

Crop Profile for Soybeans in Kansas

Prepared April, 2000

General Production Information

1998 data

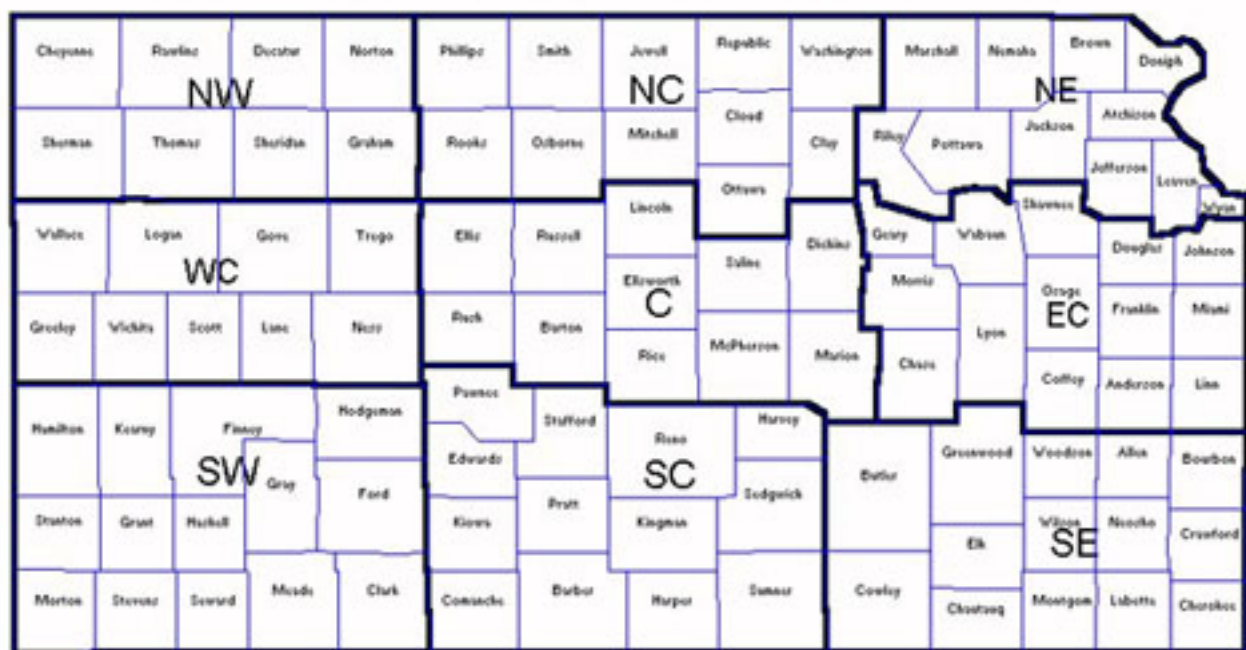


- **State rank:** 10.
- **State production:** 75 million bushels, down 14 percent from 1997. The value of production in 1998 was \$401.3 million, 28 percent below 1997. Dryland and irrigated areas produced 81 and 19% of Kansas total soybean production, respectively.
- **Percent U.S. production:** 2.7%.
- **Acre planted:** 2.55 million acres, compared with 2.45 million acres in 1997. According to USDA Statistics there are more than 14,000 soybean farmers in Kansas.
- **Acre harvested:** 2.5 million acres. Dryland and irrigated regions harvested 2.212 million and 288,100 acres, respectively.

- **Yield per acre:** 30 bushel. Irrigated areas produced 51 bushel, while dryland areas had 27 bushels per acre.
- **Cash value:** it has been estimated that soybean industry generated nearly \$ 500 million to the Kansas economy. (1998 USDA Crop estimate, from Kansas Soybean Association Web page).
- **Yearly production costs:** about \$113.6 was the average production cost in southeast, northeast, south central, north central, and irrigated production regions (1997 data).
- **Leading Counties:** three counties in the northeastern region of Kansas (dryland) were the leaders in total yield production and acres harvested in 1998. Brown county harvested 101,400 acres with 4.116 million bushels, followed by Marshall harvested 100,100 acres with 3.464 million bushels, and Doniphan county harvested 68,000 acres with 2.697 million bushels.

Figure 1. Production Regions

AGRICULTURAL STATISTICS DISTRICTS



The state of Kansas is divided into nine districts (Figure 1). Soil types vary within a district. In general, northwestern and most of the west is deep, dark gray-brown silt loams, except the southwest counties are silt and sandy loams, and brown loamy fine sands. A moderately deep, dark gray-brown silt loams, and gray clays dominate the central and north central districts of Kansas. Northeastern Kansas has very dark brown silt, clay and silty clay loams soils whereas, the southeastern part has shallow, very dark gray-brown silt, clay, and silty clay loam soils. Average rainfall in Kansas ranges from about 6 inches in the west central to over 38 inches in the southeast.

Most of the soybean is grown in the dryland (northeastern) region. In 1998, Brown was the leading county, followed by Marshall, then Doniphan. The acreage ranged between 101,500 to 68,400.

Cultural Practices

Number of tillage and planting systems are used in soybean production, including primary and/or secondary tillage, or no preplant tillage. Conservation tillage that includes reduced till, mulch-till, ecofallow, strip-till, ridge-till, zero-till, and no-till methods are used to conserve moisture and prevent soil erosion.

Soybean plants leave the soil surface loose and mellow, which enhance soil erosion. Also, the little residue of the soybean plants is fragile and easily broken down. Thus, conservation tillage or other erosion-control practices are very important before, during, and after soybean production.

Soybean seed requires soil that is warm, moist, well supplied with air, and provides good contact between the seed and soil for rapid germination. Soybean producers use a 30-inch row width to allow cultivation for weed control, or narrower rows.

The optimum planting depth for soybean seed is 1 to 1.5 inches, no more than 2 inches in sandy soil. Planting dates vary from early May to late June. Nonirrigated soybeans may be planted from May 1 until June 20 in most Kansas areas, but mid-May is suggested for northeast and east central Kansas, late May to early June for central areas, and early to mid-June for southeastern Kansas. If nonirrigated soybeans are to be planted in western Kansas, they should be planted in early to mid-May.

Seeding rate of soybean depends on seed size and quality. It is essential to consider planting rates in term of seeds per foot of row or seeds per square foot.

Insect Pests

Three general groups of insect may attack soybean crop and cause economic loss: foliage feeders, pod feeders, and stem tunnellers. Bean leaf beetle, webworms, grasshoppers and green cloverworms are examples of foliage feeders. Control of foliage feeders depends on the amount of foliage that is being destroyed. Plants can withstand as much as 35% foliage loss during the blooming stage, however more than 20% loss during pod formation and filling may decrease yields. Defoliation after the crucial filling stages has no significant effect on yield reduction.

Growers in extreme southeastern Kansas occasionally may encounter pod feeders such as stink bugs or corn earworms that may cause serious yield reduction. Recent surveys reveled that the soybean stem borer is more common in some north central, south central, and southwestern areas than had been previously recognized.

In 1997, insect damage in Kansas soybean was not sufficiently reported to publish any data, according to the survey conducted by the Kansas Agricultural Statistics (KAS) and the National Agricultural Statistics Service (NASS).

Insecticide and miticide classes are indicated as follows:

1. Organophosphates

2. **Biologicals**
3. **Carbamates**
4. **Organochlorines**
5. **Pyrethroids**

Following are the important pests and recommended insecticides for soybean in Kansas:

Bean Leaf Beetle is red to light tan with 4 to 6 black spots on the back. This insect is found in all parts of the state. The insect is foliage feeder, causing oval holes that are of little economic consequence for most of the season. However, severe cotyledon feeding, or populations of 7 beetles per row foot on plants with 4 or fewer nodes and 25% defoliation may call for limited-area treatments. Also, treatments might be justified if pod feeding by beetles results in loss of 3 or more seeds per plant, if the pods are not completely dry, and if the beetles remain in the fields.

Insecticide treatments:

- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ ½ -1 Ib. a.i./A; 12 hr REI; 0 day PHI.
- Chlorpyrifos (Lorsban 4E) @ ½-1 Ib. a.i./A: 24 hr REI. Not applied within 28 days of harvest.
- (5) Esfenvalerate (Asana®* XL 0.66) @ 0.03-0.05 Ib. a.i./A; 12 hr REI; 21 day PHI.
- (1) Dimethoate @ ½ I Ib. a.i./A; 48 hr REI. Last treatment may not be applied within 21 days from harvest.
- (5) Permethrin (Ambush®* 2E, Pounce®* 3.2EC) @ 0.05-0.10 Ib. a.i./A; 12 hr REI. Not applied within 60 days of grain harvest.
- (3) Thiodicarb (Larvin®* 3.2EC) @ 0.45-0.75 Ib. a.i./A, 12 hr REI; 28 day PHI.
- (5) Lambda-cyhalothrin (Warrior®* T) @ 0.015-0.025 Ib. a.i./A; 24 hr REI. Not applied within 45 days of harvest.

Some Blister Beetles have a long (3/4-inch) and cylindrical body. They feed on leaves and rarely cause economic loss when the foliage is stripped from plants in small areas. Field wide treatments are almost never recommended.

Corn Earworms are found in southeastern Kansas from August through September. Damage is not serious until larvae feed on pods. These insects feed through the pod wall to consume or damage the beans. Large worms are difficult or impossible to control. Control measures should be applied when an average of 1 small worm per foot of row is detected.

Insecticide treatments:

- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ 1.5 Ib. a.i./A; 12 hr REI; 0 day PHI.
- (5) Esfenvalerate (Asana®* XL 0.66) @ 0.03-0.05 Ib. a.i./A; 12 hr REI; 21 day PHI.
- (3) Methomyl (Lannate®*) @ 0.225-0.45 Ib. a.i./A; 48 hr REI. Not applied within 14 days of harvest.
- (1) Chlorpyrifos (Lorsban®* 4E) @ 1 Ib. a.i./A; 24 day REI. Last treatment may not be applied within 28 days of harvest.
- (5) Permethrin (Ambush®* 2E, Pounce®* 3.2EC) @ 0.1-0.2 Ib. a.i./A; 12 hr REI. Not applied within 60 days of grain harvest.
- (5) Lambda-cyhalothrin (Warrior®* T) @ 0.015-0.025 Ib. a.i./A; 24 hr REI. Not applied within 45 days of harvest.
- (1) Methyl Parathion @ 1 Ib. a.i./A; 48 hr REI. Not applied within 15 to 20 days of harvest.

Flea Beetles: The adults chew on leaves causing tiny holes. Treatments rarely recommended.

Grasshoppers cause damage to the field margin from June through September. They are foliage feeders, chewing leaves from the edge inward. Fields may be treated when more than 8 grasshoppers per square yard are found.

Insecticide treatments:

- (5) Esfenvalerate (Asana®* XL 0.66) @ 0.03-0.05 Ib. a.i./A; 12 hr REI; 21 day PHI.
- (1) Dimethoate (Cygon®) @ 0.5 Ib a.i./A; 48 hr REI. Last treatment may not be applied within 21 days from harvest.
- (3) Carbofuran (Furadan®* 4F) @ 0.125-0.25 Ib.a.i./A; 48 hr REI; 21 day PHI.
- (1) Chlorpyrifos (Lorsban®* 4E) @ 0.25-0.5 Ib. a.i./A; 24 REI. Last treatment may not be applied within 28 days of harvest.
- (1) Methyl parathion @ 0.5-1 Ib. a.i./A; 48 hr REI. Not applied within 15 to 20 days of harvest.
- (1) Microencapsulated Methyl Parathion (PennCap®* M) @ 0.5 Ib. a.i./A; 5 day REI in areas where average rainfall is less than 25 inches per year and 4 days where rainfall is 25 inches or greater. Not applied within 20 days of harvest.
- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ 0.5-1.5 Ib. a.i./A; 12 hr REI; 0 day PHI.
- (5) Lambda-cyhalothrin (Warrior®* T) @ 0.025-0.030 Ib. a.i./A; 24 hr REI. Not applied within 45 days of harvest.

Green Cloverworms are caterpillars with four pairs of abdominal prolegs. The larvae are light green with three pairs of white stripes running the length of the body. They feed on leaves and sometimes cause economic defoliation, especially in eastern Kansas from May to August. Treatment of larvae depends on soybean developmental stage, density of larvae, control costs, and expected soybean market value.

Insecticide treatments:

- (5) Permethrin (Ambush®* 2E, Pounce 3.2EC) @ 0.05-0.1 Ib. a.i./A; 12 hr REI. Not applied within 60 days of grain harvest.
- (5) Esfenvalerate (Asana®* XL) @ 0.015-0.03 Ib. a.i./A; 12 hr REI; 21 day PHI.
- (2) *Bacillus thuringiensis* (Agree, Dipel, Javelin and others), rates vary by product and formulation; 4 to 12 hr REI; 0 day PHI.
- (3) Methomyl (Lannate®*) @ 0.25-0.45 Ib. a.i./A; 48 hr REI. Not applied within 14 days of harvest.
- (3) Thiodicarb (Larvin®* 2.3 EC) @ 0.25-0.4; 12 hr REI; 28 day PHI.
- (1) Chlorpyrifos (Lorsban®* 4E) @ 0.25-0.5 Ib. a.i./A; 24 REI. Last treatment may not be applied within 28 days of harvest.
- (1) Malathion, rates vary by product and formulation; 12 hr REI; 3 to 7 day PHI.
- (1) Methyl Parathion @ 0.5-1 Ib. a.i./A; 48 hr REI. Not applied within 15 to 20 days of harvest.
- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ 0.5-1 Ib. a.i./A; 12 hr REI; 0 day PHI.
- (5) Lambda-cyhalothrin (Warrior®* T) @ 0.015-0.025 Ib. a.i./A. 24 hr REI. Not applied within 45 days of harvest.

Seed Corn Beetles and Seed Corn Maggots are soil-infesting insects that attack before the delayed seedling emerges especially during cool, wet springs.

Soybean seeds are treated with Lindane and/or Diazinon or a combination of the two plus a fungicide.

Spider Mites are very small arthropods that cause leaves to drop prematurely from plants. Foliage loss progresses rapidly up the plant, and damage becomes serious during pod filling stages. Heavy infestations are more likely during dry years. Miticide treatments may be beneficial if significant pods remain unfilled and leaves have not already turned yellow. Dimethoate @ 0.5 Ib. a.i./A is the only product currently recommended for spider mite control on soybean.

Saltmarsh Caterpillars and other Woollybear Caterpillars: Woollybears are very hairy and yellowish brown caterpillars. The smaller larvae feed in groups on the underside leaves.

Insecticide treatments:

- (5) Permethrin (Ambush®*2E, Pounce 3.2 EC) @ 0.05-0.1 Ib. a.i./A; 12 hr REI. Not applied within 60 days of grain harvest.
- (5) Esfenvalerate (Asana®* XL 0.66) @ 0.015-0.03 Ib. a.i./A; 12 hr REI; 21 day PHI.
- (3) Thiodicarb (Larvin®* 3.2 EC) @ 0.25-0.4 Ib. a.i./A; 12 hr REI; 28 day PHI.
- (1) Chlorpyrifos (Lorsban®* 4E) @ 0.5-1 Ib. a.i./A; 24 hr REI. Last treatment may not be applied within 28 days of harvest.
- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ 1.5-2 Ib. a.i./A; 12 hr REI; 0 day PHI.
- (5) Lambda-cyhalothrin (Warrior®* T) @ 0.015-0.025 Ib a.i./A: 24 hr REI. Not applied within 45 days of harvest.

Soybean Stem Borer is more common in north central, south central, and southwestern parts of Kansas. Larvae live inside the stem and tunnel to the base of the plant late in the season. Stems may be internally girdled from ground level to 3 inches above the soil surface and can cause yield reduction and plant lodging which causes significant problems during harvest. To date, no resistant varieties or labeled insecticides provide good control of this insect. Cultural practices such as crop rotation and timely harvesting have been reported to minimize crop loss.

Stink Bugs are most common in southeastern Kansas soybean, but even in this area are seldom economically important. Stink bugs feed on soybean seeds by piercing and sucking through the pod wall producing shrunken and deformed seeds. Treatments should be applied when 10 bugs per 30 feet of row are found.

Insecticide treatments:

- (5) Esfenvalerate (Asana®* XL 0.66) @ 0.03-0.05 Ib. a.i./A; 12 hr REI; 21 day PHI.
- (1) Chlorpyrifos (Lorsban®* 4E) @ 1 Ib. a.i./A; 24 hr REI. Last treatment may not be applied within 28 days of harvest.
- (1) Methyl Parathion @ 0.5 Ib. a.i./A; 48 hr REI. Not applied within 15 to 20 days of harvest.
- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ 1 Ib. a.i./A; 12 hr REI; 0 day PHI.
- (5) Lambda-cyhalothrin (Warrior®* T) @ 0.025-0.030 Ib. a.i./A; 24 hr REI. Not applied within 45 days of harvest.

Thistle Caterpillars are hairy dark-colored caterpillars that web soybean leaves together. Treatments are required when 10 or more are found per foot of row or more than 25 to 35% of leaves are defoliated during pod set.

Insecticide treatment:

- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ 1.5-2 Ib. a.i./A; 12 hr REI; 0 day PHI.

Webworms are slender green worms with 3 dark spots arranged in a triangle on each side of each body segment. They are foliage feeders that web soybean leaves together from July through August. Treatments are required when more than 10 to 12% of plants show significant webbing.

Insecticide treatments:

- (5) Permethrin (Ambush®* 2E, Pounce 3.2 EC) @ 0.1-0.2 Ib. a.i./A; 12 hr REI. Not applied within 60 days of grain harvest.
- (3) Carbaryl (Sevin® 4F, 50WP, 80WSP, 80S, XLR Plus) @ 1-1.5 Ib. a.i./A; 12 hr REI; 0 day PHI.
- (5) Lambda-cyhalothrin (Warrior®* T) @ 0.025-0.03 Ib. a.i./A; 24 hr REI. Not applied within 45 days of harvest.

Diseases

With the exception of soybean cyst nematode (SCN) and charcoal rot, soybean disease losses are normally negligible under Kansas growing conditions. From time to time however, growing conditions combined with improper management practices can produce significant losses from Phytophthora root rot, seedling blights, sudden death syndrome and Phomopsis pod and stem blight.

To minimize soybean disease losses, the following are general practices followed in Kansas:

- Use of high quality, disease-free seed.
- Planting of resistant varieties when available.
- Rotation with non-host crops such as corn, wheat, or sorghum.
- Use of fungicide seed treatments when planting conditions are favorable for disease

development.

FUNGAL DISEASES

The severity of diseases caused by fungal pathogens is related to both environmental conditions and host susceptibility. The diseases are grouped according to the plant part affected.

Leaf and seed diseases:

Brown spot is caused by *Septoria glycines*. The fungus enters through leaf stomata and grows intercellularly. It survives from season to season in crop residue left on the soil surface. It generally occurs early in the season and may cause significant leaf defoliation, but it results in no significant yield loss in Kansas. Symptoms consist of small, irregular, dark-brown lesions on the upper and lower surface of the leaf. Later, leaves turn yellow and drop. Lowest leaves drop first and the disease then progresses up the plant.

Management:

- Rotate crops.
- Remove infested debris.

Downy mildew is caused by *Peronospora manshurica*, a fungus that survives on infected leaf debris and on seeds. This disease is found wherever soybean plants are grown in the United States, especially in cooler, humid locations. It rarely cause damage in Kansas. Infected plants produce poor quality seed that is small in size and low in test-weight. In the early stages of infection, yellowish green lesions can be found on the upper surface of leaves. Later, these lesions turn grayish- to dark-brown and are surrounded by chlorotic, yellowish-green margin. A fluffy, gray, mold-like growth develops on the lower surface of leaves opposite the lesion. Leaves become dry, curl at the edge and fall prematurely. The seed and inner pod surface may become encrusted with a whitish mold.

Management:

- Rotate crops.
- Plant resistant varieties.
- Treat seeds with a metalaxyl or mefenoxam containing fungicide.

Purple seed stain is caused by the fungus, *Cercospora kikuchii*. The fungus overwinters on infected leaves, stems and seeds. It is one of the most prevalent and widely distributed seed diseases on soybeans. Wet weather from flowering through maturity can increase the severity of the disease and discoloration of the seed. Seed discoloration varies from pink or light purple to dark purple.

Management:

- Plant resistant varieties.
- Treat infected seed with fungicides.

Root and stem diseases:

Phytophthora root rot, caused by the fungus *Phytophthora sojae*, is not a widespread problem in Kansas, but isolated areas of infestation frequently occur. Phytophthora root rot is one of the most destructive diseases of soybean in the United States. The fungus produces spores that swim through soil water and infect roots directly through epidermis. It is more severe on heavy clay soils, and in low, poorly drained areas. Symptoms consist of a complete destruction of the lateral roots and a dark brown discoloration of the main root and stem extending from the soil line up into the canopy. Under heat and drought stress, the plants turn yellow, wilt, and frequently die.

Management:

- Rotate crops.
- Plant resistant or field tolerant varieties.
- Improve soil drainage.
- Apply metalaxyl as a seed treatment for seedling blight problems, or in-furrow for full season control.

Stem canker is caused by the fungus *Diaporthe phaseolorum* var. *caulivora*. It rarely causes economic problems in Kansas. The fungus overwinters in plant stubble or can be seed borne. Symptoms consist of small reddish brown cankers that form at the base of the petioles on the lower part of the stem. Cankers can enlarge and completely girdle the stem, killing the plant. Advanced stages of stem canker can easily be confused with Phytophthora symptoms.

Management:

- Rotate crops.
- Use less susceptible cultivars.

- Plant disease free seed.
- Eliminate diseased crop residue.

Charcoal rot is caused by the soil borne fungus *Macrophomina phaseolina*. It is the most destructive soybean disease in Kansas. In severe years, statewide yield losses of 15-20 percent have occurred. Nationally, production losses attributed to charcoal rot are more than 30 million bushels per year. The disease is especially severe in the shallow soiled, non-irrigated fields of east central and southeastern Kansas. High temperatures and moisture stress during pod fill favor disease development. Plants wilt, turn yellow, and die, with the leaves remaining attached. Small, black reproductive structures known as sclerotia form just under the epidermis of the roots and can also be found in the pith and cortex of the stem, and imbedded in the stem surface.

Management:

- Rotate crops.
- Plant late-maturing varieties.
- Reduce final plant populations to 3-6 plants per foot of row.
- Use supplemental irrigation or any other moisture conserving cultural practices.

Pod and stem blight is caused by several species of *Phomopsis* that survive in diseased residue or are seed borne. The disease is favored by high humidity and rainfall late in the season. Symptoms consist of linear rows of black fruiting bodies known as pycnidia that form on stems, petioles and pods. Infested seeds develop various degrees of seed-coat cracking, shriveling and discoloration. Seed may be partially or completely covered with a white fungal growth.

Management:

- Rotate crops.
- Eliminate crop residue.
- Use fungicide seed treatments on infested seed.
- Foliar sprays with benomyl or thiobendazole may be economical for soybeans grown for seed.

BACTERIAL DISEASES

Bacterial blight is the major bacterial disease of soybean. Caused by *Pseudomonas syringae* pv. *glycinea*, the pathogen survives in crop residue and on the seed. It usually appears on susceptible varieties following heavy rains accompanied by high winds. Leaf symptoms begin as small, water-

soaked leaf spots that soon turn brown with a yellow border. The lesions will coalesce and drop out, giving a leaflet a ragged shot hole appearance.

Management:

- Rotate crops.
- Select resistant varieties.
- Avoid field operations when foliage is wet.
- Do not save seed for planting from severely infected fields.

Bacterial bacterium, *Xanthomonas campestris* pv. *glycines*. This disease develops later in the season than leaf blight when temperatures are warmer. Symptoms are similar to bacterial blight except for the development of raised pustules in the center of lesions on the under side of the leaf.

Management:

- Rotate crops.
- Plant resistant varieties.
- Avoid field operations when foliage is wet.
- Do not save seed for planting from severely infected fields.

VIRAL DISEASES

Bud blight is caused by the tobacco ringspot virus. It is transmitted mechanically, by seed, or by immature thrips that can vector the disease. Many weeds serve as alternate hosts. Symptoms consist of dwarfed and distorted plants with the terminal shoot forming a "shepard's crook". There is a browning of the pith in the upper nodes of the stem. Pods frequently abort, or are small and under developed. The surface of the pod may develop purple-to-brown blotches and seed development may be inhibited.

Management:

- Plant disease-free seed.
- Control weeds around fields.
- Remove infected soybean plants.

Soybean Mosaic Virus (SMV) is often confused with injury from certain phenoxy-type herbicides such as 2,4-D. Aphids act as a vector for the disease, but it can also be seed and mechanically transmitted.

Symptoms consist of crinkled, smaller than normal young leaves, with a yellowish-strapped appearance. Maturity is delayed. Symptoms are more severe under cool temperatures.

Management:

- Plant disease-free seed.
- Remove infected soybean plants.
- Avoid harvesting infected plants for seed.

Nematodes

Soybean cyst nematode (*Heterodera glycines*) is the most important soybean disease in the United States and second most important in Kansas after charcoal rot. The egg hatches into a second stage juvenile that finds its way through the soil and penetrates young soybean roots. Males fertilize the female and then leave the root without feeding. As the females feed and begin to produce eggs, their bodies begin to swell until eventually they break through the surface of the root. Initially lemon shaped and white, the female nematode turns yellow and then brown as it matures. Several races of the nematode are present in Kansas's fields, primarily races 1, 3, 6 and 14. The cyst nematode can be spread by anything that causes soil to move from one field to another including farm implements, seed with small soil peds in it, mud on the feet of livestock and wildlife, and water as it flows through a field. Symptoms can include stunting and occasionally chlorosis, although frequently, no discernable symptoms are present.

Management:

- Rotate with nonhost crops.
- Plant resistant varieties with appropriate sources of resistance.

Sting nematode (*Belonolaimus longicaudatus*) is mainly distributed in the sandy soils of the Arkansas River basin. Nematodes feed on the growing points of the roots, injecting a toxin as they feed that causes a necrosis of the root tip and severe pruning of the roots. Above ground field symptoms include patches of moderate to severely stunted plants.

Management:

- Rotation with wheat or alfalfa is generally recommended.

Weeds

Weeds in soybeans reduce yield and interfere with harvest. It has been estimated that weeds cause more than \$13 million in losses to Kansas soybean production each year. Soybeans are very competitive with weeds, thus early-season weed control is important to minimize the effect of weeds after canopy development. Weed control in soybeans is best achieved with an integrated approach including crop rotations, cultivation, sound agronomic practices, and use of herbicides to enhance the ability of soybean to compete with emerging weeds.

Cultural practices for weed control:

1. Plant weed-free soybean seeds and use clean equipment when moving between infected fields.
2. Crop rotation is one of the most effective method to control velvetleaf, cocklebur, or devilsclaw in soybean.
3. Use of a rotary hoe after planting to control small-seeded weeds like crabgrass, foxtail, and pigweed.
4. Follow production practices that enhance quick soybean emergence and canopy development.

Primary Weeds in Kansas Soybean Fields:

1. Common annual grasses:
 - **Fall panicum** (*Panicum dichotomiflorum*) is a native weed. Seeds are the only source of reproduction. It flourishes in warm conditions. Common in cultivated fields, waste areas, roadsides, abused pastures, and disturbed areas.
 - **Foxtail, including giant** (*Setaria faberi*) (**giant bristlegrass, Chinese foxtail, Chinese millet, nodding foxtail**) native of Asia; **green** (*Setaria viridis* L.) (**green bristlegrass, pigeongrass, wild millet**) native of Eurasia; and **yellow** (*Setaria glauca* L.) (**yellow bristlegrass, pigeongrass, wild millet**) native of Europe. Seeds are the only source of reproduction. Common on cultivated soils, waste places, roadsides and degraded rangeland and pastures.
 - **Crabgrass, including large** (*Digitaria sanguinalis* L.) (**hairy crabgrass, purple crabgrass**) native of Europe; **smooth** (*Digitaria ischaemum*) native of Europe. Seeds are the only source of reproduction. Both flourish in warm conditions. Both are common in lawns, cultivated fields, gardens, roadsides, pastures, and waste places.
 - **Shattercane** (*Sorghum bicolor* L.) (**Black amber, chicken corn, wild cane**) native of Africa. Seeds are the only source of reproduction. Flourish in warm conditions. Grown in cultivated fields of corn, grain sorghum, and soybeans. Treflan treatment provides fairly good control of shattercane.

- **Barnyardgrass** (*Echinochloa crusgalli* L.) (**cockspur, watergrass**) originally from Europe. Seeds are the only source of reproduction. It flourishes in warm conditions. Common particularly in moist area high in fertility, such as irrigated fields and old feedlots.
- **Longspine sandbur** (*Cenchrus longispinus*) (**field sandbur, burgrass**) is a native weed. Seeds are the only source of reproduction. Flourish in warm conditions. Common in roads, waste places, cultivated fields, lawns, and rangeland in poor condition. Grows well on sandy soils, but also found on heavier soils.

2. Annual broadleaf weeds:

- **Kochia** (*Kochia scoparia* L.) (**summer cypress, fireweed, belvedere, mock cypress, Mexican firebush**) native of Eurasia. Flowering season from July to October. Seeds are the only source of reproduction. Found on rangeland, pastures, fields and disturbed sites. Confirmed resistance to triazine and ALS inhibiting herbicides.
- **Common cocklebur** (*Xanthium strumarium* L.) is a native weed. Flowering season from July to September. Seeds are the only source of reproduction. Found in open fields, gardens, pastures, and waste areas. Common cocklebur is especially abundant in areas where retreating water has exposed previously submerged land. Confirmed resistance to ALS inhibiting herbicides.
- **Common sunflower** (*Helianthus annuus* L.) (**annual sunflower**) is a native weed. Flowering season from July to September. Seeds are the only source of reproduction. Found in cultivated fields, pastures, gardens, roadsides, waste ground, and disturbed sites. Confirmed resistance to ALS inhibiting herbicides.
- **Velvetleaf** (*Abutilon theophrasti*) (**Indian mallow, butter print, elephant ear, buttonweed**) originated from India. Flowering season from July to October. Seeds are the only source of reproduction. Found in summer crop fields such as sorghum, corn, and soybeans, in waste places, roadsides, and fence rows.
- **Venice mallow** (*Hibiscus trionum* L.) (**Flower-of-an-hour, brown-eyed Suzy**) originated from Europe. Flowering season from June to September. Seeds are the only source of reproduction. Found in gardens, cultivated fields, pastures, roadsides, railroad rights-of-way, and waste places.
- **Lambsquarters** (*Chenopodium album* L.) (**lambsquarters goosefoot, white goosefoot**) native of Europe. Flowering season from June to September. Seeds are the only source of reproduction. Found in cultivated crop fields, gardens, pastures, vacant lots, waste ground, and other disturbed areas.
- **Palmer amaranth** (*Amaranthus palmeri*) is a native weed. Flowering season from June to October. Seeds are the only source of reproduction. Confirmed resistance to triazine and ALS inhibiting herbicides. Found in cultivated and fallow fields, gardens, waste ground, and roadsides.
- **Redroot pigweed** (*Amaranthus retroflexus* L.) (**rough pigweed, careless weed**) is a native weed. Flowering season from July to October. Seeds are the only source of reproduction. Confirmed resistance to triazine herbicides. Found in cultivated and fallow fields, gardens, waste ground, and roadsides.
- **Tumble** (*Amaranthus albus* L.) (**tumbleweed, white pigweed**) is a native weed.

Flowering season from June to October. Seeds are the only source of reproduction. Found in drylands, cultivated and fallow fields, roadsides, and waste places.

- **Waterhemp** (*Amaranthus rudis* and *tuberculatis*) (**common and tall waterhemp**) are native weeds. Flowering season from June to October. Seeds are the only source of reproduction. Found in cultivated fields, roadsides, marshes, sandbars, riverbanks, and waste places. Confirmed resistance to triazine and ALS inhibiting herbicides.
- **Eastern blacknightshade** (*Solanum ptycanthum*) (**black nightshade**) is a native weed. Flowering season from May to October. Seeds are the only source of reproduction. Found in roadsides, open woodland, stream banks, gardens row crops, and waste places.
- **Smartweed** (*Polygonum pensylvanicum* L.) (**Pennsylvania knotweed, lakeweed, pinweed**) is a native weed. Flowering season from July to October. Seeds are the only source of reproduction. Found in wet soils or sometimes flooded soil of roadsides, ditches, cultivated ground, waste ground, waste places, and pond banks.
- **Horseweed** (*Conyza canadensis* L.) (**marestail, horseweed fleabane**) is a native weed. Flowering season from June to September. Seeds are the only source of reproduction. Found on rangeland, open cultivated fields, gardens, waste ground, and disturbed sites.
- **Prickly sida** (*Sida spinosa*) (**teaweed, Indian and false mallow**). Flowering season from July to September. Seeds are the only source of reproduction. Abundant throughout the southeast to Texas into Kansas and Missouri.
- **Ivyleaf morningglory** (*Ipomoea hederacea*) is a native weed. **Tall morningglory** (*Ipomoea purpurea*) native of tropical America. Flowering seasons from June-October. Seeds are the only source of reproduction. Found on gardens, waste places, and in corn and soybean fields.

3. Common perennial weeds:

- **Johnsongrass** (*Sorghum halepense* L.) is a perennial grass originated from the Mediterranean region. Flourish in warm conditions. Rhizomes and seeds are the source of reproduction. Found in moist soil of waste places, cultivated fields, pastures, and roadsides.
- **Field bindweed** (*Convolvulus arvensis* L.) (**creeping Jenny**) is a native of Eurasia. Flowering season from June to September. Seeds, spreading roots and rhizomes are the source of reproduction. Found on both cultivated and uncultivated land. It is most common in small grain and summer crop fields, in waste places, gardens, and roadsides.
- **Common milkweed** (*Asclepias syriaca* L.) is a native weed. Flowering season from May-August. Rhizomes and seeds are the source of reproduction. Found in cultivated fields, floodplains, pastures roadsides, and waste places.
- **Honeyvine milkweed** (*Cynanchum laeve*) (**sandvine, climbing milkweed**) is a native weed. Flowering season from June-September. Rhizomes and seeds are the source of reproduction. Found in cultivated fields, gardens, and fence rows.
- **Yellow nutsedge** (*Cyperus esculentus*) (**yellow nutgrass**) native of Eurasia. Flowering season from July-August. Rhizomes and seeds are the source of reproduction. Found in cultivated fields, gardens, and roadsides.

Chemical treatment:

Herbicides are available for early preplant, preplant incorporated, preemergence, or postemergence application to soybeans.

In 1997, ninety-four percent of soybean acres were treated with some type of herbicide. About 2.9 million pounds of herbicides were applied to Kansas soybean fields. Broadcasting without incorporation after seeding was the most common method of application. Sixty-five percent of soybean producers applied herbicide to their soybean fields after planting. Pendimethalin was the most frequently used herbicide, applied to thirty-five percent of Kansas soybean fields. The average application rate was 0.88 lb. a.i./A per application.

The following are data from the Kansas Agricultural Chemical usage, 1997 Soybean Pesticide Summary publication in response to survey provided by the Kansas agricultural Statistics (KAS) and the National Agricultural Statistics Service (NASS) to Kansas producers. Herbicides are classified according to the primary mode of action:

Photosynthesis (D-1 quinone-binding protein) inhibitor:

Metribuzin

- **Trade name and formulation:** Sencor®75DF, Lexone®.
- **Average use rate per application:** 0.4 lb a.i./A.
- **Number of application:** 1.0.
- **Percent acres treated:** 22%.
- **Amount applied per year:** 214,000 lb.
- **Application time:** at planting or preemergence.
- **Target plants:** annual grasses and small-seeded broadleaf weeds.
- **Component of other products:** Axiom®, Canopy®75DF, Turbo.
- **Comments:** use of this product is influenced by soil texture, organic matter, or the pH.

Bentazon

- **Trade name and formulation:** Basagran®.
- **Average use rate per application:** 0.69 lb a.i./A.
- **Number of application:** 1.0.
- **Percent acres treated:** 14%.
- **Amount applied per year:** 230,000 lb.
- **Application time:** postemergence when weeds are small and actively growing but before they reach size limits on label.
- **Target plants:** broadleaf weeds such as cocklebur and velvetleaf.
- **Component of other products:** Result® B, Galaxy®, Storm®, Conclude B&G®.

Cell membrane disrupters (inhibit protoporphyrinogen oxidase):

Lactofen

- **Trade name and formulation:** Cobra®.
- **Average use rate per application:** 0.1 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent acres treated:** 3%.
- **Amount applied per year:** 8,000 Ib.
- **Application time:** postemergence 2 to 3 weeks after planting or when weeds are small and actively growing.
- **Target plants:** broadleaf weeds.
- **Component of other products:** Stellar®.
- **Comments:** no grazing or feeding is allowed.

Acifluorfen

- **Trade name and formulation:** Blazer®, Status®.
- **Average use rate per application:** 0.17 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent acres treated:** 17%.
- **Amount applied per year:** 72,000 Ib.
- **Application time:** postemergence when seedling weeds are in the 4- to 6- leaf stage and growing actively.
- **Target plants:** broadleaf weeds such as pigweed, prickly sida, and morningglory.
- **Component of other products:** Conclude® B & G, Storm®, Galaxy®.

Flumiclorac pentyl

- **Trade name and formulation:** Resource®.
- **Average use rate per application:** 0.02 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent acres treated:** 2%.
- **Amount applied per year:** 1,000 Ib.
- **Application time:** postemergence when weeds are small and actively growing.
- **Target plants:** velvetleaf and certain other broadleaf weeds.
- **Component of other products:** Stellar®.

Amino acid Synthesis (ALS synthase enzyme) inhibitor:

Imazethapyr

- **Trade name and formulation:** Pursuit® DG.
- **Average use rate per application:** 0.05 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent acres treated:** 15%.
- **Amount applied per year:** 18,000 Ib.
- **Application time:** preplant, 45 days before planting; preemergence within 7 days of planting with enough rainfall; postemergence to small and actively growing weeds and before they exceed a height of 3 inches.
- **Target plants:** annual grasses and broadleaf weeds.
- **Component of other products:** Pursuit Plus®, Steel®.

Imazaquin

- **Trade name and formulation:** Scepter® DG.
- **Average use rate per application:** 0.1 Ib a.i./A.
- **Number of application:** 1.1.
- **Percent acres treated:** 29%.
- **Amount applied per year:** 71,000 Ib.
- **Application time:** preplant 45 days before planting; preemergence within 7 days of planting with enough rainfall; postemergence.
- **Target plants:** annual weeds.
- **Component of other products:** Detail®, Squadron®, Tri-Scept®, Steel®.

Chlorimuron-ethyl

- **Trade name and formulation:** Classic®.
- **Average use rate per application:** 0.02 Ib a.i./A.
- **Number of application:** 1.2.
- **Percent acres treated:** 12%.
- **Amount applied per year:** 6,000 Ib.
- **Application time:** at any time after the first trifoliolate has opened but no later than 60 days before soybean maturity; when weeds are small and actively growing.
- **Target plants:** many annual, broadleaf weeds.
- **Component of other products:** Synchrony STS®, Canopy®, Canopy®XL.

Seedling shoot inhibitors:

Metolachlor

- **Trade name and formulation:** Dual®, Dual II Magnum®.
- **Average use rate per application:** 1.52 Ib a.i./A.
- **Number of application:** 1.0.

- **Percent acres treated:** 8%.
- **Amount applied per year:** 288,000 Ib.
- **Application time:** preplant in minimum tillage system up to 30 days before planting; preplant incorporated into top 2 inches of soil; preemergence after planting but before soybean emerge.
- **Target plants:** annual grasses and small-seeded broadleaf weeds.
- **Component of other products:** Turbo®.
- **Comments:** to avoid spray drift, this product is not applied under windy conditions.

Alachlor (Lasso) was used on soybean, however there were insufficient reports to publish.

Seedling root (tubulin protein) inhibitor:

Trifluralin

- **Trade name and formulation:** Treflan®, Tri-4®.
- **Average use rate per application:** 0.87 Ib a.i./A.
- **Number of application:** 1.1.
- **Percent acres treated:** 26%.
- **Amount applied per year:** 588,000 Ib.
- **Application time:** preplant up to 45 days before planting and incorporate in top 2 inches of soil; preemergence.
- **Target plants:** annual grasses and small seeded broadleaf weeds.
- **Component of other products:** Tri-Scept®, Freedom®, Commence®.

Pendimethalin

- **Trade name and formulation:** Prowl® 3.3 EC, Pentagon®.
- **Average use rate per application:** 0.88 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent acres treated:** 35%.
- **Amount applied per year:** 744,000 Ib.
- **Application time:** preplant up to 60 days before planting; preplant and incorporated in top 2 inches of soil; preemergence with enough rainfall to wet the soil to a depth of 2 inches within 7 days of planting.
- **Target plants:** annual grasses and small seeded broadleaf weeds.
- **Component of other products:** Squadron®, Pursuit Plus®, Steel®.

Growth regulators:

2,4-D

- **Trade name and formulation:** available in several formulations or brand names.

- **Average use rate per application:** 0.32 Ib a.i./A.
- **Number of application:** 1.0.
- **Percent of acres treated:** 7%.
- **Amount applied per year:** 52,000 Ib.
- **Application time:** preplant (burndown) 7-30 days before planting depending on the rate of application.
- **Target plants:** annual and perennial broadleaf weeds.

2,4-DB

- **Trade name and formulation:** Butyrac 200+.
- **Recommended rate per application:** 0.03 Ib a.i./A.
- **Number of application:** not available.
- **Percent acres treated:** not available.
- **Amount applied per year:** not available.
- **Application time:** postemergence.
- **Target plants:** applied as tank mix with Basagran, Blazer, Classic, Cobra, Pinnacle, Pursuit, Synchrony STS, or Scepter to control morningglories, cocklebur, and other broadleaf weeds.

Amino acid synthesis (EPSP synthase enzyme) inhibitor:

Glyphosate

- **Trade name and formulation:** Roundup™, Roundup Ultra™.
- **Average use rate per application:** 0.61 Ib a.i./A.
- **Number of application:** 1.4.
- **Percent acres treated:** 22%.
- **Amount applied per year:** 466,000 Ib.
- **Application time:** preplant burndown; postemergence only to Roundup-Ready soybeans; spot treatments (direct postemergence) to control shattercane and rhizome johnsongrass; preharvest.
- **Target plants:** most annual and perennial weeds.
- **Component of other products:** Bronco®.
- **Comments:** not applied directly to water or to areas where water is present.

® Registered name

*Restricted-Use Pesticide (PUP)

™ Trade name

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