than 2 applications per season allowed. Cost would be $14.63 per acre per application. Used to control Asian soybean rust.

**Class Triazole**

- **Tebuconazole (Folicur 3.6F, Orius):** have a 30-day PHI and a 12-hr REI. These products have “Caution” listed as the signal word. Folicur is applied at the formulation rate range of 4 to 8 fl oz or 0.1125 to 0.225 lbs ai per acre per season. Cost would range from $8.63 to $17.25 per acre per application. Product has protective and curative action, has post-infection activity and anti-sporulant activity. Used to control Asian soybean rust. May provide control of *Rhizoctonia* spp., and southern blight. Treated forage or hay should not be fed to livestock.

- **Tetraconazole (Domark 230ME):** has a 21-day PHI and a 24-hr REI. This product has “Caution” listed as the signal word. Product is formulated at 1.9 lb ai per gallon formulation. It is labeled to be applied at formulation rate range of 4 to 6 fl oz or 0.059 to 0.089 lbs ai per acre per application. Cost would range from $10.58 to 15.87 per acre per application. Limited to one application and should not be used after R5. Used to control Asian soybean rust.

- **Myclobutanil (Laredo EC):** has a 28-day PHI and a 24-hr REI. It has “Danger” listed as the signal word. Applied at the formulation rate range of 4 to 8 fl oz or 0.0625 to 0.125 lbs ai per acre per application. Treated forage or hay should not be fed to livestock. Used to control Asian soybean rust.

- **Propiconazole (Bumper, Propimax, Tilt):** have a 28-day PHI and a 24-hr REI. Both products have “Warning” listed as the signal word. Normally applied at R1 (50 days after planting) and may be repeated at a 14-day interval if conditions warrant use. No more than 12 fl oz of Bumper per season. Propimax is applied at the formulation rate range of 4 to 8 fl oz or 0.113 to 0.225 lbs ai per acre per treatment. No more than 0.34 lbs ai per acre per year is allowed. No more than two applications of propiconazole products per year. Livestock should not be allowed to graze or fed forage or hay of treated areas or treatment materials should not be used as bedding. Used to control Asian soybean rust. Cost ranges from $10.50 to $21.00 per acre per application.

**Class Benzimidazole**

- **Thiophanate-methyl (various 85WDG):** no PHI was listed but has a 12-hour REI. It has “Caution” listed as the signal word. Applied at the formulation rate range of 0.4 to 0.8 lbs or 0.34 to 0.68 lbs ai per acre per treatment. Livestock should not be allowed to graze or feed on treated vines or hay of treated areas. Normally, applied when full bloom when pods are 1/8 to ¼ inch in length and applications end when beans begin
Nematodes

Soybean Cyst Nematode

*Heterodera glycines*

The soybean cyst nematode (SCN) is a common pest of soybeans. There are several races of this pest which can be found in Tennessee. Growers experiencing losses from the SCN infestation are urged to use resistant varieties and/or rotate out of soybean production for a minimum of five years. Rotation into other crops helps reduce populations of the SCN, however, this pest can survive past the five year rotation scheme. Temik (aldicarb) nematicide has been recommended in past years for control of the SCN however, due to commodity pricing, it is not feasible. Oxamyl (Vydate-L) is another product labeled for control, however is not used by producers. Most growers use resistant varieties to help control yield reductions caused by this pest. Growers are still encouraged to take soil samples every two to three years, even if using resistant varieties.
Weeds

There are various weeds observed in soybean production. Most weeds have been controlled using products containing glyphosate. However, until recently horseweed (*Conyza canadensis*) and palmer pigweed (*Amaranthus palmeri*) have been reported resistant. Efficacy of herbicides labeled for weed control may be found in Tables 2 and 3. Table 1, lists the estimated herbicide usage during 2005.

**HERBICIDES**

**Glyphosate-resistant horseweed management systems**

Management of glyphosate-resistant horseweed has recently become one of the biggest challenges for growers throughout West Tennessee. The glyphosate-resistant biotype of horseweed has now ended the era of glyphosate only weed control for the cotton and soybean fields. Moreover, recent research conducted by the University of Tennessee has found that horseweed will germinate from March through November. This information dictates that weed management programs must be constructed that utilize herbicides with different sites of action as well as herbicides that can provide residual and/or can be applied post or post-directed. While considerations should always be given to the entire weed spectrum, one or more of the following strategies are recommended to manage glyphosate-resistant horseweed in soybeans. These recommendations are listed below.

**Preplant burndowns:**

- **Glufosinate** (Ignite): formulation rate range from 32-40 fl oz or 1.67 to 2.09 lbs ai per acre. Cost would range from $9.57 to 11.97 per acre per application. Day temperatures should exceed 60F for best product performance.
- **Glyphosate and dicamba** (Roundup WeatherMax and Clarity): a tank mix using 22-43 fl oz formulation or 0.75 to 1.5lbs a.e of Roundup WeatherMax and 8 fl oz formulation or 8 fl oz or 0.25lbs ai of Clarity. Cost would range from $9.85 to 19.26 for Roundup and $5.88 for Clarity. Since dicamba is used, a 21-day waiting period after rainfall is required before planting soybeans to avoid crop injury. Livestock should not be allowed to graze or fed hay, fodder within 25-days of last application of glyphosate products.
- **Glyphosate and 2,4-D** (Roundup WeatherMax and 2,4-D): a tank mix of Roundup WeatherMax at 0.75 to 1.5 lbs a.e. and 2,4-D at 22 to 43 fl oz or 0.5 to 1 lb ai must be applied 30-days prior to planting soybean. Cost would range from $9.85 to 19.26 for Roundup and would range from $2.56 to 5.15 for 2, 4-D. 2, 4-D should not be used on light sandy soils. Livestock should not be allowed to graze or fed hay, fodder within 25-days of last application of glyphosate products.
- **Flumioxazin** (Valor 51WDG): applied at the rate of 1 -2 oz or 0.03125 to 0.0625 lbs ai per acre. No more than 3oz. per acre per season allowed. Product will not control existing horseweed. Cost would range from $4.53 to 9.05 per acre per treatment. May be applied as a preplant or preemergence treatment to control spring germinating horseweed. Livestock should not be fed hay or treated forage. Livestock should not be allowed to
graze treated fields.

**Preemergence:**

- **Paraquat with metribuzin (Gramoxone Max and Sencor DF):** These products are tank mixed at the rate of 32 oz or 0.75 lbs ai of Gramoxone Max and 4 oz formulation or 0.19 lbs ai of Sencor DF. Cost would be $10.93 for Gramoxone Max per acre and $5.55 for Sencor DF. Mixture should be applied to horseweed six inches in height or less. Products should be mixed with a non-ionic surfactant to obtain optimum control. Soybeans should not be grazed or harvested for forage or hay before the R3 stage of soybean development (early pod) when treated with paraquat products.
- **Flumioxazin (Valor 51% WDG):** Applied at the rate of 1-2 oz. or 0.5 to 1 oz ai. per acre per treatment. No more than 3 oz formulation per acre per growing season should be made. Cost would range from $4.53 to 9.05 per acre per treatment. Will not control existing horseweed. Livestock should not be allowed to graze treated fields.

**Postemergence:**

- **Cloransulam-methyl (FirstRate 84DG or Amplify 84DG):** Applied at the formulation rate of 0.3 oz or 0.016 lb ai per acre. This product is generally mixed with other glyphosate products in which a non-ionic surfactant is used. When using products such as Roundup WeatherMax, UltraMax or GlyphosateMax the addition of surfactants is not needed. Ammonia sulfate may be added at the rate of 8.5 to 17 lbs per 100 gallons of solution. Soybeans should not be fed or forage or hay for 14 days after application.

**Products recommended for burndown use in No-till Soybeans**

- **Paraquat (Gramoxone Max):** Applied at the formulation rate range of 20-32 fl oz or 0.47 to 0.75 lbs ai per acre per treatment. Should only be applied to weeds less than six inches in height. A non-ionic surfactant should be added to obtain optimum control. Soybeans should not be grazed or harvested for forage or hay before the R3 stage of soybean development (early pod) when treated with paraquat products.
- **Glufosinate (Ignite):** Applied at the formulation rate range of 32 to 40 fl oz or 1.67 to 2.09 lbs ai per acre per treatment.
- **Glyphosate 3 a.e. (Touchdown, others):** Applied at the formulation rate range of 32-64 fl oz or 0.75 to 1.5 lbs ae per acre per treatment. Higher rates should be used on larger annual and perennial weeds. Do not graze or harvest treated hay or fodder for livestock feed within 25-days of last preharvest application. Glyphosate products are more effective than Gramoxone Max for control of smartweed and fall panicum.
- **Glyphosate 4.5a.e. (Roundup WeatherMax, others):** Applied at the formulation rate range of 22 – 43 fl oz or 0.75 to 1.5 lbs ae per acre per treatment. Higher rates should be used on larger annual and perennial weeds. Do not graze or harvest treated hay or fodder for livestock feed within 25-days of last preharvest application. Glyphosate products are more effective than Gramoxone Max for control of smartweed and fall panicum.

On many occasion manufacturers may list a number preceding the formulation designation (L, EC, DF, etc.). This does not indicate pounds active ingredient per gallon or pounds, but rather the acid equivalent (a.e. = acid equivalent) per gallon or pound. The term acid equivalent is one that many people are less familiar. Acid equivalent may be defined as that portion of a formulation (as in the case of 2,4-D ester for example) that theoretically could be converted back to the corresponding or parent acid. Another definition of acid equivalent is the theoretical yield of parent acid from a pesticide active ingredient which has been formulated as a
derivative (esters, salts, amines are examples of derivatives). For instance, the acid equivalent of the isooctyl ester of 2,4-D is 66% of the ester formulation, but 88% of the ethyl acetate ester formulation.

Preplant and/or Pre-emergence Control Products

The majority of the products listed below are applied as a pre-emergent herbicide, however several may be applied after the crop has emerged. The post harvest intervals are indicated for products, which is listed as PHI on the label. The majority of conventionally grown soybean acreage is treated with a preemergent herbicide when non-Roundup Ready soybeans are grown. If Roundup Ready varieties are selected, glyphosate products are primarily used for weed control. Often producers will have to apply a post emergent herbicide, post directed herbicide or spot treat when previously treated with a preemergent herbicide. Preemergent products are generally applied one to six weeks prior to planting the field. Many preemergent herbicides are non-selective products and may cause plant injury if applied just prior to or during crop emergence.

Soybean Weed Control Products:

Preplant incorporated herbicides:

- **Trifluralin (Treflan, Tri-4, Trilin and other trade names)** Rate range of 1 – 2 pints formulation or 0.5-1.0 lb. active ingredient per acre. High rates are used in a silty clay loam soil. A 2X rate may be needed to obtain effective control of rhizome johnsongrass. Cost ranges from $3.38 to 6.75 per acre per treatment. A preemergent herbicide should be used for broadleaf weed control.

Preemergence herbicides:

- **S-metolachlor + metribuzin** (Boundary 7.8EC): applied at the rate range from 1 – 3 pints depending on soil type. Cost ranges from $9.91 to 29.73 per acre depending on rate used. It is used for grass and broadleaf weed control. Higher rates are recommended in soils containing 3% or more organic matter. It has a dual classification it is a triazine and a substituted amine mixture. Treated soybeans may be grazed or fed to livestock 40 days after the last application of Boundary.

- **Sulfentrazone + Chlorimuron** (Canopy XL 56.3DF): Applied at the formulation rate range of 5.1 to 6.8 oz. per acre depending on soil type. Cost ranges from $10.52 to 14.02 per acre. Do not feed treated soybean forage or soybean hay to livestock. A STS (sulfonylurea tolerant soybean) variety should be used with this product. Cotton should not be planted on soils with a pH of 7.0 or less within 18 months after application or within 30 months on soils with a pH greater than 7.0.

- **Clomazone** (Command 3ME): Applied at the rate range of 1.3 to 3.3 pints or 0.49 to 1.24 lbs ai per acre. Cost ranges from $16.66 to $42.28 per acre. Livestock should not be allowed to graze on, feed treated soybean vines or feed treated vine trash. Livestock should not be allowed to feed on treated cover crops for 9 months after treatment. Wheat should not be planted within 12 months of application.

- **Flufenacet + metribuzin** (Domain 60DF): Applied at the formulation rate range of 9-16 oz or 0.345 to 0.6lbs ai per acre per application. Cost ranges from $7.30 to 12.97 per acre. Rates are increased in high weed pressure areas or areas with high organic (3%) matter. Do not graze or feed forage, hay or straw to livestock.

- **S-Metolachlor** (Dual II Magnum or Cinch): Applied at the formulation rate range of 1 to 1.67 pints or 0.96 to 1.59
- **Dimethenamid-P (Outlook 6EC)** formulation rate ranges from 10 to 18 oz or 0.47 – 0.84 lbs. active ingredient per acre. Do not graze or feed forage, hay or straw to livestock. A broadleaf herbicide may be needed to provide broad spectrum control of weeds. This product provides good grass control.

- **Pendimethalin (Prowl 3.3 EC, Pendimax)** formulation rate ranges from 1.2 to 3.6 pints or 0.5-1.5 lbs. active ingredient per acre. Cost ranges from $3.15 to 9.45 per acre. Higher rates are used on heavier soil types. Livestock may be fed forage or allowed to graze treated fields. This active ingredient provides good grass control. A 2X or double rate may be needed to increase suppression of rhizome johnsongrass.

- **Imazethapyr (Pursuit 2AS or 70DG)** 85 days PHI. Applied at the 2AS rate of 4 fl oz or 1.44 oz of the 70DG formulation or 0.063 lbs. active ingredient per acre. Cost ranges from $16.43 for the 2AS formulation and $16.49 for the70DG formulation. Do not graze or feed treated soybean forage, hay or straw to livestock. Cotton may not be planted for 18 months after application. Edible beans and tobacco require a 9.5 month waiting period before planting.

- **Flumetsulam (Python 80WDG):** Applied at the formulation rate ranges of 0.8 to 1.25 oz or 0.04 to 0.05 lbs ai per acre. Cost ranges from $8.00 to 12.50 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Cotton should not be planted within 18 months of application and grain sorghum should not be planted within 12 months of application.

- **Metribuzin (Lexone or Sencor 4L or 75DF)** 40 days PHI. Formulation rate ranges from 0.5 to 0.83 lbs or 0.38 - 0.6 lbs. active ingredient per acre. Cost ranges from $11.10 to 18.43 per acre. Treated forage may be grazed or fed to livestock 40-days after application. May provide control of emerged volunteer cotton. Often mixed with Gramoxone Max.

- **Imazaquin (Scepter 1.5 AS or 70DG)** 90 days PHI. Applied at the formulation rate range of 0.5 to 0.67 pints AS formulation or 2.1 to 2.8 oz. 70DG formulation or 0.09 - 0.125 lbs. active ingredient per acre. Higher rates are used on heavier soil types. Do not graze or feed treated soybean forage, hay or straw to livestock. Do not plant grain sorghum within 11 months or cotton within 18 months of application. Do not plant corn or tobacco within 9.5 months of application. A recommended grass herbicide should be used to obtain grass control.

- **Pendimethalin + imazaquin (Squadron 2.33EC)** Applied at the formulation rate of 3 pints or 0.87 lbs ai. 2.0 lbs. (p) + 0.33 lb. (i) active ingredients per acre. Cost would be $13.70 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Provides control for grass and broadleaf weeds.

- **Flumioxazin (Valor 51WDG):** formulation rate range of 2 – 2.5 oz or 0.063 to 0.078 lbs ai per acre. Cost ranges from $9.05 to $11.31 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Should be mixed with a grass herbicide to obtain broad-spectrum weed control.

**Postemergence herbicides***:

- **Carfentrazone-ethyl (Aim):** Applied at the formulation rate range of 0.5 to 1.6 oz or 0.008 to 0.025 lbs active ingredient per acre. Cost ranges from $2.95 to 9.44 per acre. Often causes foliar burn which lasts for a short duration. Provides control of velvet leaf and morningglories. Product may need glyphosate added to control larger morningglories.

- **Quizalofop (Assure II 0.88E):** Applied at the formulation rate range of 5 -10 oz or 0.034 to 0.069 lbs ai per acre. Cost ranges from $5.27 to 10.54 per acre per application. Do not graze or feed treated soybean forage, hay or straw to livestock. Controls rhizome johnsongrass when less than 10” in height, repeated applications may be needed when height is greater than 10”. Higher rates may be needed to control annual grasses or bermudagrass.
- **Bentazon** (Basagran 4SC): Applied at the formulation rate range of 1.5 to 2 pints or 0.75 to 1.0 lbs ai per acre per application. Cost ranges from $15.45 to $20.60 per acre per application. Do not graze or cut treated soybean fields for forage or hay for at least 30 days after the last treatment. Used to control cocklebur, prickly sida and other broadleaf weeds. The addition of crop oil may be needed to improve control of ragweed and lambsquarter.

- **Chlorimuron** (Classic 25DF): Applied at the formulation rate range of 0.5 to 0.75 oz or 0.008 to 0.012 lbs ai per acre per treatment. Cost ranges from $6.70 to 10.05 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control cocklebur, pigweed, burcucumber, and various other broadleaf weeds. Weak on prickly sida and lambsquarter. Do not plant corn, cotton, or sorghum within 9 months after application. Product may be applied after the first trifoliate until 60 days before harvest.

- **Lactofen** (Cobra 2E): Applied at the formulation rate of 12.5 oz or 0.2 lbs ai per acre. Cost would be $13.36 per acre. Do not graze animals on green forage or stubble. Do not utilize hay or straw for animal feed or bedding. Do not feed treated soybean silage (ensiled soybeans) to cattle. Used to control morningglory, ballonvine and several other broadleaf weeds. Causes foliar burn on soybeans which lasts a short duration.

- **Acifluorfen + Bentazon + Sethoxydim** (Conclude Xact B+G): Applied as a co-pack with 24 oz of acifluorfen 4L and 24 oz of sethoxydim 2E or 0.75 lbs ai of acifluorfen and 0.38 ai. of sethoxydim per acre. Cost would Used as an early overtop herbicide to control small annual grasses and small annual broadleaf weeds. This product provides suppression only of rhizome johnsongrass. Do not use treated plants for feed or forage.

- **Cloransulam-methyl** (FirstRate 84DG or Amplify 84DG): Applied at the formulation rate of 0.3 oz or 0.016 lbs ai per acre. Treatment cost of $9.18 per acre. Do not graze soybeans for forage or hay for 65 days after application. Applied over the top prior to 50% flowering stage of soybeans. Application prior to full emergence may cause temporary yellowing. Provides good control of cocklebur, common ragweed, giant ragweed and sicklepod. Crop oils should be added to solution to obtain optimum control.

- **Fomesafen** (Flexstar 1.88SC): Applied at the formulation rate range of 1 to 1.5 pints or 0.2 to 0.35 lbs ai per acre. Cost ranges from $13.13 to 19.69 per acre. Adjuvants are normally added to obtain greater control. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control cocklebur, morningglories and pigweed. May cause foliar burn which is usually a short duration.

- **Chloransulam-methyl + flumetsulam** (Frontrow): Applied at the formulation rate of 0.42 oz. or 0.022 lb ai per acre. Treatment cost of $9.32 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control prickly sida, cocklebur, common ragweed, giant ragweed and sicklepod.

- **Fluazifop** (Fusilade DX 2E): Formulation rate range is 6 to 12 oz or 0.094 to 0.188 lbs ai per acre per treatment. Cost ranges $6.87 to 13.73 per acre per treatment. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control most annual grasses before they exceed 4” in height. May be used for johnsongrass when plant reaches 8-18” in height. High rates may be needed for johnsongrass and/or bermudagrass.

- **Fluazifop + Fenoxaprop** (Fusion 2.56E): Applied at the formulation rate range of 8-12 oz or 0.16 to 0.24 lbs ai per acre. Cost ranges from $9.69 to 14.53 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Applied over the top for control annual grasses and johnsongrass. Also controls volunteer Roundup Ready corn.

- **Sethoxydim** (Poast 1.5E, Post Plus 1.0E): Applied at the formulation rate of 16 oz 1.5E or 24 oz. of 1E or 0.19 lbs ai per acre. Cost per acre would be $8.50 per acre for the 1.5E formulation and $9.75 per acre for the 1E formulation. Only meal of soybean seeds or hay processed may be fed to animals. Used to control most annual grasses. Controls Roundup Ready corn. Crop oil concentrate is needed for optimum control.

- **Imazethapyr** (Pursuit 2AS, 70DG): Applied at the 2AS formulation rate of 4 fl oz or 1.4 oz for the 70DG formulation or 0.063 lbs ai per acre. Cost is $16.44 for the 2AS formulation and $16.49 for the 70DG formulation.
per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control morningglory, spurge, pigweed, cocklebur and various other broadleaf weeds.

- **Imazamox** (Raptor 1AS): Applied at the formulation rate range of 4 to 5 oz or 0.03 to 0.04 lbs ai per acre. Cost ranges from $16.64 to 20.80 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control cocklebur, morningglory, pigweed, velvetleaf and seedling johnsongrass. Weak on sicklepod and hop hornbeam copperleaf. No more than one application per season allowed. Crop oil concentrate should be added to obtain optimum control.

- **Fomesafen** (Reflex 2LC): Applied at the formulation rate range of 1 to 1.5 pints or 0.25 to 0.38 lbs ai per acre. Cost ranges from $12.33 to 18.48 per acre. Sorghum may not be planted within 18 months of application. Do not graze or feed treated soybean forage, hay or straw to livestock. High rates control morningglories and various broadleaf weeds. Fairly safe on soybeans. Grain sorghum should not be planted within 18 months of application.

- **Flumiclorac** (Resource 0.86E): Applied at the formulation rate of 4 oz or 0.03 lbs ai per acre. Cost of $5.32 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control velvet leaf with up to 6 leaves. Crop oil concentrate may be needed to obtain optimum control.

- **Glyphosate 3ae** (Touchdown and others): Applied at the rate of 32 to 48 fl oz or 0.75 to 1.1 lb a.e. per acre. Cost ranges from $5.00 to 7.50 per acre per treatment. May be only used on Roundup Ready varieties. Do not graze or harvest treated hay or fodder for livestock feed within 25 days of last pre-harvest application. Dry conditions may reduce effectiveness.

- **Glyphosate 4.5ae** (Roundup WeatherMax and others): Applied at the formulation rate of 22 – 32 oz. or 0.75 to 1.1 lb a.e. per acre. Cost ranges from $5.23 to 7.60 per acre per application. May be only used on Roundup Ready varieties. Allow a minimum of 14 days between final application and harvest of soybean grain or feeding of soybean grain, forage or hay to livestock. Dry conditions may reduce effectiveness.

- **Imazaquin** (Scepter 1.5AS or 70DG): Applied at the formulation rate of 0.33 to 0.75 pints 1.5AS or 1.4 to 2.8 oz. of 70DG or 0.063 to 0.125 lbs ai per acre. Cost ranges from $4.24 to 8.47 per acre. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control pigweed and cocklebur.

- **Clethodim** (Select 2E, Arrow 2E): Applied at the formulation rate range of 6 to 8 oz or 0.094 to 0.125 lbs ai per acre per application. Cost ranges from $8.95 to 11.93 per acre per treatment. Do not graze or feed treated soybean forage, hay or straw to livestock. Used to control most annual grasses up to 6” in height. Control volunteer Roundup Ready corn.

- **Bentazon + Acifluorfen** (Storm): Applied at the formulation rate of 1.5 pints or 0.75 lbs ai per acre. Cost is $14.21 per acre per application. Do not use treated plants for feed or forage. Used to control cocklebur, morningglory, and several other broadleaf weeds.

- **Fomesafen + Fluazifop** (Typhoon): This product is a premix applied at the rate of 1.6 quarts or 0.56 lbs ai per acre. Cost is approximately $22.40 per acre. Do not graze treated areas or harvest forage or hay. Do not graze rotated small grain crops or harvest for livestock forage or straw. Used to control morningglories, pigweed, copperleaf, cocklebur and grasses such as seedling and rhizome johnsongrass, fall panicum and signalgrass.

- **Acifluorfen** (Ultra Blazer 2L): Applied at the formulation rate range of 0.5 to 1.5 pints or 0.13 to 0.38 lbs ai per acre. Cost ranges from $3.94 to 11.82 per acre. Do not use treated plants for feed or forage. Used to control morningglory, pigweed, and several other broadleaf weeds.

* If a band treatment is used, the rate is reduced proportionately to the band width and row spacing.
Soybean Harvest Aids

Harvest aid chemicals are sometimes needed to dessicate weeds in order to improve the timeliness of harvest. This is most frequently encountered with early maturing varieties which may be ready for harvest prior to a killing frost. Harvest aid chemicals do not speed-up maturity of the soybean plant; they merely reduce moisture in weeds and may improve harvest efficiency, in addition to timeliness. Producers are encouraged to make harvest aid decisions by comparing cost with anticipated benefits. Products commonly used for this process include materials which contain the active ingredient glyphosate, sodium chlorate, or paraquat. Due dry weather conditions which occurred in late season of 2005 little if any harvest aid materials were used.

Table 1. Estimated Herbicide Usage in Soybean Production During 2005*.

<table>
<thead>
<tr>
<th>Method</th>
<th>Herbicide</th>
<th>Non-Roundup Ready production (2% of total acres)</th>
<th>Roundup Ready Production (98% of total acres)</th>
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<tr>
<td>Burndown</td>
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<td>Glyphosate 3</td>
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<td>Amplify</td>
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* Roundup Ready production accounts for approximately 98% of the soybean production with the remaining 2% in non-Roundup Ready production. Numbers listed in the columns below conventional tillage or no-tillage systems represent percent acreage treated for each system. Estimates provided by Angela Thompson, University of Tennessee, Extension Service.

**Table 2. Expected Weed Response to Soybean Herbicides 2005**

<table>
<thead>
<tr>
<th>Weed</th>
<th>PPI</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>P</th>
<th>S</th>
<th>S</th>
<th>Preemergence</th>
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<tr>
<td>Crabgrass, Foxtails, Goosegrass</td>
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<td>9</td>
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<td>9</td>
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<tr>
<td>Johnsongrass, seedling</td>
<td>9</td>
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<th>Weed</th>
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<th>C</th>
<th>O</th>
<th>P</th>
<th>U</th>
<th>V</th>
<th>Preemergence</th>
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<td>9</td>
<td>9</td>
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<tr>
<td>Johnsongrass, seedling</td>
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<td>Broadleaf Signalgrass (Brachiaria)</td>
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<td>Groundcherries / Black nightshade</td>
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<td>Morningglories (annual)</td>
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<td>Pigweed, Smooth or Redroot</td>
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</table>

Soybean Tolerance
1 2 3 3 0 1 1 1 2

0 = No control or crop injury; 10-100% control or severe, yield-reducing crop injury; -- = data not available

\* 8 for PPI; 6 for PRE.

Table 3. Expected weed response from postemergence soybean herbicides.
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<tr>
<td>Yellow nutsedge</td>
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SOYBEAN TOLERANCE * Soybean variety must be Roundup Ready.
0 = No control or crop injury; 10 = 100% control or severe, yield reducing crop injury; -- = No data available

**Vertebrates**

**Voles:**

Voles can be a serious threat to soybean producers who select no-till technologies for production. The prairie vole (*Microtus ochrogaster*) is the most common in Tennessee. Vole may be observed feeding on soybeans from the time they are established until they are harvested. Vole infestation is usually greatest when land enrolled in the Conservation Reserve Program (CRP) is returned to row crop production.

**Chemical pest management tools:**

NOTE: currently no toxicants or repellents are approved for use in cropland, however zinc phosphide baits can be broadcast or drilled into field borders to help reduce invasion into soybean fields. Generally, 4 to 6 lbs per border acre are needed to obtain control.
Non-chemical pest management tools:
- Scouting for their presences
- Hay removal produced the previous year
- Low mowing prior to planting
- Burning 30-days prior to planting
- Broadcasting seeds prior to planting may provide an alternate food source for voles therefore reducing damage to developing seedlings.

Deer:
Deer can be found in almost any area of soybean production in Tennessee. Deer are browsers and may be found feeding on developing seedlings, top foliage or developing pods. They can cause 100% loss if not controlled.

Chemical pest management tools:
- Products containing sulfur or products which break down into sulfur, often reduce feeding of various vertebrate pests.

Non-chemical pest management tools:
- Hunting
- Fences – not cost effective

Ground hog:
Chemical pest management tools:
- None

Non-chemical pest management tools:
- Hunting
- Trained dogs

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References


