Crop Profile for Soybeans in North Carolina

Prepared: May 2005

General Production Information

- North Carolina ranked 17th in the nation in soybean production in 2003 and is the largest soybean producer on the East Coast.
- North Carolina produced 1.7% of the total U. S. production of soybeans in 2003.
- In 2003, North Carolina soybean harvested amounted to 30,960,000 bushels from 1,400,000 acres (2,100,000 acres were harvested in 1982). This is the highest acreage of any row crop in the state.
- Average soybean yields have varied from 9 bushels per acre in 1943 to 32.5 bushels per acre in 2000.
- Farmers received an average of $6.20 per bushel for soybeans in 2003, up from $4.75 in 2001.
- The value of the soybean crop in North Carolina in 2003 was $174,305,000. Almost half of the crop is grown following small grains or vegetable crops and it is a valuable alternative in several crop rotation schemes.
- Biotechnology varieties of soybeans (modified for herbicide resistance) accounted for 85% of the total U.S. production from 2001 to 2004.

Production Regions

Most production occurs in the coastal plain where Robeson County led the State in production of 3,100,000 bushes in 2003 (Figure 1). In the Piedmont, only Union County (ranked third in the State) harvested more than 800,000 bushels. Twenty-one counties in the western North Carolina harvested less than 10,000 bushels.

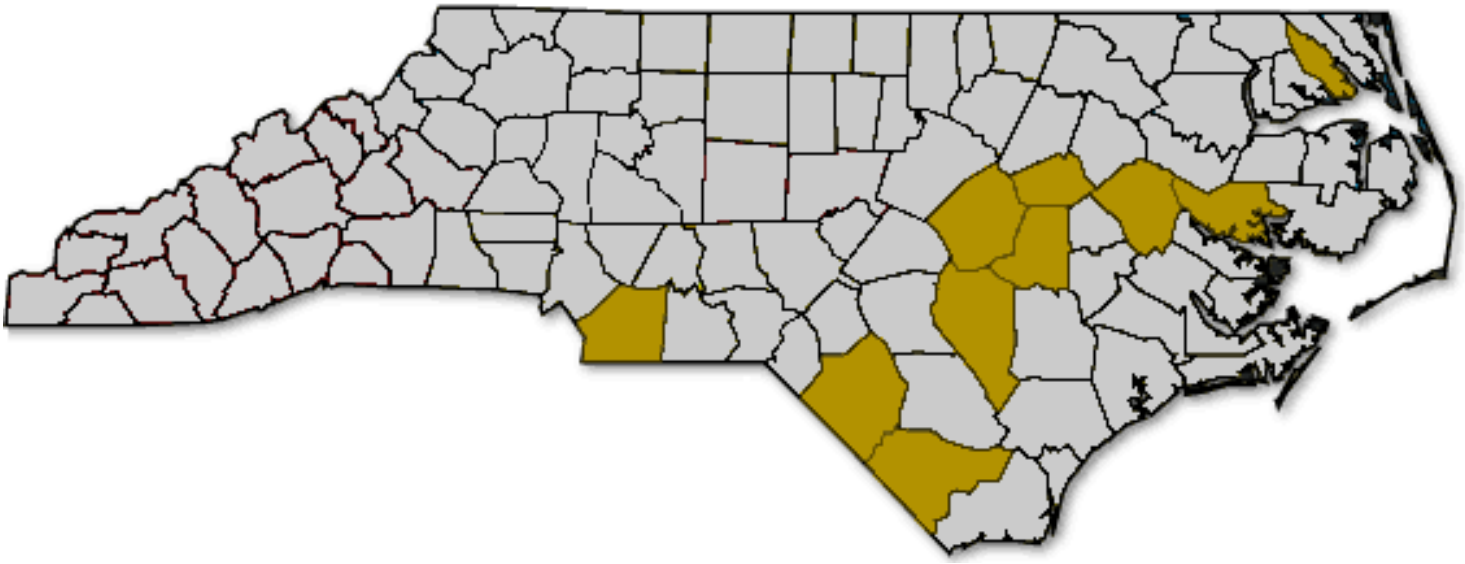

Figure 1. Leading soybean-producing counties in North Carolina , including Robeson, Beaufort, Union , Wayne , Johnston , Sampson, Columbus , Pitt, Pasquotank and Wilson counties.

Production Practices

In North Carolina, soybeans are planted May 1 to July 18 with most planting done from May 20 to June 30. Soybeans are harvested from about October 10 to December 20 with the bulk of the crop harvested from November 12 to December 3.

Seed selection is a major building block of a soybean management program. Farmers must decide on indeterminate or determinate varieties, varieties that are disease resistant and herbicide resistant, the variety's standability (resistance to lodging), and its resistance to seed shattering. Seed quality determines future pesticide use (good quality seed requires less protection by fungicides). Farmers also must keep up with new traits in soybean varieties. However, the most yield-limiting factor in North Carolina is water stress.

Soybeans are grown on a variety of soils, but they grow best on soils that are easy to till and offer a moderately deep rooting zone for easy penetration by air, water, and roots. Soil compaction restricts the growth of plant roots, and plants on compacted soils cannot obtain enough water and nutrients. Compacted soils have a larger proportion of water-filled pore space, making the crop more susceptible to drowning, and compacted soils lead to increased runoff of water, nutrients, and sediment. Reduced tillage practices can slow the onset of soil compaction, encourage residue cover, and reduce erosion and excessive runoff. Most growers continue to use conventional tillage. Fewer use reduced tillage, and a small percent of growers practice no-till soybean production.

Crop rotations are important in controlling diseases and weeds in soybean production (or in the production of the other crops in the rotation). Rotation with grass-type crops is effective in reducing nematode and soil-borne disease problems and permits better control of weeds. Depending on where in North Carolina they

are being grown, soybeans are usually rotated with corn, small grains (usually wheat or barley), cotton, and peanuts. Various rotations result in three crops of soybeans in 2 years, four crops of soybeans in 2 years, four crops of soybeans in three years, and four or five crops of soybeans in 4 years.

Soybeans obtain required nitrogen from symbiotic nitrogen fixation in root nodules by the bacterium *Bradyrhizobia*. In soils where soybeans have not been grown in three years, *Bradyrhizobia* inoculant should be mixed with slightly moistened seeds at planting. Farmers sometimes use small amounts of nitrogen, but this can significantly inhibit the nitrogen-fixing bacteria and cause later nitrogen deficiencies. Application of other nutrients should follow soil testing and foliar testing results.

Planting date, seeding rate, and row width are selected to minimize time required for soybeans to close canopy. Planting date is usually determined by the harvest of the previous crop in the rotation cycle. To maximize production, soybeans need a leaf area index of 4. Cool soil temperatures, poor quality seed, lack of fungicide seed treatment, deer depredation, and insect defoliation all can contribute to lower leaf area indices. In fields with perennial histories of heavy deer depredation, it is recommended not to grow soybeans. With moderate levels of deer depredation, later maturing varieties planted in narrow rows at high plant populations will help compensate for deer damage. Hunting and fencing help reduce deer depredation.

To help prevent pest problems, North Carolina farmers till 34% of soybean acreage to manage pests whereas ground covers are maintained on 17% of soybean acres. Farmers remove or plow down crop residue on 37% of the soybean acreage. Only 6% of the acreage has planting and harvesting dates adjusted to avoid pests. Crops on 60% of soybean acreage are rotated to avoid pests, but only 5% of the acreage is rotated to alternate planting sites. Farmers keep pest records on 9% of the acreage. They map weed problems on 15% of the acreage, but only use soil analysis to detect pests on 10% of soybean acreage. Weather monitoring is used to forecast pest problems on 57% of soybean acreage. A whopping 78% of the acreage is planted in herbicide resistant biotech varieties. Farmers alternate pesticides on 21% of acres. (Source: Agricultural Chemical Usage: 2002 Field Crops Summary. May 2003. USDA National Agriculture Statistics Service.)

Worker Activities

Growers sometimes apply a fungicide or fungicide treated seed at planting. Most applicators use ground equipment with enclosed cabs. Smaller farms are less likely to have tractors with closed cabs.

Nearly 90% of the soil insecticide is loaded into the spreader with a "lock and load" system that limits exposure to the mix/loader. During the season, a grower typically makes one to three pesticide spray applications per year. A typical applicator could cover about 25 acres per hour. On smaller farms, a single individual may make all of the pesticide applications. On larger farms, the crop is treated by several workers that operate the spray rigs.

Nearly all soybeans are monitored informally. The grower or an employee will spend 1 to 2 hours per week

driving near the fields or walking in the field margins. Some soybeans are formally scouted once per week. It takes a typical scout about 2 hours to scout 100 acres of soybeans. Nearly all of the professional scouts are scouting other crops (e.g., cotton) in addition to soybeans. These scouts spend a majority of the day scouting fields or traveling to the next location.

Insect Pests

Insects that feed primarily on the foliage:

Bean leaf beetles, *Cerotoma trifurcata*, are oval, red and black to brown and black insect about 1/4 inch long. They feed on the youngest leaves (and occasionally on stems and pods). Beetles may have three or four black spots on each outer wing. The outer edges of the wings are black. However, this beetle always has a black head as well as a black, triangle on the forward margin of its wings. Adults overwinter in an around bean fields. In spring, they feed on weeds until early-planted soybeans come up.

Blister beetles, *Epicauta* spp., are ½ to $^{3}/_{4}$-inch-long, elongate, black, gray with black spots, or black and yellow striped beetles. Most species feed heavily on foliage along field margins but some prefer the flowers. Adults feed mainly between the veins of leaves. Rarely do they attack other plant parts such as flowers, young pods or stems. Blister beetle grubs feed on grasshopper eggs and are harmless to soybeans. Soybeans fields should be scouted for migrating blister beetles if nearby fields of alfalfa or weeds have been cut. Blister beetles seldom cause economic damage.

Grape colaspis beetles, *Colaspis brunnea*, are oval, yellowish-brown, and $^{3}/_{16}$-inch-long beetles. Its wing covers appear slightly striped. The grape colaspis feeds on foliage, but rarely causes any significant damage. Grape colaspis grubs have dark brown heads and grayish-white or tan bodies up to ¼ inch long. Grubs have three pairs of legs near the head and fleshy bumps on the abdomen. Although uncommon, grape colaspis grubs occasionally infest soybean fields during the early season and can cause areas of yellow, stunted plants and stand reduction to the point that replanting is sometimes required. Grape colaspis grubs are only found in abundance in non-rotated soybeans.

Japanese beetles, *Popillia japonica*, are oval, metallic green and copper beetles about ½ inch long. These beetles typically congregate together and feed on soybean foliage in June and July; they seldom defoliate soybean at or above threshold levels.

Mexican bean beetles, *Epilachna varivestis*, are yellow to copper colored beetles about ¼ to $^{5}/_{16}$ inch long. They have eight black spots on each wing cover. They feed on the undersurface of leaves between the veins, leaving a lacy network that eventually turns brown. Adults sometimes feed on pods and stems, opening the way for pod and stem blight. Mexican beetle larvae are yellow and spiny and grow to $^{5}/_{16}$ inch long. They feed on the undersides of leaves between the veins, turning the leaves into lace that soon turns

brown. Mexican bean beetle was formerly a common pest but changes in farming practices have greatly reduced its status as a pest.

Beet armyworms, *Spodoptera exigua*, are dark-headed, green to black caterpillars that sometimes have three light stripes along the body. They usually grow to just over 1 inch long. A small, black spot occurs on each side above the second set of legs behind the head. Young caterpillars web leaves together and feed inside, but older beet armyworms feed openly where they skeletonize leaves or cause large, irregular holes. They occasionally feed on bloom buds, blooms, and small pods. They curl up when they are disturbed.

Yellowstriped armyworms, *Spodoptera ornithogalli*, are pale gray to black and grow to almost 1 ¾ inches long. The caterpillars have a yellowish-orange stripe along each side and have pairs of black triangular spots on the back. This armyworm has a pale, upside down "Y" marking on its dark head capsule. It is most injurious to seedling stands where the worms clip stems and reduce plant numbers, but yellowstriped armyworms feed on soybean all through the growing season. Yellowstriped armyworms chew large holes, skeletonize, or completely destroy the leaves. These worms sometimes attack the pods.

Green cloverworms, *Plathypena scabra*, are pale green caterpillars with white strips that grow to just over 1 inch long. They are distinguished from all other caterpillar pests of soybeans by the presence of four pairs of prolegs (loopers have three pairs and the other caterpillars have five pairs). Green cloverworms thrash violently when disturbed. Beneficial insects and diseases usually inhibit green cloverworm populations, and chemical control is rarely needed. They eat large holes in leaves and may leave only the main veins behind.

Soybean loopers, *Pseudoplusia includens*, sometimes appear in large numbers and cause severe defoliation after bloom. This light green caterpillar has three pairs of prolegs and grows to about 1¼ inches. Soybean loopers have thin, white lines along the sides and top. It seems to tapers from the rear forward, and it walks with a "looping" motion. Soybean loopers have developed resistance to some insecticides, but are often suppressed by diseases. Soybean loopers feed in the lower part of the canopy and tend to prefer more mature foliage. They move upwards as defoliation occurs. The damage of early stages looks like a "window pane." Other stages produce "lacelike" damage since they feed on everything but the leaf veins. The last two stages do 95% of the total feeding. Soybean loopers usually feed only on leaves, but when the plant is bare, they also feed on soybean pods, seeds or stems.

Velvetbean caterpillars, *Anticarsia gemmatalis*, are pale green to black with a light stripe along each side and five pairs of prolegs, the last pair resembling a forked tail. It wiggles rapidly when disturbed. Velvetbean caterpillars grow to about 1½ inches long. This caterpillar feeds primarily on intervein leaf tissue, but older stages defoliate the leaf leaving only veins and midribs. After eating the leaves, stems and pods are attacked.

Insects that damage pods:

Corn earworms, *Helicoverpa zea*, are also called podworms in soybeans and bollworms in cotton. In soybean they are typically greenish to black with pale, longitudinal stripes and scattered black spots when fully grown. The head is orange-brown, to chestnut colored and it does not have a prominent pale, upside-

down “Y.” Occurring on soybeans during late summer, young earworms are cream-colored or yellowish-green with few markings, and they do little harm. They grow to about 1¼ inches, and the last two stages causing most of the damage. The corn earworm may defoliate plants and damage blooms, pods and seeds; they prefer to feed on fruiting structures. Populations in soybean often peak during peak flowering and early pod fill. Yield loss, to pod feeding, per large earworm per row foot has been calculated as 1.93 bushels per acre.

Stink bugs (*Acrosternum, Euschistus, Nezara* spp.) pierce the pods with their mouthparts and leave sunken, brown or black spots on the seed. They are about ½ inch long and are green or brown. The most common species found in soybean are the green stink bug, southern green stink bug, and brown stink bug. Stink bugs overwinter as adults and, the next season, feed and reproduce on crops, weeds, and in home gardens. Younger plant tissue and developing seeds are preferred. Damaged soybean pods may not fill-out properly, and can be malformed, discolored, and infected with a yeast pathogen. Damaged seed may sell at a lower grade. Brown stink bugs usually become most abundant late in the season. The brown stink bug may be more difficult to control than other stink bugs.

Insects that damage stems or roots:

Soybean stem borers, *Dectes texanus texanus,* are white, legless grubs that grow to $^{5}/_{8}$ inch long as they bore in bore through leaf petioles and into the main stem, ultimately moving to the underground portion of the stem. Feeding by larvae may kill leaves and, as plants mature, lower stems are girdled from the inside. The main damage caused by soybean stem borer results from plants lodging, an unsatisfactory harvesting situation. The adult soybean stem borer is a small long-horned beetle.

Threecornered alfalfa hopper, *Spissistilus festinus,* is a green, wedge-shaped insect about ¼ inch long when mature. It damages the stem by puncturing it with its "beak" to suck sap and by ovipositing within plant tissues causing lodging or breaking. Threecornered alfalfa hopper nymphs are green to light brown and wingless; they feed on the stems of young plants, killing the stem near the soil surface. Young seedling plants may lodge from being girdled or die as a result of stem girdling near the soil surface. Girdling can also result in lower weight and number of seeds, lower nitrogen fixation and yield loss due to lodging. When bean pods are set, maturing plants may break over from early seedling damage. Both adults and nymphs also feed on the petioles of leaves, blooms and pods, and this damage may reduce yields. A tiny, beetle-like strepsipteran is the only reported parasitoid of threecornered alfalfa hoppers.

INSECTICIDES LABELED FOR SOYBEANS IN THE FIELD

1. *Bacillus thuringiensis kurstaki* (Dipel, Javelin, and others) — bacterium: Specific to caterpillars, *B. t.* gives control of young worms without harming beneficial organisms. (REI of 4 hours)

2. carbaryl (Sevin and others) — carbamate: This broad-spectrum insecticide kills as a contact and stomach poison. Carbaryl is used to manage armyworms, leaf-feeding beetles, caterpillars, centipedes, cutworms,

and loopers. (REI of 12 hours)

3. chlorpyrifos (Lorsban) — organophosphate: This broad-spectrum insecticide is labeled for numerous insects and mites, and it has a fairly long residual life in the environment. On soybeans it is used to control bean leaf beetle, beet armyworm, corn earworm, and velvetbean caterpillar. (REI of 24 hours)

4. encapsulated methyl parathion (Penncap-M) – organophosphate: Encapsulation reduces the risk of accidental exposure to methyl parathion. This restricted use pesticide is useful for stink bugs on soybeans. (REI of 48 hours)

5. indoxacarb (Steward 1.25 SC) — indoxacarb: This product is labeled for caterpillar pests of soybeans. (REI of 12 hours)

6. lambda-cyhalothrin (Karate Z and Warrior) — pyrethroid ester: This restricted use pesticide is labeled for numerous pests including aphids, caterpillars, and spider mites, but on soybeans it is used for beetles, bugs, and threecornered alfalfa hoppers. (REI of 24 hours)

7. methomyl (Lannate) – carbamate: This short-lived, restricted use pesticide gives good contact control of caterpillars and other leaf-feeding insects, but it is also harmful to lady beetles and other naturally occurring predators and parasites. (REI of 48 hours)

8. methyl parathion — organophosphate: This highly toxic, restricted use pesticide insecticide gives some contact control of stink bugs. (REI of 48 hours)

9. spinosad (Tracer) — macrocyclic lactone: This insecticide has broad labeling for thrips, fire ants, and other pests, but on soybeans, it is used primarily for caterpillar control. (REI of 4 hours)

10. thiocarb (Larvin) — carbamate: This product is labeled for caterpillar pests of soybeans. (REI of 12 hours)

11. zeta-cypermethrin (Fury and Mustang Max) — pyrethroid: On soybeans this restricted use pesticide is used to control beetles, bugs, and threecornered alfalfa hoppers. (REI of 12 hours)

INSECTICIDE USE ESTIMATES FOR SOYBEANS IN THE FIELD

In 97% of soybeans grown in the U.S., insecticides were applied to only 6% of the acreage. Louisiana producers applied insecticides to 72% of the planted acreage followed by Virginia at 46% of the planted acreage. North Carolina farmers treated 25% of so ybean acreage. (Source: Agricultural Chemical Usage: 2002 Field Crops Summary. May 2003. USDA National Agriculture Statistics Service.)

Table 1. Insecticide use on soybeans in North Carolina in 2002. Source: Agricultural Chemical

Usage: 2002 Field Crops Summary. May 2004. U. S. Department of Agriculture, National Agricultural Statistics Service.

Insecticide Active Ingredient	Area Applied [1] (Percent)	Number of Applications	Rate per Application (lbs./ acre)	Rate per Crop Year (lbs./ acre)	Total Applied (1,000 lbs.)
Esfenvalerate	4	1	0.03	0.03	2
Lambda-cyhalothrin	14	1	0.02	0.02	4

[1] Planted acres in 2002 for North Carolina were 1.36 million acres.

CURRENT INSECTICIDE RECOMMENDATIONS FOR SOYBEANS

Current North Carolina Cooperative Extension Service recommendations for insecticide use on soybeans (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 5-8: Insect Control on Soybeans
http://ipm.ncsu.edu/agchem/chptr5/508.pdf

INSECTICIDES LABELED FOR SOYBEANS IN STORAGE

1. aluminum phosphide (Phostoxin, Deltia, Fumitoxin) — metal phosphide: Unless applied by the owner (operator), an F-Phase license is required under the North Carolina Structural Pest Control Law. (REI after ventilation lowers the level of phosphine to 0.3 pm or less)

2. Bacillus thuringiensis (Dipel and others) — bacterium: This product is sprayed on top of stored beans and the treated beans are mixed into the top 4 inches. It is useful for indianmeal moth and almond moth suppression. (REI of 4 hours)

3. dichlorvos (DDVP, Vapona) — organophosphate: Strips of 20% product are hung in the head space over the beans at a rate of one strip per 1000 cubic feet. (REI indefinite)

4. methyl bromide (Metho-O-Gas) — volatile organic: Safety training is required before purchase. Unless applied by the owner (operator), an F-Phase license is required under the North Carolina Structural Pest Control Law. (REI after treated areas have been aerated to lower the level of methyl bromide to 5 ppm or less.)

INSECTICIDE USE ESTIMATES FOR SOYBEANS IN STORAGE

No data on insecticide use for soybeans in storage in North Carolina are available.

CURRENT INSECTICIDE RECOMMENDATIONS FOR SOYBEANS IN STORAGE

Current North Carolina Cooperative Extension Service recommendations for insecticide use on soybeans in storage are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 5-12E: Insect Control for Stored Products - Soybeans
http://ipm.ncsu.edu/agchem/chptr5/518.pdf

Diseases

Seed and Seedling Diseases:

Seedling diseases are a minor, yet chronic problem in North Carolina. Our mild coastal climate usually results in warmer soil temperatures earlier in the spring than occurs in states further inland. As a result, seedling diseases are generally of minor importance in this state. Seedling diseases generally cause problems in when poor quality, untreated seeds are planted cool, wet, compacted soils. Seedling diseases can reduce stands and limit crop growth, getting the crop off to a slow start, making management of other pest problems more difficult and lowering yields.

Soybean seedling diseases are caused by fungi that reside on the seed or in the soil. *Pythium* spp., *Phytophthora sojae*, and *Rhizoctonia solani* are the soil fungi most commonly associated with seedling diseases. *Pythium* and *Rhizoctonia* are found in all agricultural soils. These fungi rot roots and cause stem lesions or soft watery tissue. Seed-treatment fungicides containing thiram or PCNB are reasonably effective against *Rhizoctonia solani*, whereas seed-treatments containing mefenoxam are necessary if *Pythium* is the problem.

Phytophthora sojae is the soil fungus responsible for *Phytophthora* rot of soybean. It is most common in heavy, poorly drained soils or low spots in fields. Diseases caused by this organism range from seed rot to stem and root rot. Rotation with non-leguminous crops for two or more years, resistant or tolerant varieties, and mefenoxam treatments can be used to manage this pest. In furrow treatments with mefenoxam (Ridomil Gold), however, are not economical in most instances when growers plant on row widths less than 30 inches.

Management of Seed and Seedling Diseases:

1. Plant high quality disease-free seed. Professionally grown seed is worth the added cost.

2. Rotations with a grass crop such as corn or grain sorghum are generally beneficial in reducing population densities of soybean pathogens.

3. Poorly drained soils should be planted later in the season when conditions for soybean germination and growth are optimal.

4. Consider resistant or tolerant varieties for fields where *Phytophthora* rot is frequently a problem.

5. Seed treatments may be beneficial when planting in cool, wet soils or when seed is of marginal quality.

6. In-furrow fungicide treatments may be considered when a persistent problem with *Phytophthora sojae* or *Pythium* spp. occurs and other options are unacceptable.

7. When soybeans are grown for seed, inspect the crop for diseases and harvest in a timely manner.

Root and Stem Diseases:

Charcoal rot, *Macrophomina phaseolina*, causes wilt and death of plants as a result of in hot, dry years. The causal fungus survives in soil and is widely distributed. Symptoms usually appear in mid-season or later following periods of prolonged drought stress. The fungus infects through the roots where it grows to produce a charcoal-appearing discoloration that generally extends to just above the soil line. Also present are reddish-brown stains in the wood along with black streaks. The black streaks in woody parts near the crown, and numerous black specks under the bark of infected roots are unique diagnostic features of the disease.

Red crown rot, *Cylindrocladium* (=*Calonectria*?) *crotalariae,* causes red crown rot in soybeans and *Cylindrocladium* black rot (CBR) of peanut. Infected plants yellow and wilt as a result of root infection and decay. The most useful diagnostic feature of the disease is reddish-orange fruiting bodies of the fungus on stems at the soil line. Fortunately, soybeans are not as susceptible as peanuts to the disease.

Stem and Pod Diseases:

Pod and stem blight is caused by various specious of the fungi *Diaporthe* and *Phomopsis*. The fungi survive the winter in both infected seed and crop residue. Infected crop residue can lead to high levels of pod and stem blight in fields. Seed infection occurs only if pods become infected. Pod infection can occur any time starting at flowering, but extensive seed infections will not take place until plants have pods that are beginning to mature (R7 growth stage).

Anthracnose, *Colletotrichum dematium* var. *truncatum* + *Glomerella* spp., can develop in soybeans at any stage of crop development. Most commonly, however, symptoms appear in the later reproductive stages.

Stems, leaf petioles and pods are covered with small to large, irregular, brown blotches. Blotches are embedded with black fungal bodies that have small, but visible, spines. Foliage develops brown lesions on the veins and cankers on leaf petioles. Leaves may roll and defoliate prematurely. Plants can be stunted. Infected pods may be shriveled and contain no seed (pod blacking); or more two-seeded pods, with shriveled moldy seed, may be evident. Anthracnose and pod and stem blight frequently occur together on the same plants late in the season. These fungi survive between seasons in infested crop residue and seed. Plants can become infected at any stage of development, but are especially susceptible during bloom and pod fill. Disease is favored during prolonged periods of wet weather and is evident to one degree or another every time soybeans are grown. Disease is most severe on soybean cultivars that mature during late summer; thus, it tends to be more of a factor on early maturing cultivars.

Foliar Diseases:

Brown spot, *Phialophora gregata*, usually follows extended periods of rainfall, but it usually does not affect plant growth and soybeans can outgrow the disease if the weather in midsummer becomes less rainy. However, if the weather continues to be rainy, the disease will progress rapidly from the lower leaves to the upper leaves. Furthermore, wet soils have been ideal for fungal root rot diseases in some soybean fields. Soybean plants with root rot are more susceptible to brown spot because the brown spot pathogen prefers to attack older leaves or weakened plants. Anything done to reduce plant stress and increase vigor will help reduce losses by brown spot.

Frogeye leaf spot of Soybean, *Cercospora sojina*, has been common in North Carolina in the last 2 years, because some varieties were susceptible and the wet growing seasons. In 2004 yields in some fields were reduced as much as 50%. The disease is now somewhat cyclical on a yearly basis now. As new varieties are released, a few are susceptible, but highly susceptible varieties are removed from the market after frogeye becomes a problem. Frogeye leaf spot is primarily a foliar disease of soybean. The fungus can be seed borne. Frogeye leaf spot is most likely to become a problem when infected seed is planted or if the disease occurred in the previous year's soybean crop and the crops are not rotated. Extended periods of wet weather during the growing season favor disease development. Infected young leaflets develop circular to angular brown spots up to $^{3}/_{16}$ inch across that are surrounded by a narrow red or dark reddish-brown margin. As lesions age, the central area becomes ash-gray to light brown. Older lesions are light to dark brown and are frequently translucent, having a gray to white center that may contain minute dark spots. Smaller lesions may coalesce to form larger, irregular spots on leaves. Heavily infected leaves die and fall prematurely. If high rainfall and humidity persist, stems and seeds also may become infected. Lesions on pods are reddish brown, may appear sunken, and are circular or elongate in shape. Older lesions on pods become brown to gray, usually with a narrow, dark-brown border.

Target spot of soybean, *Corynespora cassicola*, was found in some susceptible varieties in 2004 for the first time in about 20 years. Target spot reduced yields in some fields by as much as 50% in some fields in 2004. Symptoms are spots on leaves that may become as large as ½ inch in diameter. Some spots have concentric circles.

Downy mildew, *Peronospora manshurica*, causes indefinite yellowish-green areas on the upper leaf surface. Later, these areas become light to dark brown spots with yellow-green margins. Grayish downy tufts of mold growth appear on the lower surface. Severely infected leaves may defoliate prematurely. The fungus grows within pods covering the seed with a white crust of spores. The disease is spread with infected seed and is carried over on plant debris. Practice crop rotation, use disease-free seed, and plow under plant residue. The fungus overwinters in infested crop debris or seed. Spores are spread to and infect soybeans during periods of high humidity/moisture and relatively cool temperatures. Excessive soil moisture may encourage disease development.

Asiatic soybean rust, caused by *Phakospora pachyrizi*, was found in the United States in 2004 and likely came from South America with hurricane Ivan in September. Soybean loss as a result of rust was negligible in North America in 2004 because it arrived so late, but this disease has emerged as a major constraint to soybean production in South America since 2001. During the 2003/2004 growing season in Brazil, Asiatic rust was severe in many areas and required sprays of fungicides in order to control this disease. The extent to which the soybean rust pathogen threatens future U.S. soybean crops is unknown. Predictive models suggest that conditions in the southeastern U.S. are favorable for epidemic development most summers, whereas conditions are generally less favorable for disease in the mid-western and northern states are less favorable. The soybean rust pathogen is primarily tropical in distribution and is likely to survive the winter only in the most southern portions of the Gulf Coast states). Spores of this fungus do not tolerate freezing temperatures. Rust spores will have to be transported by wind from these areas, or possibly the Caribbean each year to infect soybean. Soybean rust may survive on alternate hosts such as kudzu, winter vetch, white clover, many bean species, and lupines.

Asiatic soybean rust causes superficial, tan to reddish brown, lesions. Lesions usually contain one to three rust pustules that are raised on the leaf surface. The lesions may be angular and limited by leaf veins. Rust pustules may appear on cotyledons, leaves, petioles, stems, or pods, but are most likely on the under side of the leaf. The pustules are quite small (about the size of a pin head) and can be confused with another disease, bacterial pustule. Bacterial pustule, however, is rare in commercial soybean varieties, since most if not all are resistant to this disease. A hand lens may aid in seeing the raised nature of the pustule. Also, placing leaves in a plastic bag with a moist paper towel for twenty-four hours may cause the pustules to erupt, thus making identification easier. Each pustule contains hundreds of spores. Spores are elliptical to obovoid, colorless to yellowish or yellowish brown, and minutely and densely spiny. Infected plants senesce early and have reduced yield with smaller seed.

FUNGICIDES LABELED FOR SOYBEANS

1. captan + PCNB + thiabendazole (Rival) — phthalimide + aromatic hydrocarbon + benzimidazole: This mixture is labeled to control damping-off and seed decay of soybeans. (REI of 4 days)

2. mefenoxam (Apron, Ridomil Gold) — acylamine benzenoid: This chemical controls *Phytophthora* and *Pythium*, as a seed treatment to control damping-off, and as a row treatment. (REI of 48 hours)

3. mefenoxam + fludioxonil (Apron Maxx RTA) — acylamine benzenoid + phenylpyrrole: This chemical

mixture is labeled as a seed treatment to prevent *Phytophthora* or *Pythium* and *Rhizoctonia*. (REI of 48 hours)

4. metalaxyl + PCNB + carboxin (Prevail) — acylalanine + aromatic hydrocarbon + dicarboximide: This chemical mixture is labeled as a seed treatment to prevent *Phytophthora* or *Pythium* and *Rhizoctonia*. (REI of 24 hours)

5. thiram + carboxin (Vitavax-200, RTU-Vitavax-thiram) — dithiocarbamate + dicarboximide: This mixture controls damping off and seed decay as a seed treatment. (REI of 24 hours)

6. Chorothalonil (Bravo, Echo, Equus) – Nitrile: This chemical suppresses many foliar diseases. (REI of 24 hours)

7. Thiophanate-methyl (Topsin M) – carbamate: This chemical suppresses a large number of foliar diseases of soybean, but not Asiatic soybean rust or downy mildew. (REI of 24 hours)

8. Azoxystrobin (Quadris) – strobilurin: This compound controls a wide range of foliar pathogens including Asiatic soybean rust. (REI of 24 hours)

9. Pyraclostrobin (Headline) - strobilurin: This compound controls a wide range of foliar pathogens including Asiatic soybean rust. (REI of 24 hours)

10. Propiconazole (Tilt, Propimax, Bumper) – triazole: This compound controls a wide range of foliar pathogens but is only labeled for Asiatic soybean rust under a section 18 emergency use label through 2007. (REI of 24 hours)

11. Myclobutanil (Laredo) triazole: This compound controls a wide range of foliar pathogens but is only labeled for Asiatic soybean rust under a section 18 emergency use label through 2007. (REI of 24 hours)

12. Tebuconazole (Folicur) triazole: This compound controls a wide range of foliar pathogens but is only labeled for Asiatic soybean rust under a section 18 emergency use label through 2007. (REI of 24 hours)

13. Tetraconazole (Domark) triazole: This compound controls a wide range of foliar pathogens but is only labeled for Asiatic soybean rust under a section 18 emergency use label through 2007. (REI of 24 hours)

14. Trifloxystrobin + Propiconazole (Stratego) strobilurin + triazole This compound controls a wide range of foliar pathogens but is only labeled for Asiatic soybean rust under a section 18 emergency use label through 2007. (REI of 24 hours)

15. Azoxystrobin + Propiconazole (Quilt) strobilurin + triazole This compound controls a wide range of foliar pathogens but is only labeled for Asiatic soybean rust under a section 18 emergency use label through 2007. (REI of 24 hours)

16. Pyraclostrobin + Tebuconazole (Headline SBR) strobilurin + triazole This compound controls a wide range of foliar pathogens but is only labeled for Asiatic soybean rust under a section 18 emergency use label through 2007. (REI of 24 hours)

FUNGICIDE USE ESTIMATES FOR SOYBEANS

In 97% of all soybeans grown in the U.S., fungicides were applied to less than 1% of the acreage. Fungicide use estimates for North Carolina soybeans were not reported. (Source: Agricultural Chemical Usage: 2002 Field Crops Summary. May 2003. USDA National Agriculture Statistics Service.)

CURRENT FUNGICIDE RECOMMENDATIONS FOR SOYBEANS

Current North Carolina Cooperative Extension Service recommendations for fungicide use on soybeans (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 6-9A, C, D: Soybean Disease Control
http://ipm.ncsu.edu/agchem/chptr6/604.pdf

Nematodes

Nematodes are round worms that are generally microscopic. The root-knot, Columbia lance, reniform, sting, and lesion nematodes sometimes cause significant yield loss, but these nematodes are more restricted in their distribution than the far more damaging soybean cyst nematode.

Nematode Diagnostic Services:

Diagnosis of nematode problems on soybean can be accomplished by soil sampling. Take systematic (stratified) soil samples in the fall when nematode numbers are high. Pull 20 to 30 soil cores 6 to 8 inches deep from 4 to 5 acres. Send soil in a plastic bag and appropriate box (obtained from county Extension agent) along with the appropriate form and payment to the North Carolina Department of Agriculture & Consumer Services, Agronomic Services, Nematode Advisory and Diagnostic Lab, 4300 Reedy Creek Road, Raleigh, North Carolina 27607. If you know you have soybean cyst nematode, you may request an egg assay from the NCDA&CS. Numbers of soybean cyst nematode eggs are more indicative of the severity of the problem, but egg assays alone may overlook other nematode problems. If you detect nematode problems during the growing season, plant and soil samples should be taken. Infected plants (stunted, but not dead) should be carefully dug from the soil (small, white to yellow cysts, about the size of the head of a pin, on the roots indicate that cyst nematode is a problem). If you cannot identify cysts on

roots, your county extension agent can assist you in identification, or will forward the samples (soil and roots) to the North Carolina State University Plant Disease and Insect Clinic or to the NCDA&CS Nematode Advisory Service for diagnosis. Analysis of the soil and/or root sample for nematodes has the advantage that it may reveal nematode and disease problems. Include an accurate crop history (including soybean varieties planted previously). Information about fertility, herbicides and cultural practices also aid in diagnosis.

Biology of Nematode Pests of Soybeans:

Soybean cyst nematode, *Heterodera glycines*, the soybean cyst nematode is the most serious soybean disease problem in the Coastal Plain, Tidewater, and some Piedmont counties with large soybean acreages where it infests at least 60% of the North Carolina acreage and accounts for at least a 5% loss in potential production. Severe yield loss caused by this pest is especially common in sandy coastal plain soils. Soybean cyst nematodes cause irregular patches of stunted and/or yellow soybeans (an up-and-down pattern of growth), yield decline over several years, and failure in weed control (weed problems are frequently more severe in soybean cyst nematode infested fields). The soybean cyst nematode can reproduce only on legumes such as soybean and snap bean (so crop rotation is a practical control measure.) Eggs of soybean cyst nematodes are contained inside a cyst, which is the body of an adult female. The eggs hatch from April through June, and juvenile nematodes migrate through the soil. If the juveniles fail to locate roots of a legume within a few weeks, they die. When soybeans germinate, the roots exude substances that stimulate more hatching and attract juveniles to the root systems. Juveniles penetrate the roots, migrating in the root until they locate a feeding site. This penetration of the roots damages them, making the roots more susceptible to *Phytophthora*, *Pythium*, and *Rhizoctonia* root rots. As many as 10,000 juveniles have been found in a single soybean root system just 10 days after planting. The nematodes then become stationary and induce nurse cells in the root. The tap root may be killed 4 or 5 inches down severely limiting the soybean root system causing moisture and nutrition stress. Because nodulation of the soybean root system is inhibited, plants may be light green or yellow. The life cycle continues with two to five generations per year (late maturing soybeans allow more generations of soybean cyst nematodes. When adult females die, nurse cells in the root also die, providing an excellent avenue for various fungi to invade and further compromise the soybean root system. Southern stem blight, *Phytophthora* root rot, *Pythium* root rot and *Cylindrocladium* black root rot (red crown rot) are commonly associated with cyst nematode. The primary tactics for managing this pathogen are cultural practices, including rotation, selection of early maturing cultivars, and double-cropping wheat and soybean.

Columbia lance nematodes, *Hoplolaimus columbus*, have become established in much of the southern portion of the North Carolina Coastal Plain. The distribution of this nematode seems to be restricted to the sandy soils. This pest can severely damage cotton as well as soybean. It may occur with other nematodes such as soybean cyst, reniform, lesion, root-knot and sting. Columbia lance nematodes cause irregular patches of stunted and/or yellow soybeans (an up-and-down pattern of growth), yield decline over several years, and failure in weed control (weed problems are frequently more severe in soybean cyst nematode infested fields). The Columbia lance nematode feeds both externally and internally on soybean roots. Lesions that develop on the roots may coalesce and give the appearance of a root rot. This nematode remains wormlike throughout its life cycle and can only be identified through a microscope. The population

densities of this nematode fluctuate only slightly during the course of a year. Columbia lance nematode can usually be detected in soil samples regardless of time of year, but fall assays still are best for predictive purposes. The amount of damage to soybean and subsequent yield loss will be directly proportional to the density of this nematode at soybean planting. Corn, cotton, and soybean are good hosts for this nematode. Nematode densities are generally in the moderate-to-high range following these crops. Peanut, tobacco and small grains are poor or nonhosts for Columbia lance nematode. Management of this nematode is difficult because of the limited acreage of rotational crops available (peanut, tobacco and small grains). Sub-soiling soils with hard pans has often been as effective as a nematicide treatment in increasing soybean yield. Soybean varieties with moderate levels of tolerance to this nematode have been identified (AG6101, DP5644RR, Mott, Centennial, DP6880RR, Musen, Benning, Hagood, Northrup King S83-30, Bogge, Maxcy, Pritchard, and Dillon).

NEMATICIDES LABELED FOR SOYBEANS

1. aldicarb (Temik) — carbamate: This restricted use pesticide is not to be used within 300 feet of a well used for drinking water in certain soil types because of its moderate potential to leach. (REI of 48 hours although there is no restricted re-entry when soil injected or incorporated as long as the worker does not touch or disrupt the soil subsurface.)

2. dichloropropene (Telone-II) — volatile organic: This restricted use pesticide is a soil fumigant with a high potential to leach. (REI of 72 hours)

NEMATICIDE USE ESTIMATES FOR SOYBEANS

Nematicides are not generally recommended for soybean production in North Carolina. It is estimated that less than 2 % of the soybean acreage is treated.

CURRENT NEMATICIDE RECOMMENDATIONS FOR SOYBEANS

Current North Carolina Cooperative Extension Service recommendations for fungicide use on soybeans (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 6-9B: Soybean Nematode Management - Nematicides
http://ipm.ncsu.edu/agchem/chptr6/604.pdf

Weeds

Types of Weeds: Numerous summer annual weeds and several perennial weeds commonly infest soybean fields in North Carolina . Winter annual weeds are also commonly found and must be controlled before planting by tillage or by herbicides.

Annual weeds complete their life cycle in a single year. They germinate from seed, grow into mature plants, produce seed, and die in one year. Summer annuals germinate in the spring, flower, and produce seed in late summer and early fall. They die when the temperature goes below freezing. Winter annuals germinate in the fall, persist in a dormant state throughout the winter, then flower, and produce seed in mid to late spring. They die in hot summer temperatures. Both grasses and broadleaf plants may be annuals.

Perennial weeds can live indefinitely because they regenerate from vegetative structures such as rhizomes, stolons, tubers, and perennial root structures. Perennial weeds are often more difficult to control than annual weeds.

Terms Relating to Herbicide Use:

The following are definitions of terms relating to herbicide use:

Early PrePlant (EPP): The herbicide is applied to the soil from a few to several weeks before planting to provide residual control of weeds.

Preplant incorporated (PPI): The herbicide is applied to the soil before crop planting and mechanically mixed into the top 2 to 3 inches using various implements.

Preemergence (PRE): The herbicide is applied after planting but before crop emergence. Success of a PRE herbicide dependents upon rainfall to leach the herbicide into the weed seed germination zone before weed emergence.

Postemergence (Post): The herbicide is applied to the foliage of weeds after the crop has emerged.

Postemergence-Directed (PDIR): The herbicide is applied using special equipment that directs the spray to the base of the crop while covering weed foliage.

Weed Pests of Soybeans:

Aizoaceae Family

Carpetweed, *Mollugo verticillata*, is a late-germinating, low-growing annual that forms a mat several feet in diameter of many branched stems and leaves that arise from a single taproot. The tips of the branches turn up, and the leaves are clustered in whorls at the joints. The small, white flowers also form at the joints in dense, flat cluster. The fruits are small berries.

Amaranthaceae, Amaranth Family

Alligatorweed, *Alternanthera philoxeroides*, is a perennial that grows in standing water or dry land. Alligator weed has long, branched, hollow, succulent stems. The stems usually grow across the ground, but turn up at the tips. The leaves are hairless except at the base. They are 2 to 4 inches long, lack petioles, are opposite, have smooth edges, and they occur on stalks ½ to 3 inches tall. The whitish papery flowers are whitish and papery and grow on stalks from late spring to early fall. It grows readily from plant fragments. The white flowers are about ½ inch across

Palmer amaranth, *Amaranthus palmeri*, is an erect summer annual that may grow to 6½ feet high. The leaves are alternate, hairless, and lance-shaped or egg-shaped. Leaves are 2 to 8 inches long and ½ to 2½ inches wide with prominent white veins on the undersurface. Leaves have relatively long petioles. The taproot is usually reddish. The fruit is a single seed in a dry, wrinkled membrane about $^{1}/_{16}$ inch long. The seed is glossy dark brown to black. Several branches arise for a central stem. The flowers are small and green in dense, compact, terminal bunches that are from ½ to 1½ feet in length. Smaller lateral inflorescences also occur between the stem and the leaf petioles.

Redroot pigweed, ***Amaranthus retroflexus,*** is an upright, summer annual that may grow to 6 1/2 feet tall. It produces abundant seeds. The leaves are opposite and oval on petioles up to ½ inch long. The upper stems are hairy, and the shallow taproot is sometimes reddish. The flowers are small, and green, but they grow in dense, compact masses 2 to 8 inches long that taper to the tip. These terminal masses also have noticeable spikes with bracts that are longer than the sepals. Dense, compact terminal masses of flowers and the tall plants with alternate leaves help to identify redroot pigweed.

Slender amaranth, *Amaranthus viridis*, is an upright, summer annual with alternate leaves. Each oval leaf has a long stalk. The plant is dull green, erect, and freely branched. Slender amaranth grows to about 2 feet. The flowers are small, green, and densely packed at the tips of the branches.

Smooth pigweed, ***Amaranthus hybridus,*** is an upright annual that is the most common pigweed in crop production. The plant is covered with very small, fine hairs throughout. The mass of flowers is extremely branched, but these branches are compact, usually more than 1½ inches long, and thin. The seeds are small, black, and round. At maturity, the entire plant and flowering mass may turn reddish purple.

Apocynaceae, Dogbane Family

Hemp Dogbane, *Apocynum cannabinum*, is a 5 to 6 foot perennial that exudes milky sap when broken. The leaves are opposite and oval or elliptical and 2 to 5 inches long. The leaves have short petioles and the lower surfaces are bare or have sparse hairs. The stems are bare and may become reddish when mature. The base becomes woody and stems branch freely at the top of the plant. Roots may develop into long horizontal rootstocks from an initial taproot. Sprouts emerge freely from horizontal rootstock. The fruit are 5 inches or more, narrow, and reddish brown when mature. Flowers: Small, white to greenish-white flowers bloom in terminal clusters.

Asclepiadaceae, Milkweed Family

Common Milkweed, *Asclepias syriaca,* is an erect perennial that grows from taproot with a deep rhizome. It exudes milky sap when broken. Plants growing from rhizomes are more robust than plants from seeds. Stems are usually unbranched, hollow, and covered with tiny hairs. The stems may become red. The oblong to oval leaves are opposite and have smooth margins. The lower surfaces of leaves are finely hairy and the upper surface is bare. The greenish-purple to greenish-white flowers occur in flat-topped cluster of 20 to 130 at the end of stalks and in the upper leaf axils. The fruit are grayish-green and teardrop-shaped. The seeds are flat, brown, and have a papery margin with a tuft of white hairs.

Bignoniaceae, Bignonia Family

Trumpetcreeper or **cow-itch**, *Campsis radicans,* is a perennial woody vine up to 40 feet or more long. The flowers are red-orange and trumpet shaped. The stems root when in contact with the soil and the taproot sends up persistent sprouts. The leaves are opposite and compound. A single leaf may contain seven to 15 leaflets toothed margins. The fruit is long and narrow, and filled with winged seeds. The stems become woody and trail or climb. Stems root where they touch the ground and also produce aerial roots that aid in climbing. Flowers: Showy red-orange trumpet shaped flowers (2 to 3 inches long) are produced in terminal clusters.

Chenopodiaceae Family

Common Lambsquarters, *Chenopodium album*, is a summer annual to 3½ feet in height that produces thousands of seeds. Leaves are alternate, light green, rounded triangles, 1¼ to 10 inches long. They have long petioles. The stems are upright, hairless, grooved, branching and pale green with some red. The taproot usually has numerous branches. From June to September, the small, green flowers appear clustered at the tips of branches and in upper leaf axils. A thin, papery membrane covers the seeds.

Commelinacae, Spiderwort Family

Common dayflower, *Commelina communis*, is also called Asiatic dayflower. It is an erect (up to 2 feet) or more often creeping annual monocot often mistaken for a broadleaf weed because of its attractive blue flowers. It is usually only found in shady and/or damp areas. The leaf blades are pointed and have parallel leaf veins, often with hairs on both the upper and lower surfaces. Leaves are 2 to 4 inches long, and $^{2}/_{3}$ to 1½ inches wide, and clasp the stem at the base. Leaves have noticeable sheaths at the base. The stems are thick and up to 2½ feet long. Stems are swollen at the nodes, where they often root when in contact with soil. The roots are fibrous. Flowers occur on long stalks arising from the leaf axils. Flowers consist of two blue petals and one white petal. Each flower lasts only one day. The fruit is a two-celled capsule.

Doveweed, *Murdannia nudiflora,* is an annual weed that resembles a fleshy grass but it has creeping stems that root at the nodes and it has purple or blue flowers. The leaves are up to 4 inches long, and the leaf sheaths have soft hairs on the upper edges. The stems are not obvious, because they are close to the ground.

The roots are fibrous and the flowers occur in small clusters on short stalks. Flowers are blue to purple with petals that are ¼ inch long.

Spreading dayflower, *Commelina diffusa*, is a pale to dark green annual or perennial that sprouts from persistent, jointed roots. It is usually less than 1 foot tall. The leaves are lance-shaped or slightly oval and have parallel veins. The leaves sheath the stem at the base. The stems are light green and spread out or lie flat on the soil. The stems have many branches that root readily at the joints. The flowers have three light-blue petals and emerge from a leafy canoe-shaped structure. The fruit is a capsule with three parts that usually contain five small, brown or reddish-brown, pitted seeds.

Compositae, Aster Family

Bristly starbur **or** **Slingshot weed**, *Acanthospermum hispidum*, is an upright, light-green annual with Y-shaped branching. The broad leaves are oval to triangular and have irregular teeth on the edges. The stems are densely covered hairy. The opposite leaves are not stalked but do narrow at the stem. The leaves are ½ inch long or smaller. Each flower head has five to nine $^1/_{16}$ inch long pale yellow ray flowers (the flowers in the center are sterile). The seeds are flat and have a pair of spines at the top that attach easily to the coats of animals. This weed produces seeds prolifically and continues to grow until frost.

Common cocklebur, *Xanthium strumarium*, is a summer annual that grows up to 6 feet tall and produces prickly cockleburs. Most leaves are alternate and are triangular to oval. Leaves have long petioles, three veins on top, stiff hairs, and are 2 to 6 inches long but have irregular lobes. Stems are upright, branched, stout, ridged, and covered with short stiff hairs and small bumps. The roots extend from a taproot. The flowers are both axillary and terminal. The ½- to 1½-inch-long cocklebur is elliptical, has two seeds, and is covered with hooked prickles. Each bur contains one that grows during the first year and one that grows a year later.

Eclipta, *Eclipta prostrata*, is a prostrate or erect summer annual to 2 feet high found in the southern and east coast states. It has a shallow taproot with fibrous root system. Seedlings have light green to light purple stems below the cotyledons. Cotyledons lack hairs, are slightly thickened, and are spatulate with a midvein evident on the lower surface. Mature plants have leaves that are opposite and are elliptic to acute. Leaves may or may not have petioles. Leaves are slightly thickened and about 1¼ to 5 inches long and up to 1¼ inches wide, with short, horizontal hairs on both surfaces. The leaf margins have widely spaced teeth. Stems are initially green, but become reddish brown. They branch freely and can root at the nodes. The flowers occur singly or in clusters of two to three on small stalks at the tips of stems or in leaf axils. Flowers are rounded and consist of small, white ray flowers surrounding greenish disk flowers. Seeds are small, dehiscent and shaped like sunflower seeds, but are less than $^1/_8$ inch tall.

Common Mugwort, ***Artemisia vulgaris,*** is a perennial weed up to 5 feet tall with persistent rhizomes easily spread by cultivation equipment. The stems are often reddish-brown and woody. The 2 to 4 inch leaves are alternate, deeply lobed, and aromatic. Upper leaves are more deeply lobed and may lack petioles. The undersides have soft, white to gray hairs. The individual flowers are inconspicuous and are

about $^{1}/_{8}$ inch wide, but they occur in clusters at the top of the plant on short stalk. Common mugwort resembles garden chrysanthemums.

Common ragweed, *Ambrosia artemisifolia*, is a summer annual 8 inches to 8 feet tall that produces abundant pollen, a major cause of hay fever. Stems below cotyledons (hypocotyls) are green, usually spotted with purple. Leaves are 1½ to 4 inches long, oval but once or twice compound. The stems are erect, branched, and hairy. Flower heads are $^{3}/_{16}$ to $^{5}/_{16}$ inch wide, green, and in bunches at the ends of branches. Roots branch off of a shallow taproot. The fruit resembles a tiny crown.

Giant ragweed, *Ambrosia trifida*, is an erect summer annual that may grow 16 feet high. The leaves usually have three lobes (sometimes five). A central taproot supports stems that are erect, branched, and hairy. Leaves: All leaves subsequent to the first pair of true leaves are 3-lobed, or less often 5-lobed. Lobes arise from the same point (palmately lobed), and each lobe is lanceolate in shape with toothed margins. Leaves are opposite, hairy, occur on long petioles and are large (4 to 8 inches wide by 6 inches long). Male flowers occur in long, slender clusters at the tips of branches and female flowers develop in the upper leaf axils. The flower heads are small and greenish and the fruit resembles a black crown ¼ to ½ inch long.

Convolvulacae, Morningglory Family

Cypressvine morningglory, *Ipomoea quamoclit*, is an annual low-climbing or twining vine with leaves that are deeply divided and feathery. The cotyledons deeply-indented and wide, but short. The hairless stems branch and trail or climb to 6½ feet in length and also without hairs. Plants have a fibrous root system. The flowers are deep red to scarlet and are 1 to 1½ inches long. Flower stalks have one to three flowers. The fruit is a hairless capsule and the seeds are reddish-brown.

Entireleaf morningglory, *Ipomoea hederacea*, is a summer annual, twining or climbing vine with heart-shaped leaves and a taproot. The hairy stems may grow 10 feet long. The alternate leaves have hairs that stick straight out. The cotyledons are green or purple and are hairless or have hairs that stick straight out from the cotyledons. The 1- to 2-inch flower petals are purple to pale blue or white and fused into a funnel. The fruit are brown capsules that separate into three or four parts when mature. Entireleaf morningglory very closely resembles tall morningglory (*Ipomoea purpurea*) , however the two species differ in the orientation of hairs on the cotyledon and/or leaf surfaces. Tall morningglory leaves have hairs that lie flat on the surface, while the hairs on entireleaf morningglory stick straight out .

Ivyleaf morningglory, *Ipomoea hederacea*, is a summer annual twining or climbing vine from a taproot with distinctive three-lobed leaves that somewhat resemble English ivy and noticeable purple, blue or white, trumpet-shaped flowers 1 to 2 inches long. The 2- to 5-inch long leaves are alternate, hairy, and on a slender, hairy petiole. The hairy stems grow up to 10 feet and run along the ground or climb. Stems also have hairs that are erect. The fruit is a brown, spherical capsule with three chambers that contain four to six seeds.

Pitted morningglory, ***Ipomoea lacunosa ,*** is a trailing or climbing annual vine up to 6 ½ feet long with heart shaped leaves that taper to a point and trumpet-shaped white flowers only about ¾ inch long. The

stems may be slightly hairy. The alternate, heart-shaped leaves are pointed at the tip and have relatively long petioles. The roots are fibrous but there is a small taproot. The fruit is a capsule.

Red morningglory, *Ipomoea coccinea*, is a twining and climbing annual vine to 6 ½ feet with leaves that have several points along the edges. The leaves have petioles and are alternate and more or less heart-shaped. The trumpet-shaped flowers 1 to 1 ¼ inches long are dark orange or red. The fruit is a round capsule.

Purple moonflower, *Ipomoea muricata*, is a twining or climbing annual vine that grows up to 20 feet long. The leaves are heart-shaped and aromatic. The stem has sharp projections. The flowers are long, narrow, trumpet-shaped, and up to 2 inches in diameter. They are pink or pale purple. It blooms throughout the growing season. Although the flower stalks are edible, the seeds are poisonous.

Cucurbitaceae, Gourd Family

Burcucumber, *Sicyos angulatus*, is a summer annual climbing vine that closely resembles cultivated cucumber, especially early on. The roots are fibrous, and the hairy stems are ridged, and develop tendrils. The leaves are alternate and 2 to 8 inches long and wide, hairy, and broad with five lobes. The edges have teeth or points. The flowers are whitish to green and have five sepals petals. The fruit resemble very small, prickly cucumber and occur in clusters of up to 20.

Fruit: Produced in clusters of 3-20, and resemble very small cucumbers covered with long bristles. Identifying

Cyperaceae, Sedge Family

Sedges look like grasses, but their stems are triangular instead of round. **Yellow nutsedge**, *Cyperus esculentus*, is a troublesome perennial weed. Yellow nutsedge is most conspicuous during the warm growing season. It looks like a pale-green, upright, weedy grass. The leaves are shiny and waxy on top and dull on the backside. The fibrous roots are mixed with rhizomes. The nutlets form at the end of each rhizome. These nutlets are actually tubers that can persist in the soil for years. Yellow nutsedge flowers form at the top of a triangular stem. The flowers form a branched, flat-topped, straw-colored burr. Yellow nutsedge blooms from July through September. Both yellow nutsedge and **purple nutsedge**, *Cyperus rotundus*, are perennials that spread rapidly in moist soils from rhizomes that produce tubers or nutlets. The leaf tips of purple nutsedge are blunter than those of yellow nutsedge.

Dioscoreaceae, Yam Family

Cinnamon vine, **Chinese yam** or **potato vine**, *Dioscorea batatas*, is a twining vine to 13 feet that may be slightly woody. The rootstock is fleshy or woody, slender or stout, simple or branched, and horizontal. The thin leaves are usually alternate (although the lower leaves may be opposite) and have nine to 13 distinct veins. The leaf petioles are often longer than the heart-shaped leaves. New leaves often appear bronzed. The flowers bloom from June through August and are greenish-yellow and are in masses at the ends of

branches. The fruit is a three-angled capsule up to 1 1/4 inches long.

Fruit: Membranous, 3-angled capsule, approximately 3/4 to 1 1/4 inches long and 3/4 inch in diameter.

Euphorbiaceae, Spurge Family

Tropic croton, *Croton glandulosus*, is a summer annual that grows from 4 to 20 inches high and has alternate, oval leaves ½ to 2 ½ inches long. Leaf margins are sharply toothed. Leaves have short petioles and have a small, white gland on each side of the petiole at the base. Leaves just below the flowers appear whorled. Leaves emit an odor when crushed. The stems branch and become reddish brown and hairy. Tropical croton has a taproot. The terminal white flowers are approximately ½ inch long and the fruit is a brown capsule.

Spotted spurge, *Euphorbia maculata*, is a prostrate summer annual that often forms dense mats up to 16 inches in diameter. All parts of the plant emit a milky sap when broken. Plants have a small taproot and a fibrous root system. The radial stems are hairy, and pink to red. Spotted spurge stems do not root at the nodes. The paired leaves are egg-shaped in outline and up to 9/16 inch long and often have a maroon spot in middle. The flowers are inconspicuous.

Gramineae, Grass Family **— Summer Annual Grasses**

Broadleaf signalgrass, *Brachiaria platyphylla*, is a spreading summer annual. Broadleaf signalgrass has short, wide leaf blades from 1½ to 6 inches long and ¼ to $^{2}/_{3}$ inch wide. Leaf blades are hairless except on the margins and bases of young plants. Broadleaf signalgrass doesn't have a papery membrane at the junction of the sheath and leaf blade.

Large crabgrass, *Digitaria sanguinalis*, is a summer annual grass that is prostrate or ascending growth habit with stems that root at the nodes. The roots are fibrous. The leaf blades are up to 8 inches long and hairy. The leaf sheaths are hairy and closed. The leaves and sheaths sometimes turn maroon. The flowers occur on four to six branches (spikes) at the top of slender stems. Each spike is 1 ½ to 7 inches long. The flowers occur in two rows along the spike.

Smooth crabgrass, *Digitaria ishaemum*, is a summer annual grass that is prostrate or ascending to 2 feet. The leaves are hairless and the stems do not root at the nodes although they branch at the lower nodes. The seed head composed has two to six branches (spikes) at the top of slender stems. The flowers occur in two rows along the spike. The leaf blades are up to six inches long. The leaf sheaths are hairless except in the collar region only. The leaves and sheaths turn maroon. The roots are fibrous.

Crowfootgrass, *Dactyloctenium aegyptium*, is an annual grass that bends over and roots at the lower nodes. The leaves grow up to 2 feet high. The roots are fibrous. The leaf blades and sheaths are hairless, but the leaf margins have long, stiff hairs. The flowers occur one to seven spikes (½ to 2½ inches and $^{1}/_{8}$ to ¼ inch wide) at tip of stem. Seed heads somewhat resemble a crow's feet. Leaf blades are ¾ to 12 inches long, and

$^{3}/_{32}$ to $^{3}/_{8}$ inch wide, usually without hairs but sometimes having long, stiff hairs. Leaf margins have hairs that point outward. The ligule is membranous, up to $^{1}/_{16}$ inch and fringed with hairs ($^{1}/_{32}$ inch long). Sheaths are without hairs.

Fall panicum, *Panicum dichotomiflorum*, is also called Texas panicum. This summer annual has large round, smooth sheaths that often bend at the nodes. It may reach 7 feet in height. A primary identifying characteristic of this grass weed is the 'zigzagged' growth pattern it takes on due to bending and rooting at the nodes. Leaves are rolled in the shoot and are $^{9}/_{16}$ to $^{13}/_{16}$ inch wide and 4 to 20 inches long. Midveins are conspicuous and leaves are usually smooth and hairless above but maybe slightly hairy near the tip and base. The lower surfaces are hairless and glossy. Stems are hairless and round. The seed head is wide and spreading and becomes purplish as it matures.

Field sandbur (southern sandbur), *Cenchrus incertus*, is a pest of cotton, tobacco, and soybeans. This warm-season annual grass is a problem since it grows in all locations although it favors sandy or well-drained gravelly soils. Young plants are often purplish, and they usually grow horizontally over the soil. The leaves have a rough surface and are hairless or have long scattered hairs on the upper surface. Blades grow 4 to 10 inches long. Field sandspur has dense, bushy growth. The blades of seedlings are flat and like sandpaper on the upper surface. The ligules are up to $^{1}/_{16}$ inch long. The lower papery portion of the ligule is very short and the fringe of hairs is less than $^{1}/_{16}$ inch long. The seed heads appear throughout the year in the South and during the summer and fall in the North. Each cluster has 10 to 30 burs and each bur has eight to 40 spines.

Giant foxtail, *Setaria faberi*, is a clumped summer annual with seed heads that resemble the tail of a fox and droop when mature. Giant foxtail has fibrous roots, and round, hairless stems up to 3 or 4 feet high. Leaves may reach 16 inches by 1 inch wide, and are usually hairy above (except near the base). Auricles are absent and the ligule is a fringe of hairs reaching 3 mm in length.

Goosegrass, *Eleusine indica*, germinates later in the spring than crabgrass. The stems are pale at the base, and they do not root at the nodes like barnyardgrass, bermudagrass, and crabgrass can. In July and September, the flowers occur on 10 to 12 fingers. Each finger resembles a zipper. It prefers full sun and can tolerate poorly drained and compacted soils.

Shattercane, *Sorghum bicolor*, is a summer annual that is difficult to distinguish from johnsongrass but the root system is fibrous and does not have rhizomes. The leaf blades of shattercane tend to be much wider than those of johnsongrass. If small shattercane seedlings are pulled carefully, a large, rounded seed may be attached (seeds of johnsongrass are smaller and more oval). Seed heads are openly branched or tightly bunched, and the seeds are large, round and shiny black.

Texas panicum, *Panicum texanum*, is a spreading summer annual that may be erect or prostrate with tips ascending. Stems may grow to 4 ½ feet long and 32 inches tall. Stems root at the lower nodes. Leaves grow up to 11 inches long and ¾ inch wide. Leaves have short, soft hairs on both sides. The roots are

fibrous. The seed head is relatively narrow and ranges from 2 ¾ to 10 inches long.

Volunteer corn, *Zea mays*, is a coarse annual grass up to 6 or more feet high. The stem is round and often 1½ to 2 inches wide. Stems may branch at the base. Female flowers are axial silks and male flowers are in terminal tassels.

Yellow foxtail, *Setaria glauca*, is a clumped summer annual up to 3 feet tall with yellow seed heads up to 6 inches long that resemble the tails of foxes. Yellow foxtail has fibrous roots. The erect, flattened, hairless stems do not root at the nodes. Stems are often reddish at the base. Leaf blades may grow 12 inches long and ¼ to ½ inch wide. Leaves have long, silky hairs at the base.

Gramineae, Grass Family **— Winter Annual Grasses**

Italian ryegrass, *Lolium multiflorum*, is a winter annual that may grow 3 ft high. The leaf sheaths are often reddish at the base. The leaves are rolled in the bud. Leaf blades grow up to 8 inches long and almost ½ inch wide. Leaves usually have a glossy appearance on the lower surfaces. The roots are fibrous. The flowers occur on a spike that is 4 to 16 inches long with long bristles arranged alternately up the stem.

Gramineae, Grass Family **— Summer Perennial Grasses**

Bermudagrass, *Cynodon dactylon*, is grown as forage for livestock, but it also can be an invasive weed. Bermudagrass also has many other common names including couchgrass, devilgrass, wiregrass, or dogtooth grass. Common bermudagrass produces seed that remain viable in soil for at least 2 years. Bermudagrass has above ground stolons and below ground rhizomes. Both stolons and rhizomes are capable of rooting in the soil and creating new plants. Leaves are generally smooth and pointed with a conspicuous ring of white hairs at the junction of the blade and sheath. The prostrate stems typically have a papery leaf sheath at each node. Stems root at the nodes in moist soil. Flowering stems are upright and bear three to seven branches on the tips of the stem. Individual spikes on the flowering stems of bermudagrass originate at the same point, are 1 to 2 inches long, and bear two rows of spikelets along one side of the central stem of the spike.

Johnsongrass, *Sorghum halepense*, is a perennial from rhizomes that may reach 6½ feet. Johnsongrass produces large amounts of seed and rhizomes. Leaf blades are hairless (except sometimes at the base) and have a prominent white midvein. Leaves are 6 to 20 inches long and $^{3}/_{8}$ to $1^{3}/_{16}$ inch wide. The stems are round or a little flattened. The sheaths are green to maroon, especially at the base. The roots are fibrous as well as thick rhizomes. The seed head is large at the base and tapers to the top and is often purplish. Seed are dark red to black and up to $^{3}/_{16}$ inch long.

Leguminosae, Legume Family

Florida beggarweed, *Desmodium tortuosum*, is also called tick trefoil. It is a summer annual that grows 3 to 9 feet tall. The leaves and stems are covered with short, stiff hairs that often stick to clothing. Seedlings have round to oval cotyledons with smooth margins. Cotyledons are $^{3}/_{16}$ inch wide and $^{5}/_{16}$ inch long. The

leaves are alternate and trifoliate, although lower leaves may have only one leaflet. Leaves have petioles with stipules where the petiole meets the stem. Each leaflet is 3 to 4 inches long and oval to lance-shaped. The stems are erect and usually covered with short stiff hairs. Plants usually have a single taproot. Flowers occur near the top of plants in loose bunches. Petals are bluish-purple to purple, 2 to 3 inches long. Fruits are slender, constricted legumes that break off individually. Each segment encloses a seed and is densely covered with short, stiff hairs that stick to clothing.

Hemp sesbania, *Sesbania exaltata*, is also called coffeebean or coffeeweed. It is a tall, blue-green, spindly weed growing up to 12 to 14 feet. The plants have a yellow, pea-like flower. Seed pods are 4 to 8 inches long, curved and often tipped with a small beak. The leaves are opposite and have up to 70 leaflets (smooth above and somewhat hairy surface below).

Showy crotalaria, *Crotalaria spectabilis*, is a summer annual weed with bright yellow flowers and seedpods1 to 2 inches long and takes on the appearance of an inflated pea pod. The pod turns brown to black and the seeds within the fruit loosen resulting in a rattling sound when shaken. Showy crotalaria is primarily a weed of agronomic crops. The plant can grow 6 ½ feet tall with stout green or purplish stems that become waxy and somewhat angled with age. The stems of seedlings below the cotyledons turn maroon and are covered with short hairs that lie flat against the bean-shaped cotyledons. The leaves are alternate and widest at the apex and tapering toward the short petiole. They are hairless above and covered with appressed hairs below. Seedlings develop a taproot as they grow. Individual flowers occur on elongated inflorescences (racemes) and are stalked from a central axis, large, showy, and bright yellow in color.

Sicklepod, *Senna obtusifolia*, is an invasive summer annual up to 6 ft high. The stems are erect, branched, and hairless. The fruit is a slender, curved seed pod 4 to 8 inches long. Plants have a taproot. The leaves are alternate on the stem and each leaf has four to six leaflets. The basal pair of leaflets smallest, terminal pair largest. Individual leaflets are egg-shaped, with the broadest end above the middle, 1 to 3½ inches long, and ½ to 1 inch wide. The flowers are yellow petals on axillary stalks.

Malvaceae, Cotton Family

Arrowleaf sida, *Sida rombifolia*, also called teaweed, is an annual or perennial plant that grows up to 4 feet tall. The taproot is long and deep. The leaves are alternate, broadly lance-shaped, with white hairy undersides. The leaf margin is toothed. The stems are erect, smooth, and have few to many branches. The flowers are solitary, yellow to yellow-orange, and long-stalked in the leaf axil on upper branches. The small, dark brown, smooth seeds occur in capsules that are $^{3}/_{16}$ to $^{5}/_{16}$ inch wide with eight to 12 partitions. Each capsule has two seeds and two projections.

Prickly sida, *Sida spinosa*, is also called prickly mallow. This annual weed is minutely, but softly pubescent. This is a low, branched plant, but sometimes it grows up to 3 feet tall. The leaves have jagged margins and are oblong or slightly pointed. Leaves have long petioles. The flowers are yellow and small. The fruit is oval and splits into two beaks on top. The seedlings are often confused with those of spurred anoda, however this weed has two heart-shaped cotyledons unlike the round and heart-shaped cotyledons of

spurred anoda.

Spurred anoda, *Anoda cristata*, is an erect annual with alternate, triangular-shaped leaves that are coarsely toothed. Spurred anoda branches freely from at base and may reach 3½ feet in height. Stems below the cotyledons (hypocotyls) are green and covered with hairs. Seedlings generally have one round and one heart-shaped cotyledon with hairs along the margins. First true leaves are alternate, triangular-shaped, and hairy along the margins and on both leaf surfaces, 2 to 4 inches long, and triangular in outline. Leaves are coarsely toothed and have three distinct lobes. It has a taproot. Solitary flowers arise from the leaf axil). Flowers are ¼ to ½ inch wide with petals that are light blue to lavender in color. The fruit are capsules with 10 to 20 segments each with one small kidney-shaped brown to black seed.

Velvetleaf, *Abutilon theophrasti*, is a tall (up to 8 feet) annual with velvety, broad leaves that taper to a point and a taproot. The leaves are up to 8 inches across. The flower stalks are shorter than the leaf petioles. The flowers are yellow to yellow orange and the fruit is hairy with 12 to 15 beaks. The seeds remain viable for 50 years in the soil.

Onagraceae, Evening-Primrose Family

Cutleaf evening primrose, *Oenothera laciniata,* is a low growing, often spreading winter annual or biennial that sometimes acts like a summer annual. It rarely gets more than 1 foot tall although some reach 2 ½ feet. The leaves are alternate and elliptical to lance-shaped although the edges may be notched and lobed. The leaves may have some hairs above, but are otherwise hairless. The hairy stems are usually reddish and are often prostrate. They branch near the base. The flowers grow in the leaf axils and are trumpet shaped yellow but fade to red-pink. The fruit capsule is up to 1 ½ inches long, cylindrical (but with four ribs), sometimes curved, and it is hairy.

Phytolaccaceae, Pokeweed Family

Common Pokeweed, *Phytolacca americana*, is a large (up to 10 feet tall), perennial weed. The branches are usually thick and reddish-purple. All parts of the plant are poisonous to cattle, horses, swine, and humans, especially the large, fat taproots. Leaves are alternate, bare, up to 12 inches long, and egg-shaped. Individual flowers are small and white to pink-tinged, but they form in heads. The ripe berries are purple to black.

Polygonaceae, Buckwheat Family

Curly Dock, *Rumex crispus*, is a taprooted perennial, developing a basal rosette of wavy-margined leaves and an unbranched stem that may reach 5 feet tall. The stems are unbranched, thick, hairless, ridged, and often reddish. The dark green rosette leaves have petioles, have wavy margins are hairless, and are alternately arranged on the stem. Stem leaves are alternate, have an ocrea, and become smaller toward the top. Older leaves become reddish-purple. Curly dock has a large, fleshy taproot that is yellowish orange. The flowers occur in clusters toward the top of the stem and they lack petals. The greenish sepals become reddish-brown with age. The fruit is a small, dry seed about $^{1}/_{16}$ inch long that is triangular, glossy, and

dark. A papery structure surrounds the seed.

Lady's-thumb smartweed*, Polygonum persicaria,* is a summer annual that may reach 3½ feet tall. The leaves are alternate, lance-shaped to elliptical, and more or less hairy on the upper surfaces. Leaves range from 2 to 6 inches long and up to 1¼ inches wide. The leaves narrow toward the petiole. Leaves sometimes have a purple spot in the middle. The root system is fibrous with a small taproot. The stems branch and are often reddish. The nodes are swollen. A thin membranous ocrea with stiff hairs around the top encircles the stem at the base of each leaf petiole. The flowers are densely clustered at the tops of stems. The flowers are small and pink or white. The fruit is a small, dry, dark seed.

Pennsylvania Smartweed, *Polygonum pensylvanicum*, is a summer annual weed that may grow 3½ feet tall. The 2- to 6-inch-long leaves are alternate, pointed to rounded, and taper toward the short petioles. Leaves often have a purple spot in the middle. The stems are often reddish, swollen at the nodes, and branched. The fruit is a small, black seed. The small, pink (sometimes white) flowers are clustered at the ends of stems.

Portulacaceae, Purslane Family

Common Purslane, *Portulaca oleracea*, is a flat, **fleshy, succulent annual that has a** taproot and fibrous secondary roots. The stems branch and are smooth and succulent. Leaves are alternate or opposite and are ¼ to 1¼ inches long and rounded at the tip. Leaves are thick, succulent and fleshy, with smooth margins. Flowers are small and yellow with five petals that open only on sunny days. Flowers form in the leaf axils or in clustered at branch tips. The fruit are small capsules that split open to release many seeds.

Pink purslane or **Kiss-Me-Quick**, *Portulaca pilosa*, is a prostrate, fleshy, branching plant with small, pink or purplish flowers at the end of branches and with tufts of whitish hairs in the leaf axils. This low, spreading plant is similar to the garden portulaca also called rock rose, *Portulaca grandiflora*, which also has tufts of hair in the leaf axils but larger flowers (up to 2 inches wide).

Rubiaceae, Madder Family

Florida pusley, *Richardia scabra*, is a summer annual with opposite leaves that are oval to elliptical to lance-shaped. The leaves are somewhat thick and are covered with fine hairs. The leaves are up to 2½ inches long and an inch wide. The stems originate from a taproot and branch freely, and grow less than a foot high. The stems are hairy and erect. The flowers are tubular, white, and occur in clusters at the tips of branches. The fruit separates into four football-shaped parts with part of the flower attached to the top.

Poorjoe, *Diodia teres,* is also called common buttonweed. This erect or spreading annual has opposite, slender leaves without petioles. The leaves have a prominent mid vein and a membrane that connects the bases of opposite leaves. The flowers are small, white, and star-shaped and have four petals. The flowers grow in the leaf axils. The stems are hairy, and usually prostrate along the ground.

Sapindaceae, Soapberry Family

Balloonvine, *Cardiospermum halicacabum*, is a summer annual vining plant with alternate leaves and axillary tendrils. The tiny white flowers have four unequal sepals (two visible) and four petals. The inflated, membranous fruits resemble a tiny hot-air balloon. The sepals remain attached in the fruit. The black seeds inside the capsule have a white heart shape spot. The cotyledons are rectangular, but subsequent leaves are divided into three lobes and are alternate on the vine. The plant has tendrils and distinctly ridged stems. Balloonvine poses a problem in fields where the soybean crop is produced for seed. Balloonvine seeds, essentially the same size and weight as soybeans, are difficult to clean out of the harvested crop.

Solanaceae, Tomato Family

Carolina horsenettle, *Solanum carolinense*, is a perennial that may grow 3 feet tall. It sprouts from deep, spreading rhizomes or from seeds. The leaves are elliptical to oval, alternate, and 2½ to 4½ long. The leaves, petioles, and stems are covered with conspicuous spines or prickles up to ½ inch long. Leaves are also covered with star-shaped hairs and they smell like potatoes when crushed. The stems are angled at the nodes and they become woody with age. The star-shaped, white to violet flowers occur on prickly stalks in clusters and have five petals and five stamens with yellow anthers clustered tightly in the center. The green fruit is round, ½ to $^3/_4$ inch berry that becomes yellow and wrinkled. Each fruit has 40 to 120 seeds.

Cutleaf groundcherry, *Physalis angulata*, is also called lanceleaf groundcherry. This annual weed grows to 30 inches and has alternate leaves 1 to 3 inches long. Leaves have five to 13 pointed lobes. The stems are branched. The flowers form from May to October on axial stalks and are yellow with a purple center. The fruit is a round berry with a papery covering. This covering is toxic.

Jimsonweed, *Datura stramonium*, is an erect summer annual with large white to purple flowers and an unpleasant distinctive odor. The leaves are 3 to 8 inches long and 6 inches wide on long stems. Leaf margins have a few large triangular teeth. Plants have thick, branched taproots. The fruit are egg-shaped capsules covered with stiff prickles. Fruit eventually split into four segments. The axillary, white to purple flowers are 2 to 5 inches long and trumpet shaped. The stems are stout, hollow, and smooth.

HERBICIDES LABELED FOR SOYBEANS[1]

1. alachlor (Lasso, Micro-Tech, or Partner) — chloroacetamide: Typically applied PRE but can be incorporated. Controls most annual grasses and small-seeded broadleaf weeds. (REI of 12 hours)

2. acifluorfen (Blazer, Ultra Blazer) — diphenylether : This postemergent herbicide controls a number of annual broadleaf weeds. Acifluorfen must be applied at least 50 days before harvest. (REI of 48 hours)

3. acifluorfen + bentazon (Storm 4S) — diphenylether + benzothiadiazinone triazine : This prepac k aged post emergence herbicide mixture controls most annual broadleaf weeds. Do not apply this mixture within 50 days of soybean harvest. (REI of 48 hours)

4. bentazon (Basagran) - benzothiadiazinone triazine: This postemergence, photosynthesis inhibitor controls certain annual broadleaf weeds and yellow nutsedge. Commonly applied in combination with acifluorfen. (REI of 48 hours)

5. chlorimuron-ethyl (Classic) — sulfonylurea: This postemergent herbicide controls selected annual broadleaf weeds and suppresses yellow nutsedge. Classic must be applied at least 60 days before harvest. (REI of 12 hours)

6. chlorimuron ethyl + thifensulfuron (Sychrony STS) — sulfonylureas: This prepackaged mixture can be used no later than 60 days before soybean maturity. (REI of 12 hours)

7. clethodim (Select) — cyclohexanedione ,: This postemergence herbicide controls annual and perennial grasses.

Clethodim must be applied at least 60 days before harvest. (REI of 24 hours)

8. clomazone (Command) — isoxazolidinone: Typically applied PRE but can be PPI. Controls most annual grasses and selected annual broadleaf weeds. (REI of 12 hours)

9. cloransulam-methyl (Amplify, FirstRate) — triazolopyrimidine: Do not harvest soybeans for grain until 65 days after application. Applied POST, usually in combination with another herbicide. Controls selected annual broadleaf weeds. (REI of 12 hours)

10. dimethenamid-P (Outlook) — chloroacetamide : Controls most annual grasses and selected small-seed broadleaf weeds. Suppresses yellow nutsedge. Typically applied PRE. (REI of 12 hours)

11. ethalfluralin (Sonalan) — dinitroaniline: Applied PPI. Controls annual grasses and selected small-seeded broadleaf weeds. (REI of 24 hours)

12. fluazifop - P- butyl (Fusilade DX) — aryloxyphenoxy propionate, chemically similar to fenoxaprop-P (‘FOPs’): Applied POST. Controls annual and perennial grasses. (REI of 12 hours)

13. flumiclorac pentyl ester (Resource) — N-phenylphthalimide : Applied POST. Controls selected annual broadleaf weeds. Typically applied in combination with another herbicide. (REI of 12 hours)

14. flumioxazin (Valor) — N-phenylphthalimide: Applied PRE. Controls most annual broadleaf weeds. Can be used in tank mixes to burndown weeds where soybeans will be planted directly into a ground cover or previous crop residue. (REI of 12 hours)

15. fomesafen (Flexstar, Reflex) — diphenylether: Applied POST. Controls a number of annual broadleaf weeds. Fomesafen must be applied prior to bloom. (REI of 24 hours)

16. glyphosate (numerous tradenames) — glycine: Applied PPF to control existing weeds before no-till

planting. Applied POST to soybean with the Roundup Ready trait. Most commonly used soybean herbicide in North Carolina . Controls annual and perennial grasses and most annual broadleaf weeds. Controls or suppresses sedges and perennial broadleaf weeds. (REI of 12 hours)

17. imazaquin (Scepter) — imidazolinone: Typically applied PRE to control most annual broadleaf weeds. Can be applied PPI. Can be applied POST to control selected broadleaf weeds. Imazaquin must be applied at least 90 days before harvest. (REI of 12 hours)

18. imazethapyr (Pursuit) — imidazolinone: Applied POST to control many annual broadleaf weeds and to suppress annual grasses, johnsongrass, and nutsedge species. (REI of 4 hours)

19. lactofen (Cobra) — diphenylether: Applied POST. Controls many species of annual broadleaf weeds It must be applied at least 45 days before harvest. (REI of 12 hours)

20. linuron (Linex, Lorox) — urea: Applied PRE to control small-seeded annual broadleaf weeds. May also be applied PDIR. (REI of 24 hours)

21. metribuzin (Sencor) —triazinone: Typically applied PRE, may be PPI. Controls most annual grasses, small-seeded broadleaf weeds, and suppresses yellow nutsedge. (REI of 12 hours)

22. paraquat (Gramoxone Max) — bipyridylium: Applied PPF in no-till and other conservation tillage systems to control existing vegetation at or before planting. Look up PHI and REI.

23. pendimethalin (Prowl) — dinitroaniline: Applied PPI or PRE. Controls annual grasses and small-seeded broadleaf weeds. (REI of 12 hours)

24. quizalofop P-ethyl (Amplify, Assure II) — aryloxyphenoxy-propionate :
('FOPs'): Applied POST. Controls annual and perennial grasses. Quizalofop must be applied at least 80 days before harvest. (REI of 12 hours)

25. sethoxydim (Poast) — cyclohexanedione , chemically similar to clethodim ('DIMs'): Applied POST. Controls annual and perennial grasses.Sethoxydim must be applied at least 75 days before harvest. (REI of 12 hours)

26. s-metolachlor (Dual Magnum, Dual II Magnum) — chloroacetamide: Typically applied PRE, may be PPI. Controls most annual grasses, small-seeded broadleaf weeds, and suppresses yellow nutsedge. (REI of 24 hours)

27. thifensulfuron-methyl (Harmony GT) — sulfonylurea: Thifensulfuron-methyl must be applied at least 60 days before harvest. Applied POST, usually mixed with another herbicide. Controls selected annual broadleaf weeds. (REI of 4 hours)

28. trifluralin (Treflan) — dinitroaniline: Applied PPI. Controls annual grasses and small-seeded broadleaf

weeds. (REI of 12 hours)

[1] Many prepackaged herbicide mixes, except for the most commonly used ones, are not listed here because their availability changes frequently. Also some seldom-used herbicides are not listed here even though they are registered in North Carolina.

HERBICIDE USE ESTIMATES FOR SOYBEANS

In 97% of all soybeans planted in the U.S., 99% were treated with herbicides (In North Carolina, 95% were treated). Nationally, the most widely used herbicides were glyphosate; applied to 78% of the soybean acreage, followed by imazethapyr and pendimethalin; each applied to 9% of the acreage, and trifluralin; applied to 7% of the planted acreage. Chlorimuron-ethyl and sulfentrazone were both applied to 6% of the soybean planted acreage.

Table 2. Herbicide use on soybeans in North Carolina in 2002. Source: Agricultural Chemical Usage: 2002 Field Crops Summary. May 2004. U. S. Department of Agriculture, National Agricultural Statistics Service.

Insecticide Active Ingredient	Area Applied[1] (Percent)	Number of Applications	Rate per Application (lbs./ acre)	Rate per Crop Year (lbs./ acre)	Total Applied (1,000 lbs.)
Glyphosate	91	1.3	0.71	0.98	1,208
Imazethapyr	5	1.0	0.04	0.04	3
Paraquat	14	1.0	0.39	0.39	77
Pendimethalin	3	1.0	0.53	0.53	22

[1] Planted acres in 2002 for North Carolina were 1.36 million acres.

CURRENT HERBICIDE RECOMMENDATIONS FOR SOYBEANS

Current North Carolina Cooperative Extension Service recommendations for herbicide use on soybeans (including information on formulations, application rates, and precautions/limitations) are provided in the following table from the *North Carolina Agricultural Chemicals Manual*:

Table 8-6A: Chemical Weed Control in Soybeans
http://ipm.ncsu.edu/agchem/chptr8/808.pdf

Table 8-6B: Weed Response to Preplant Incorporated and Preemergence Herbicides in Soybeans
http://ipm.ncsu.edu/agchem/chptr8/808.pdf

Table 8-6C: Weed Response to Postemergence Herbicides in Soybeans
http://ipm.ncsu.edu/agchem/chptr8/808.pdf

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2. Holshouser, David L., ed. May 2001, Cultural Practices in 2001 Soybean Production Guide. Virginia Cooperative Extension Service. http://www.vaes.vt.edu/tidewater/soybean/soyproduction/soyguide.html#TOC

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7. Van Duyn, John W. Management of Soybean Insect Pests in North Carolina. http://www.ces.ncsu.edu/plymouth/pubs/ent/index3.html
8. Weeds in Florida, SP 37, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication date: May 1991. Revised: December 2004. http://edis.ifas.ufl.edu

On-Line Resources

Soybean Insect Pests
http://ipm.ncsu.edu/soybeans/insects/insects_soybeans.html

Pests of Soybeans, from Insect and Related Pests of Field Crops
http://ipm.ncsu.edu/AG271/soybeans/soybeans.html

Management of Insect Pests of North Carolina Grain Crops
http://plymouth.ces.state.nc.us/pubs/ent/index2.html

Soybean Disease Information Notes
http://www.ces.ncsu.edu/depts/pp/notes/Soybean/soybean_contents.html

Soybean Weeds
http://ipm.ncsu.edu/soybeans/weeds/soybean_weeds.html

Pesticides and Wildlife – Soybeans
http://ipm.ncsu.edu/wildlife/soybeans_wildlife.html

IPM Soybean Scouting Manual
http://ipm.ncsu.edu/soybeans/Scouting_Soybeans/soyfinal.pdf

North Carolina Pest News
http://ipm.ncsu.edu/current_ipm/pest_news.html

Virginia Tech Weed Identification Guide, Crop and Garden Weeds. Virginia Cooperative Extension Service.
http://www.ppws.vt.edu/scott/weed_id/cropweeds.htm

Soybean Production Guide, Virginia
http://www.vaes.vt.edu/tidewater/soybean/soyproduction/soyguide.html

Agricultural Chemical Usage: 2002 Field Crops Summary. May 2003. USDA National Agriculture Statistics Service.
http://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agcs0504.pdf

Identification of Broadleaf Weeds in Citrus by Stephen H. Futch and David W. Hall
http://edis.ifas.ufl.edu/HS150

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