

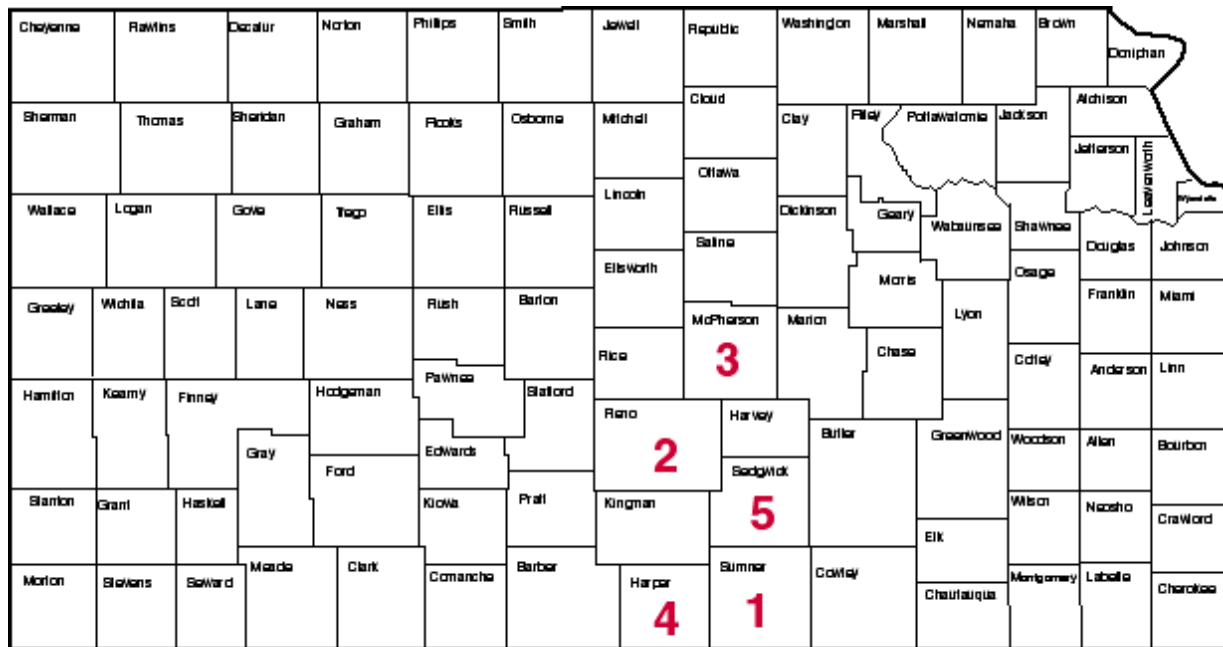
Crop Profile for Wheat in Kansas

General Production Information



- Kansas is number one in wheat production in the United States. In 1997, the crop cash value was estimated at \$1.6 billion.
- The 1997 and 1998 Kansas production was the largest single-state harvested in U.S. history. Kansas also leads the country in wheat plantings. In 1999, 10 million acres were planted in Kansas, or 15.9% of U.S. total wheat plantings. For 1998, it was 16.2% of U.S. total wheat production or 10.7 million of the U.S. 65.871 million acres.
- Kansas Agricultural Statistics estimate of 1998 wheat production was 494.9 million bushels. The top 5 wheat production counties in central and south central regions include Sumner, Reno, Sedgwick, McPherson, and Harper, they accounted for 12% of the total wheat production in the state (Fig. 1).
- In 1998, the statewide yield average was 49 bushels per acre, a new record, up 3 bushels from the 1997 record average yield per acre.

Figure 1. Top five Kansas counties wheat production in 1998.



1. 15.7 million bu.
2. 11.7 million bu.
3. 11.1 million bu.
4. 10.8 million bu.
5. 10.3 million bu.

Types of wheat produced in Kansas:

- Hard red winter (98%), the largest class of wheat produced and exported in Kansas, accounts for 43.5% (average 1994-1998) of U.S. hard red winter wheat production and 33.6% (average 1994-1998) of U.S. exports.

- Soft red winter wheat accounts for less than 1% of Kansas production.
- Hard white winter wheat accounts for less than 1% of Kansas production.

U.S. market:

- Hard red winter wheat is the favorite for American wheat buyer.
- The domestic market is the biggest market for Kansas wheat.
- Kansas mills produce more flour than any other state. In 1996, 37.6 million hundred weight of flour was milled.
- Americans consume 54% of the hard red winter wheat crop.
- Kansas stores 10% of U.S. grain storage through its 834 million bushel storage capacity (21% for wheat storage).

Figure 2. Production Regions

AGRICULTURAL STATISTICS DISTRICTS

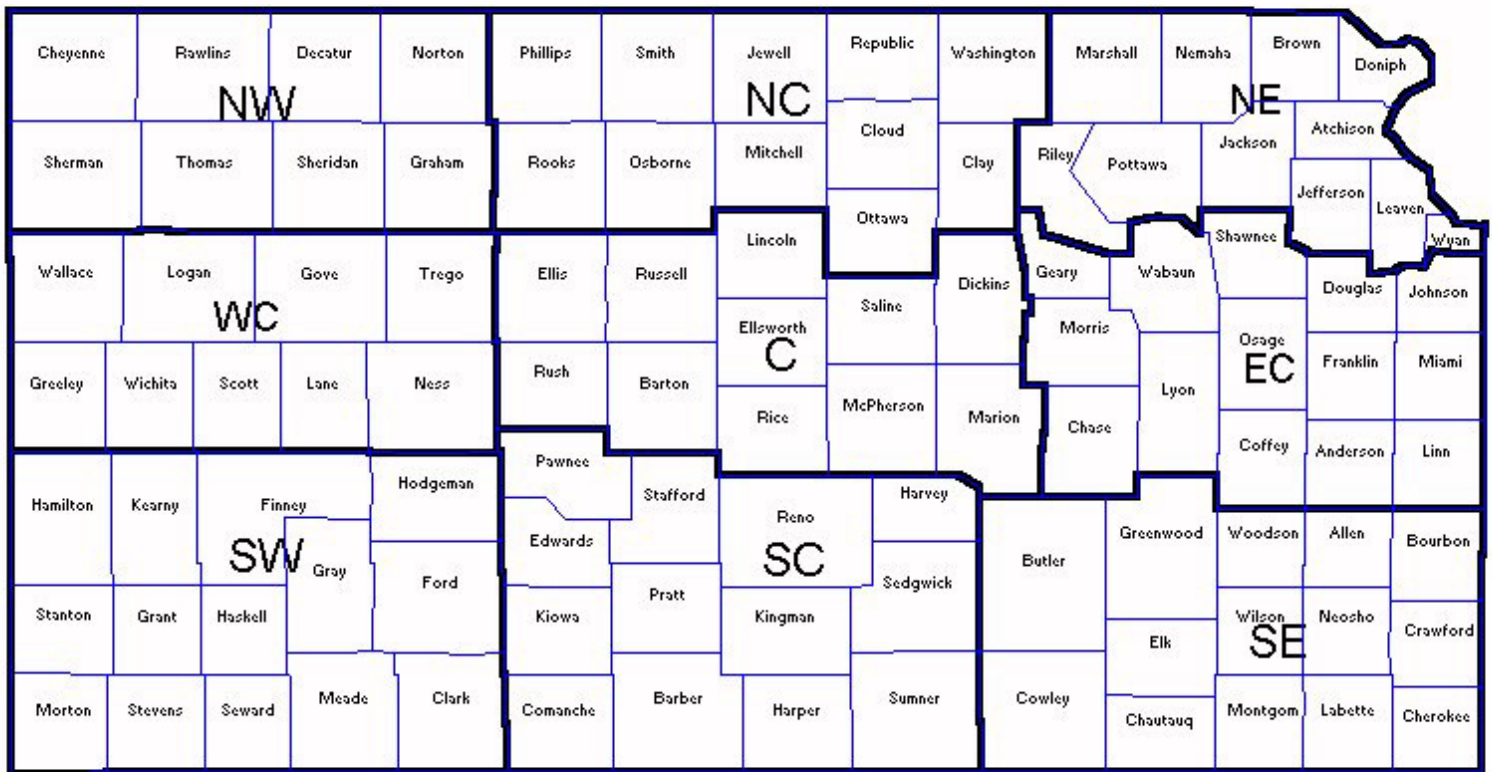
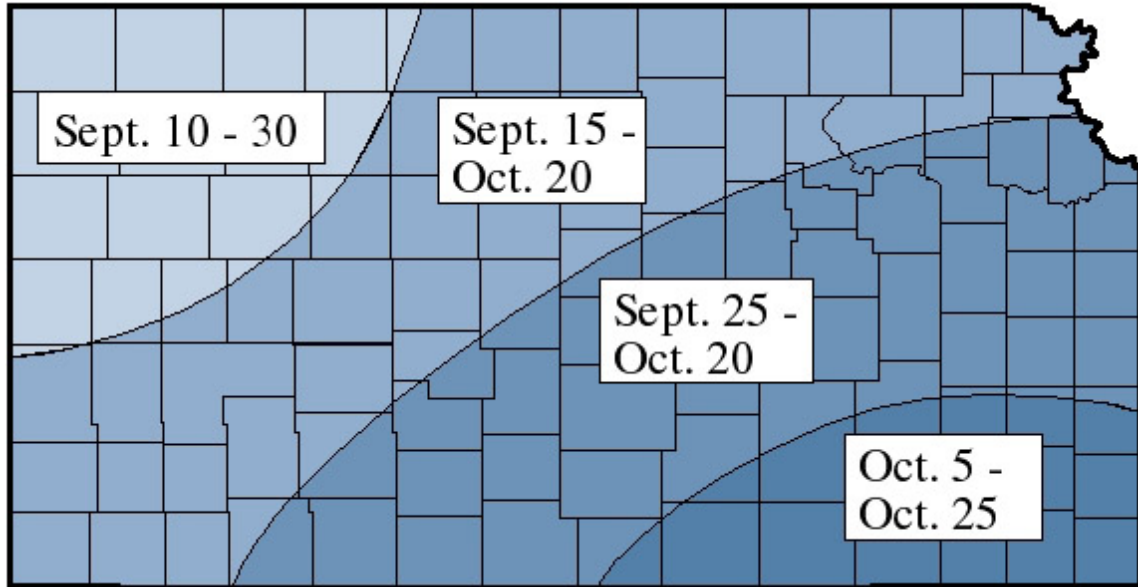


Figure 2 shows the nine production regions for Kansas. Soil types vary within a district. In general, northwestern and most of the west is deep, dark gray-brown silt loams, except the southwest counties, which consist of silt and sandy loams, and brown loamy fine sands. A moderately deep, dark gray-brown 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.

Cultural Practices

Hard red winter wheat class is adapted to Kansas temperatures, can withstand both cold and hot weather. Winter wheat in Kansas not only can survive the freezing temperatures of winter, but it needs the cold temperatures to joint and flower so it can set grain in spring. Wheat is planted in early fall (mid-September through October) and harvested in the summer. Normally, Kansas starts harvesting wheat in mid June and continues through early July.

Figure 3. Optimum planting dates of wheat in Kansas.



Optimum seeding dates vary across Kansas due to different environmental conditions. Figure 3 shows Kansas divided into four different zones with varying seeding dates.

Seeding rates as planting dates vary across the state due to lower rainfall and irrigation systems in western Kansas and high rainfall in the eastern region of Kansas. Optimum seeding rates in western Kansas range from 600,000 to 900,000 seeds per acre planted. In central Kansas, the rate ranges from 750,000 to 900,000 seeds per acre. About 900,000-1,125,000 seeds per acre are planted in eastern part of the state. With irrigation, seeding rates may range from 900,000 to 1,350,000 seeds per acre.

Seedbed preparation varies across the state depending on residue of the preceding crop and the need for moisture conservation. The amount of tillage in Kansas has been reduced during the past decade. Plowing is practiced on a limited basis in the continuous wheat areas of south central Kansas where residue management is difficult. Most farmers use 1 to 2 disking or a chisel operation to incorporate residues followed by another disking or field cultivator as planting time approaches. In this cropping system, resistant wheat varieties to foliar diseases are planted to tolerate tan spot and Septoria leaf blotch. On the heavier, sloping soils of eastern Kansas, soil erosion by water is a major concern. Terraces, waterways, and crop residue management are required on many highly erodible acres. Where crop rotations are used, the low crop residue after harvest is left until late summer when 1 or 2 disking or field cultivations are used before wheat seeding. Many farmers have saved time and moisture by planting no-till wheat, double-cropping after row crop harvest.

In western Kansas where moisture conservation is the most important goal, the wheat-fallow system has been dominant. In this system, a wheat crop is produced every 2 years. But, the wheat, row crop, fallow rotation is gaining acreage and interest. In this system, two crops are grown in three years. Soil moisture is replenished by using conservation tillage methods so that a summer crop (corn, grain sorghum, sunflower, or millet) can be planted to utilize the stored moisture.

After wheat harvest in the summer, triazine herbicides are used to replace several tillage operations to control summer weed growth. To maximize moisture savings, wheat residue is left undisturbed until the summer crop is planted no-till into stubble. After the summer crop harvest, the residue is left untouched until the following fall for wheat seeding on no-till or for the spring to plant another summer crop if there is enough moisture in the soil profile.

Insect Pests

In 1998, insect damage in Kansas wheat was not reported sufficiently to publish any data. A discussion of the important pests and recommended insecticides for the state's wheat fields follows:

Seed-Attacking Insects:

False Wireworms (*Blapstinus substriatus*) are found usually in the western two-thirds of the state from prior to planting until after crop emergence. Worms are cylindrical and yellow brown in color. Larvae attack and destroy the seeds before germination. Unusual number of dark colored, long-legged beetles run over the ground and hide under weeds during the summer. Damage may be worse in dry soils. Seed treatment is used if worms are detected prior to planting in a dry seedbed. An average of one worm per 3 square foot of row may be of economic concern and justify treatment during dry periods.

Chemical treatments:

- Either Lindane in a formulation or Gaucho is used to treat the seeds before planting. The latter is applied at 1.0-3.0 fl oz/100 lb seed. Grazing or feeding livestock in treated areas is not allowed for both treatments.

Above-Ground and Other Below-Ground Insects:

Army Cutworm (*Euxoa auxiliaris*) is found during warm winter days and early spring, commonly in western half of Kansas during dry years. Adult moths lay eggs just beneath the soil surface where they hatch into brownish, faintly striped worms during late fall and early winter. Initial damage to the growing point of wheat is during the fall or the winter. Larvae feed on the young spring growth first by eating holes in the leaves, later by eating entire leaves, and finally only the older leaves are left untouched. Infested plants look dead due to loss of leaves, but the crowns and roots are usually undamaged, and capable of recovery if the feeding period is not long. Fields should be inspected frequently during warm periods in February, March and early April, particularly after a dry fall. Treatment is recommended when an average of four to five half-grown worms per foot is present, if vegetative growth is lost.

Chemical treatments:

- Warrior® * T @ 0.015 to 0.025 lb a.i./A. Applied when four to five per foot of row of wheat with thin little top growth or one or two worms per square foot are found in very late-planted fields. Applied by ground or air. Not applied within 30 days of harvest. No more than 0.06 lb actual per acre per season is allowed.

Armyworm and/or Wheathead Armyworm damage in Kansas is usually more common in the southern and eastern areas during warm, moist periods from April to early June. Armyworms feed on lush stands of wheat, especially in places where lodging is present. Larvae feed mostly at night. The worms vary from green to black, marked with stripes of various colors. Treatment is recommended at infestations of 5-8 per foot. Wheat is likely to suffer loss in yield if the flag leaf is destroyed before the soft dough stage is completed. The wheathead armyworm is a green tapered worm, sometimes found feeding on wheat heads, usually in conjunction with armyworm infestations.

Chemical treatments:

- Methyl Parathion* @ ¾ lb a.i./A. Not used within 15 days of harvest at rates over ¼ lb a.i./A.
- Lannate® * @ 0.225-0.45 lb a.i./A. Harvesting within 7 days or grazing or feeding treated forage or hay to livestock within 10 days of last application is not allowed.

- Sevin® * @ 1- 1 ½ Ib a.i./A. More than 2 applications are not allowed after grain heads emerge from boot. Not applied within 21 days of grain harvest.
- Warrior® * T @ 0.02-0.03 Ib a.i./A. Applied by ground or air. Not applied within 30 days of harvest.

Banks Grass Mite (*Oligosyshus pratensis*) damage occurs in the fall or early spring. Found in the extreme western portion of the state in field margins bordering volunteer wheat or sorghum fields. Leaves are finely mottled and some webbing along with very small transparent mites are found on the undersides of leaves. Mites often enter in the fall from nearby corn, milo or stubble fields.

Chemical treatments:

- Parathion* @ ¾ -1 Ib a.i./A. Not applied within 15 days of harvest. Applied when winds are not more than 10 mph. Not applied within 100 feet of adjacent property. Plants are treated by aerial application only.
- Di-Syston® * 8 @ ½ - ¾ Ib a.i./A. Grazing or feeding treated forage is not allowed. Not applied within 30 days of harvest.

Bird Cherry Oat Aphid found statewide, but fall infestations are more common in southern region. Aphids are dark olive–green with a reddish brown area on the back of the abdomen. They are found in the fall, but sometimes in the spring. Generally, plants look normal except for sticky leaves. They usually cause no apparent injury, but populations of 50 or more per tiller in the boot to heading stage may be damaging. This aphid is a vector of barley yellow dwarf virus. Conventional sprays are generally ineffective in reducing incidence of the virus.

Chemical treatments:

- Gaucho seed treatment @ 1.0 oz/100 cwt provides early season protection.

Brown Wheat Mite (*perobia latens*) mostly found in the western third of the state during warm days from January to April. They are small, dark brown, oval shaped with the front pair of legs longer than the others. They are active in late fall and early spring. Infestations peak around mid April as females lay eggs during the summer in the soil and on plant residue. More are found in the continuous wheat fields or where volunteer was present during the previous spring. It feeds on the tips of the leaves causing them to dry out and die. Field infested with mites appears bronze or brownish. Infested leaves are finely mottled and mites drop off when plants are disturbed. Treatment is recommended if mite populations average several hundred per foot of row during February or March. Mites decline naturally by April.

Chemical treatments:

- Methyl Parathion* @ ½ Ib a.i./A. Not used within 15 days of harvest at rates over ¼ Ib a.i./A.
- Dimethoate @ 1/3 Ib a.i./A. Grazing immature plants within 14 days of application or harvesting for grain within 60 days of last application is not allowed.
- Di-Syston® * 8 @ ½ - ¾ Ib a.i./A. Grazing treated forage or harvesting within 30 days is not allowed.

English Grain Aphids are bright green cornicles and legs back. Infestation occurs in fall and March through June. Aphids feed on leaves in the fall, colonies are found in the heads in the spring. Causes no evident injury, thus chemical treatment is rarely applied.

Fall Armyworm (*Spodoptera frugiperda*) attacks in the fall, thus early-planted fields should be inspected regularly during the first couple of weeks of emergence. Infestation appears in Kansas during July, and begins to develop on corn, sorghum and other summer crops. The amount of food consumption is related to the age and the size of the larvae. Chewing of the

leaves begins as small "window-pane" scars on the seedling leaf surface. The very small larvae at this time hide in or around the base of the seedling. As larvae get larger, they destroy the entire leaves. Control should be applied if this begins to occur at a magnitude sufficient to threaten the entire stand. Later, where abundant, the larvae may destroy entire stand of wheat.

Chemical treatments:

- Lannate® * @ 0.45 Ib a.i./A. Applied at 5-7 day intervals as needed. Harvesting within 7 days or grazing or feeding treated forage or hay to livestock within 10 days of last applications is not allowed.
- Methyl Parathion* @ ¾ Ib a.i./A. Has very short residual action and possibly should not be considered except where larvae are small and actively feeding. Not used within 15 days of harvest at rate over ¼ Ib.
- Warrior® * T @ 0.02-0.03 Ib a.i./A. Applied by air or ground in sufficient gallonage to obtain full coverage of target location. Not applied within 30 days of harvest.

Flea Beetle occurs statewide, but more common in the western areas in September and October. These tiny, shiny, jumping beetles strip off the upper surface of the leaves. Damage occurs in the fall when plants emerge. The beetle eats leaf surface in long, narrow streaks. Infestation often limited to field borders next to corn or sorghum but can occur throughout the field as well. Three to five beetles per square foot of row may kill seedling plants and require treatments. Flea beetles are easy to control, however most of the current registered insecticides are not labeled for flea beetle control on wheat. The use of insecticides for armyworms and grasshoppers on wheat may reduce flea beetles.

Chemical treatments:

- Warrior® * T @ 0.02-0.03 Ib a.i./A. Applied by air or ground. Not applied within 30 days of harvest. More than 0.06 Ib actual per acre per season is not applied.

Grasshopper damage occurs more in the fall in western Kansas on newly emerged wheat plants. Chewing damage to the marginal field plants signal the presence of grasshoppers in the area. Seven to twelve grasshoppers per square yard of the crop feeding species signal the need for treatment. Three or five grasshoppers per square yard could destroy seedling wheat.

Chemical treatments:

- Malathion* @ 1-1.25 Ib a.i./A. Applied 7-days waiting interval for grazing or harvesting.
- Methyl Parathion* @ ½ Ib a.i./A. Not used within 15 days of harvest at rate over ¼ Ib a.i./A.
- Thimet® * 20G @ 1.2 oz of 20G per 1,000 feet of row. Granules are applied in the seed furrow at planting time. Applied as a border treatment for 30 to 40 feet around the outside margins of the field. No grazing foliage within 45 days of treatment is allowed.
- Sevin® * @ 1 ½ Ib a.i./A. No more than 2 applications are allowed after grain heads emerge from boot. Not applied within 21 days for grain harvest. There is no time limitation on use as pasture.
- Dimethoate® * @ ½ Ib a.i./A. Not applied within 14 days of grazing or 60 days of grain harvest.
- PennCap-M® * @ ½ Ib a.i./A. Not applied within 15 days of harvest.
- Asana® * XL @ 0.015-0.03 Ib a.i./A. **This is Not Applied to Wheat.** It is used for non-crop use on land adjacent to tilled area to control migrating insects. No feeding of treated crop is allowed. Ditch banks or areas adjacent to water are not sprayed.
- Lorsban® * 4E-SG @ ¼ to ½ Ib a.i./A. Applied by ground or air. Not applied closer than 28 days before harvest. No grazing or feeding within 14 days of application is allowed
- Warrior® * T @ 0.02-0.03 Ib a.i./A. Applied by air or ground. Not applied within 30 days of harvest.

Greenbug damage may occur in the fall or in the spring. Found statewide, but infestations in wheat are more likely to occur in southern Kansas. Greenbugs usually prefer to feed on the underside of the lower leaves. Off-color yellowish or reddish spots within a field signal signs of infestation. Infestations beneath the surface of loess soils are not uncommon. Later, as greenbugs increase, affected leaves turn yellow and then brown and gradually die. Infestation is serious when greenbugs average about 50 per foot of row on 3-6 inch plants. Fall treatment is advised unless unusually high degree of beneficial insects is present. Greenbugs usually decline naturally during December and January. Overwintering

infestations can develop rapidly during warm periods in February and March.

Chemical treatments:

- Lorsban® * 4E-SG @ ¼ to ½ lb a.i./A. Grazing or feeding treated forage to livestock within 14 days of application or treatment 28 days before harvest is not allowed.
- Methyl Parathion* @ ½ to ¾ lb a.i./A. Not used within 15 days of harvest at rates over ¼ lb a.i./A.
- Di-Syston® * 8 @ ½ lb a.i./A. No grazing treated forage is allowed. A second application may be needed within 30 days. Not applied within 30 days of harvest.
- Dimethoate (may not give control in Kansas) @ 1/3 lb a.i./A. Not applied within 14 days of grazing or 60 days of grain harvest. Some Dimethoate 400 labels specify a 35 day harvest interval.
- Malathion* @ 1-1 ¼ lb a.i./A. Seven days waiting interval for grazing or harvest is allowed.
- Gaucho @ 1.0-3.0 fl oz per 100 lb seed. A seed treatment insecticide that offers early season protection is applied in southern Kansas where resistance to conventional insecticides limits other options. No grazing or feeding livestock in treated areas for 45 days is allowed.

Other treatments:

- TAM 110 is the first variety to carry resistance to the greenbug biotypes prevalent in Kansas. It carries a good level of resistance against the current biotypes E, I and K
- Unusual early or late wheat planting increases the risk of greenbug damage
- Increased amounts of residue on the soil surface can lower the risk of infestation
- Natural beneficial insects such as lady beetles or others are beneficial to prevent greenbugs from becoming established.

Hessian Fly occurs statewide but mostly in the eastern Kansas. Injury is more serious during wet years which occur in the fall as well as in the spring. Prevention, using good management and community cooperation, is better than later control of infested areas. Fall injury consists of stunted tillers often with an unusually large broad green leaf. Symptoms extend from mid-October into early-November.

Chemical treatment:

- Gaucho @ 1.0-3.0 fl oz per 100 lb seed. A seed treatment insecticide that offers control for early season protection, and may have application in fly prone areas when planting susceptible varieties prior to fly-free date. However, the risk of infestation is usually difficult to predict, and use may not prove to be cost effective.

Other treatments:

Good management practices:

- Plant resistant varieties especially when planting very early or very late
- Bury the stubble following harvest where erosion control practices allowed
- Control volunteer wheat
- Plant after the fly-free date.

Pale Western Cutworm (*Agrotis orthogonia*) damage occurs in April and May. Limited to the western third of Kansas in the dry weather. Pale to whitish worms feed underground and is usually found just above the moisture line. It destroys roots, the plants lose vigor and die. Two to three worms per square foot are considered damaging.

Chemical treatment:

- Warrior® * T @ 0.015-0.025 lb a.i./A. Applied by ground or air. Not applied within 30 days of harvest. No more than 0.06 lb a.i./A per season is allowed.

Russian Wheat Aphid (*Diuraphis noxia*) is a new pest to the U.S. It is small, lime-green colored aphid, with an elongated, spindle-shaped body. The aphids are found mainly on the newest growth of wheat plant within rolled up leaves. Commonly found in the western third of Kansas close to Colorado border in early spring. This aphid can feed on wheat from the time it emerges until it mature and poses a severe threat to wheat. Small grains such as wheat, barley, and triticale are the host plants. Native and introduced grasses as well serve as host plants for Russian aphid in the summer when small grains are not available. This aphid not only withdraws plant sap, but also injects a toxic substance, injuring and stunting host plants. Signs of damage include rolled leaves and leaves with whitish, pink or purple streaks. Infestations often originate close to infested volunteer. Heavily infested plants exhibit a flattened appearance, with young tillers lying almost parallel to the ground. This insect should be controlled as soon as it becomes established. The sooner it appears, the greater the risk to the crop, but high numbers developing late in the season may also be of major significance. A September or early October infestation would be of greater concern than one that begins closer to the onset of cold weather. Major problems have been infestations from jointing to heading. Treatment is considered when 10 to 20% of the tillers shows signs of infestation where the yield potential is at least 20 bushels per acre. Loss would be less where infestations are limited to late developing secondary tillers.

Chemical treatments:

- Di-Systone® * 8 @ ¾ Ib a.i./A. Not applied within 30 days of harvest. No grazing is permitted.
- Dimethoate @ 1/3 Ib a.i./A. Not applied within 14 days of grazing or 60 days of grain harvest. Some Dimethoate 400 labels specify a 35 days harvest interval.
- Lorsban® * 4E-SG @ ¼ - ½ Ib a.i./A. Applied by air or ground. Not applied closer than 28 days before harvest. No grazing or feeding treated forage within 14 days is allowed.
- Methyl Parathion* @ ½ - ¾ Ib a.i./A. Not used within 15 days of harvest at rates over ¼ Ib a.i./A
- Gaucho @ 1.0-3.0 fl oz per 100 Ib seed. A seed treatment insecticide that offers early season protection. No grazing or feeding livestock in treated areas for 45 days after planting is allowed.

Other treatment:

- Resistant variety such as Halt, from Colorado, contains resistance to Russian wheat aphid. This may be of interest to growers in counties that border Colorado, where Russian Wheat aphid occurs more often.

Wheat Curl Mite (*Eriophyes tulipae*) adult is tiny, cigar-shaped, whitish mite carries and spreads the virus that causes wheat streak mosaic and the High Plains Virus, a disease of wheat and corn in the Great Plains. Eggs are placed in rows along leaf veins. It feeds on the upper surface of leaves and is found in the vicinity of leaf axils. Where abundant, their feeding prevents leaves from unrolling normally, or commonly known as "rolled leaves". Chemical control has not been effective.

Other treatments:

- Cultural practices such as controlling volunteer wheat at least 2 weeks prior to planting winter wheat in the fall and delaying planting until after the fly-free date are the most effective management practices for this mite and the disease that it vectors.
- Planting resistance varieties such as TAM 107 and TAM 200 have had effective resistance to the mite. However, there is now evidence that the mite is beginning to defeat this source of resistance.

Wheat Stem Maggot (*Meromyza americana*) damage that might occur in May through June rarely exceed 1 to 2 percent. The larvae over winter and stay in the lower parts of the stems of cereal crops such as wheat, rye, barley, and oats; other hosts include bluegrass, millet, and timothy. Adults lay eggs on the leaves near the stem where they hatch into green-colored maggots that feed inside the stem of the upper most joint of the host plant. Damage is indicated by dying out and whitening of the head and upper stem above the green flag leaf when field is still green. No chemical pesticide is labeled for this pest.

Other treatments:

- Delay planting until after fly-free date
- Control volunteer plants.

Winter Grain Mite (*Penthaleus major*) is confined to the south central areas of Kansas. Found during the fall in the continuous wheat. It is a very small, brown to dark brown pest, and has reddish-orange colored legs. Its front legs are longer than the others. On a sunny day, they are found around the bases of the plants, on the surface of the soil, or hiding under clods just beneath the crust. Feeding occurs mostly at night. Damaged leaves reflect a silverish cast. The tips of some leaves may become brown, and plants may become stunted. Treatment is necessary on stunted, poorly tillered wheat, and if 6 to 10 mites per plant are found.

Chemical treatments:

- Methyl Parathion* @ ½ - ¾ lb a.i./A. Not used within 15 days of harvest at rates over ¼ lb a.i./A
- Di-Syston 8* @ ½ - ¾ lb a.i./A. No grazing treated forage is allowed. Not applied within 30 days of harvest. Not used for forage use.
- Dimethoate @ 1/3 lb a.i./A. Not applied within 14 days of grazing or 60 days of grain harvest. The Dimethoate 400 label specifies a 35 day harvest interval.
- Lorsban® * 4E-SG @ ½ lb a.i./A. Grazing or feeding within 14 days or harvesting within 28 days of application is not allowed.

White Grub damage occurs in fall and spring. Occur statewide but confined sometimes in western areas of the state. Grubs in the soil feed on the roots or cut off plants above roots. Severe feeding prunes roots of stressed or dying plants. To prevent damage from grubs, delay planting where 4-5 grubs per square foot in the upper 6 inches soil surface are found in early fall. No insecticides are labeled for this pest.

®Registered name

™Trade name

*Restricted-use pesticide

Diseases

Diseases reduce yield and the grain test weight. Some diseases, such as ergot and scab, contaminate the grain with mycotoxins. Kansas wheat is subject to more than 30 different diseases. A cumulative disease loss of 9.6 percent was estimated for the 1999 Kansas wheat crop. This estimate was greater than recent losses but lower than the 10 year average of 11.8 percent. Following are the main components of an integrated disease management program used in Kansas wheat fields.

Integrated Disease Management Programs Followed in Kansas:

1. **Scouting** is important for monitoring crop development and identifying problems in the early stages before they become severe. Correct diagnosis is crucial because control practices are different for the different diseases.
2. **Planting Resistant Varieties** are the most effective, economical, and environmentally friendly method of disease control. Planting several different varieties with different strengths and weaknesses and planting early maturing varieties are good disease management practices.
3. **Crop Rotation** is the best management practice because it reduces the carryover of diseases, insects, and weeds between crops. Wheat is not recommended to be planted after barley or brome or into heavy corn residue.

4. **Crop Residue Destruction** can reduce the risk of disease carryover following wheat, barley, brome, or corn crops. Residue destruction is not needed if wheat is planted into residue of soybeans, sorghum, alfalfa, rye, oats, sunflowers, or year-old wheat residue.
5. **Control of Volunteer Wheat** is necessary to break the life cycle of the pests. Volunteer wheat not only serves as a reservoir for many wheat diseases, it also harbors many vectors for wheat diseases. Volunteer wheat is controlled 2 weeks before wheat planting by either tillage or herbicides.
6. **Delaying Planting** after the Hessian fly-free date reduces the risk of many wheat diseases.
7. **Seed Treatments** are excellent for control of seedborne diseases, can reduce seed rot, and may increase stands when planting in poor conditions or using seed of poor vigor.
8. **Planting Certified Seed** reduces the risk of introducing a seed borne disease into the field.
9. **Foliar Fungicides** are used in the spring to control leaf rust, Septoria leaf and glume blotch, powdery mildew, and Stagonospora nodorum leaf blotch. However, the yield increase from fungicides is often not enough to pay for fungicide application. Therefore, treatments are mostly used in high yield potential fields or in seed production fields.
10. **Using Biocontrol** such as biological competition, predation, or antagonism to manage wheat diseases is currently limited.
11. **Balancing Fertility** such as correcting chloride deficiency, avoiding high nitrogen levels, and liming of acid soils in conjunction with crop rotation may reduce some wheat diseases.

Estimated wheat disease losses in Kansas were based on expert opinion, but were not statistically designed. Estimates utilized a disease survey, cultivar acreage, crop district yield estimates, and loss functions or estimates for each disease. The followings are the main wheat diseases in Kansas and the recommended management practices:

Soilborne Mosaic (SBM) virus can cause more than 50 percent losses in fields in the eastern half and central Kansas. Once the virus has infested the field, it is impossible to eradicate. High soil moisture during seedling emergence and cool weather in the spring favors the disease. Symptoms appear as yellow spots in low parts of the fields in early spring, then fade as the weather warms up. However, the plants may remain permanently stunted. The leaves show a mosaic of green spots on yellowish background. Estimated wheat loss in 1999 was 0.4 percent and 0.47 percent for 10 year period.

Management:

- Use resistant varieties in any field where SBM has ever appeared
- Avoid overhead irrigation during emergence of a susceptible wheat variety.

Wheat Spindle Streak Mosaic (WSSM) or Wheat Yellow Mosaic virus can cause light losses in eastern and central Kansas. It occurs with SBM because both viruses are carried by the same vector. High soil moisture during seedling emergence and cool weather in the spring favors the disease. Symptoms appear as yellow spots in low parts of the fields in early spring then fade as the weather warms up but the plants do not suffer stunting. Leaves show a mosaic of yellow spindle-shaped streaks on green background. Estimated wheat loss in 1998 was 0.1%.

Management:

- Use resistant varieties
- Avoid overhead irrigation during emergence of a susceptible wheat variety.

Wheat Streak Mosaic (WSM) virus can cause severe losses in western and central Kansas. Hail during harvest and a wet summer favors volunteer wheat, which harbors the virus. Yellow areas appear on the field edges adjacent to volunteer wheat during spring. Symptoms consist of leaves with a mosaic of long yellow streaks that are concentrated at the leaf tips and plants become stunted with prostrate tillers. Estimated wheat losses in 1999 was 1.5 percent and 1.02 percent for 10 year period.

Management:

- Plant resistant varieties away from volunteer wheat
- Control volunteer wheat within ½ mile of the field at least 2 weeks prior to planting

- Delay wheat planting after the Hessian fly-free date.

Barley Yellow Dwarf (BYD) virus can cause 30 percent losses in eastern and central Kansas. This virus is carried by aphids and occurs everywhere in Kansas. Early planting of wheat and high populations of aphid vectors in fall favor the disease. Symptoms consist of small or large patches of yellow plants noticed around the boot stage. Leaf tip turns yellow or purple, the midrib remains green, and plants become stunted. Estimated wheat loss in 1999 was 2.3 percent and for 10 year period was 1.45 percent.

Management:

- Although no varieties have high resistance to BYD, some varieties that are more tolerant than others should be planted
- Delay wheat planting until after the Hessian fly-free date
- Plant seeds treated with systemic insecticides.

Leaf Rust (*Puccinia triticina*) damage occurs in all parts of the state especially areas with high rainfall such as eastern and central Kansas. Leaf rust can reduce wheat yield by about 5 to 10 percent over wide areas. Symptoms consist of bright orange pustules containing dusty orange spores on the upper leaf surface. Estimated wheat loss in 1999 was 3.4 percent compared to 5.0 percent over 10 years.

Management:

- Plant resistant varieties
- Use foliar fungicides
- Plant seeds treated with fungicides
- Control volunteer wheat.

Stem Rust (*Puccinia graminis*) attacks leaves, stems, and heads of wheat but damage is usually negligible. However, in some years if the rust arrives early from the south, it can cause heavy losses on susceptible varieties. A warm wet spring favors the disease. Symptoms consist of dark reddish brown pustules on leaves and stems. Trace amount wheat loss in 1999 was estimated.

Management:

- Plant resistant varieties
- Plant early varieties that may escape damage from the disease
- Use foliar fungicides
- Control volunteer wheat.

Septoria Leaf Blotch or Speckled Leaf Blotch (*Septoria tritici*) is common in eastern and central Kansas. Symptoms consist of leaves with tan lesions and distinct black fungal structures. Estimated wheat loss in 1999 was 0.4 percent and 1.65 percent over the last 10 years.

Management:

- Use resistant varieties
- Plant seeds treated with fungicides
- Use foliar fungicides. In April 1999, Kansas Department of Agriculture established a State registration for Tilt ® to control Septoria leaf blotch, glume blotch, tan spot, and other foliar diseases through full head emergence stage of wheat.

Glume Blotch (*Septoria tritici* and *Stagonospora nodorum*) disease is caused by both the speckled leaf blotch and the *Stagonospora nodorum* leaf blotch pathogens. It may cause serious losses in some years. Rain after heading favors the disease. Symptoms consist of small brown to light tan spots on the glumes or awns, sometimes with black or light brown speckles.

Management:

- Use resistant varieties
- Use foliar fungicides
- Plant seeds treated with fungicides.

Tan Spot (*Pyrenophora tritici-repentis*) disease occurs commonly in central and eastern Kansas. Continuous, minimum tillage wheat and a wet spring favor this disease. Symptoms consist of tan lesions with a yellow border. Estimated wheat loss in 1999 was 1.4 percent and 1.5 percent for the last 10 years.

Management:

- Use resistant varieties
- Use foliar fungicides
- Destroy wheat crop residue
- Use crop rotation

Powdery Mildew (*Blumeria graminis*) is not a serious disease in Kansas. High nitrogen fertilizer, cool temperatures and high humidity favor the disease. Symptoms consist of small cottony white fungus on leaves, stems and heads. Trace amount wheat loss in 1999 was estimated.

Management:

- Use resistant varieties
- Use foliar fungicides
- Plant seeds treated with fungicides
- Avert over-fertilizing with nitrogen

High Plains Mosaic is a new disease that is thought to be caused by a virus. Although this disease and wheat streak mosaic are frequently found together, it seems to be less common and less important than wheat streak mosaic. Hail at harvest and wet summer favor the growth of volunteer wheat. Early planting of wheat or planting near volunteer wheat increases this disease. Also, warm fall temperatures favor the wheat curl mite vector. Symptoms are similar to wheat streak mosaic, but they tend to be spottier. Yellow areas in field appear in the spring especially near the edges adjacent to volunteer wheat.

Management:

- Control volunteer wheat
- Delay planting of wheat

American Wheat Striate Mosaic virus is carried by leafhoppers and tends to be randomly scattered through the field. It is a rare disease in Kansas. Symptoms consist of fine white yellow or brown striations on leaves with dark streaks on sheaths and glumes. No control practices are needed because most wheat varieties are highly resistant to this disease. Trace

amount wheat losses was estimated.

Bacterial Leaf Blight (*Pseudomonas syringae*) disease may cause severe losses on susceptible wheat varieties. Rain and high humidity at boot stage favor the disease. Symptoms consist of water-soaked spots and blotches on leaves that soon turn to white or gray and the whole leaf may die.

Management:

- Use highly resistant varieties

Bacterial Streak or Black Chaff (*Xanthomonas campestris*) losses are minor. Rain and high humidity favor the disease. Symptoms consist of water-soaked, long streaks on leaves that turn brown, and the lesions may sometimes be covered with yellow droplets of exudate. No control practices are needed.

Stripe Rust (*Puccinia striiformis*) disease is rare and losses are minor. Very cool and wet springs favor the disease. Symptoms consist of yellowish orange pustules occur in long stripes on the leaves. No control practices are needed. Some wheat varieties are resistant. Trace amount wheat loss in 1999 was estimated.

Ergot (*Claviceps purpurea*) sclerotia replace the developing grain and contain mycotoxins. It is rare in wheat. Rain and high humidity during flowering favor the disease. Kernels are replaced with hard black-purple fungal structures with a white or gray interior.

Management:

- Kernels can be screened from the grain

Scab or Fusarium Head Blight (*Fusarium graminearum*) losses may be serious in eastern and north central Kansas. Rain and high humidity during flowering favor the disease. Heads become completely or partially blighted and masses of pinkish-orange fungal spores are seen on the spikelets or on the rachis. Seeds become pink or discolored and chalky in texture. Estimated wheat loss in 1999 was 0.2 percent compared to 0.4 percent for the last 10 years.

Management:

- Use resistant wheat varieties
- Use crop rotation except planting into corn residue
- Plant different varieties with various maturity dates.

Black Point or Black Tip Fungus reduces germination and lowers grade grain. Rain after wheat matures favors the disease. The embryo end of kernel becomes black and the kernel may become shriveled.

Management:

- Prompt wheat harvest

Loose Smut (*Ustilago tritici*) is occasionally a problem with bin-run seed. Rain during flowering favors the disease. Floral parts of the wheat head are replaced by masses of brownish-black, powdery fungal spores. Trace amount wheat loss in 1999 was estimated.

Management:

- Use seed treated with fungicides
- Use certified wheat seed.

Crown Rot is common throughout the state after a severe winter. Drought stress, loose soil, and cold tender varieties favor the disease. Symptoms consist of the crowns with interior browning, thin stands, reduced tillers, and poor vigor. Trace amount wheat loss in 1999 was estimated.

Management:

- Plant cold hardy varieties
- Use moisture conservation practices
- Use soil packer if soil is extremely loose after planting.

Dryland Foot Rot or Fusarium Crown Rot (*Fusarium graminearum*) occurs in dry years in south central and southwestern Kansas. Drought stress and continuous wheat favor the disease. Symptoms consist of white heads, pinkish brown stem base filled with white fungus with internal browning of the crown tissue, and stunted plants.

Management:

- Follow moisture conservation practices
- Use crop rotation.

Take-all Root Rot (*Gaeumannomyces graminis*) common in eastern and central Kansas and sometimes in center pivot fields in southwestern Kansas. Continuous wheat with minimum tillage, early planting, planting wheat after barley or brome, good soil moisture in the fall, volunteer wheat and liming soils favor the disease. Symptoms appear in patches in the field, consist of white heads, stunted plants, shiny black discoloration of the stem base, and black rotten roots. Estimated wheat loss in 1999 was 0.01 percent and 0.29 percent for the last 10 years.

Management:

- Rotate crops except barley and brome
- Reduce crop residue with tillage
- Delay wheat planting
- Control volunteer wheat in continuous wheat
- Use seed treated with fungicides
- Use biocontrol management program

Eyespot, Strawbreaker, or Foot Rot (*Tapesia yallundae*) is a rare disease but may cause severe lodging. Continuous wheat and cool and wet springs favor the disease. Symptoms consist of brown lesions at the base of stem, sometimes with charcoal gray fungal structures in the center. Trace amount wheat loss in 1999 was estimated.

Management:

- Rotate crops.

Sharp Eyespot (*Rhizoctonia cerealis*) common but usually not severe and may cause seedling blight when it attacks young seedlings. Early planting and continuous wheat favor the disease. Symptoms consist of white heads, stunted plants, tan lesion with brown border and sharply pointed ends at the base of stem.

Management:

- Delay planting of wheat
- Rotate crops.

Fungicides used during 1998 were not reported sufficiently to publish any data. However, the following list is the recommended wheat foliar fungicides for Kansas wheat fields:

Mancozeb

- **Trade name and formulation:** Dithane® M-45, Manzate® 75 DF, Penncozeb® DF @ 1.6 lb a.i./A, 1.5 lb a.i./A, and 2 lb at 0.75-1.5 lb a.i./A, respectively.
- **Application time:** after flag leaf emergence but before significant disease develops on the flag leaf
- **Comments:** a protectant fungicide with no systemic action. Has fair to good activity on tan spot and Septoria leaf blotch and leaf rust, respectively. Poorly controls powdery mildew. Has the shortest residual effect. Do not apply after Feeke's Growth Stage 10.5 (full head emergence). A minimum of 26-day waiting period is required between application and harvest.

Propiconazole

- **Trade name and formulation:** Tilt®
- **Use rates:** 4 fl oz/A (41.8% a.i)
- **Number of application:** 1.0
- **Application time:** through Feeke's Growth Stage 10.5 (full head emergence)
- **Comments:** a partially systemic fungicide. Has a good-excellent control on leaf rust, Septoria leaf blotch, tan spot, and powdery mildew. Remains effective more than 3 weeks and has 40 day PHI.

®Registered name

™Trade name

*Restricted-use pesticide

Weeds

Weedy plants and wheat require the same resources for growth such as nutrients, water, and sunlight. Use of these resources by growing weeds makes them unavailable for wheat growth. Weeds not only reduce wheat yield, they also interfere with harvest and result in dockage and lower quality grain. It has been estimated that weeds caused over \$50 million annual loss in production of Kansas wheat. Timely weed control is important to minimize early season weed competition

with wheat plants. A healthy stand of winter wheat that has a head start on winter annual weeds is very competitive and will suppress weed growth.

Preventive Weed Control Practices:

- Plant weed-free wheat seeds
- Harvest the clean fields or parts of fields before harvesting weedy areas
- Clean equipment and combines when moving between infested fields
- Hand remove scattered weeds such as volunteer rye when first observed.

Cultural Practices to Control Winter Annual Grasses:

- Crop rotation (74.1% of wheat acreage in 1994) has been reported to be the most effective method of nonchemical control of winter annual grasses in Kansas wheat acres. Rotating to summer crops helps break the life cycle of these weeds and allows the use of tillage or herbicides during fall or spring to prevent seed production and deplete seed reserves in the soil.
- Burning (31.9% of wheat acreage in 1994) and moldboard plowing wheat stubble (35.5% of wheat acreage in 1994) are still used to manage winter annual grasses, but are discouraged due to soil erosion potential and incompatibility with conservation compliance provisions.
- Delayed seeding (25.5% of wheat acreage in 1994) is another method of nonchemical control that can reduce winter annual grass populations, but provides only partial control and varies with precipitation patterns and soil temperatures.
- A small percentage of wheat acreage infested with winter annual grass weeds is diverted to hay or uses other than grain to control winter annual grasses.

The most abundant, widespread, and troublesome grasses in Kansas wheat fields are the cheatgrasses (cheat, Japanese brome, and downy brome), followed by jointed goatgrass and volunteer rye. The first two weeds are competitive and difficult to control. State wide, 13% of wheat acres in 1994 was infested by cheatgrass with the greatest concentration in south central Kansas. About 5% of Kansas wheat fields were infested by volunteer rye which was most common in north central, central, and south central Kansas. Only 2% of wheat fields were infested by jointed goatgrass, found mainly in western and central Kansas. Statewide, 13, 18, and 14% of Kansas wheat acreage infested with cheatgrass, volunteer rye, and jointed goatgrass, respectively, were treated with herbicides.

Winter annual broadleaf weeds such as flixweeds, tansymustard, and field pennycress are the most abundant weeds in winter wheat fields. These weeds can cause significant yield reduction if left uncontrolled, but can be easily controlled by herbicides. Herbicides are safe and effective options for control of certain weeds in wheat. However, herbicides can't solve all weed problems and are used only as needed in an integrated weed management program. Herbicides are applied at the stages of applications recommended on the label and when wheat is in the proper and safe stage to avoid crop injury. No herbicide is labeled for application when wheat is in early boot to soft dough stage.

Primary Weeds in Kansas Wheat Fields:

1. Common winter annual weeds:

Broadleaf weeds

- **Henbit** (*Lamium amplexicaule* L.) is annual weed native of Europe. Flowering season is from March to May. Seeds are the source of reproduction. Found in lawns, gardens, waste places, roadsides, and cultivated small grain and alfalfa fields. It is a common urban weed.
- **Field pennycress** (*Thlaspi arvense* L.) (**fanweed, stinkweed**) is a broadleaf weed native of Europe. Flowering season is from March to June. Seeds are the source of reproduction. Found in small grain fields, alfalfa fields, hayland, pastures, gardens, roadsides, and waste places.
- **Tansymustard** (*Descurainia pinnata*) (**green tansymustard**) is a broadleaf native weed. Flowering season is from March to June. Seeds are the source of reproduction. Found on rangeland, roadsides, sparsely wooded areas, small grain and alfalfa fields, waste places, and abundant on dry and sandy soils.
- **Flixweed** (*Descurainia sophia* L.) (**herb sophia**) is a herbaceous winter annual or summer annual weed, native of Eurasia. Flowering season is from May to June. Seeds are the source of reproduction. Found on rangeland, roadsides, sparsely wooded areas, small grain and alfalfa fields, waste places, and abundant on dry and sandy soils.

- **Bushy wallflower** (*Brassicaceae*- Mustard family) (**wallflower mustard, wormseed wallflower, wormseed mustard**) has larger petals than those of wallflower mustard. Flowering season is from March to June. Seeds are the source of reproduction. Found in roadsides, cultivated fields, waste places, meadows, and disturbed sites.

Grasses

- **Jointed goatgrass** (*Aegilops cylindrica*) (**jointgrass**) is a cool season grass weed native of Europe. Seeds are the source of reproduction. A troublesome weed in wheat fields because of its competitiveness and difficulty to control. Found on roadsides, waste places, alfalfa fields, and pastures.
- **Cheat** (*Bromus secalinus*), **Downy brome** (*Bromus tectorum* L.), and **Japanese brome** (*Bromus japonicus*) (**cheatgrass, chessgrass, wild oats, military grass**) are cool season grasses, native of Europe. Seeds are the source of reproduction. Troublesome weeds in wheat because of their competitiveness and difficulty to control. Found on rangeland, fields, disturbed sites, roadsides, and waste places.

2. Common summer annual weeds:

- **Wild buckwheat** (*Polygonum convolvulus* L.) (**climbing buckwheat**) is a native of Europe. Flowering season is from June to September. Seeds are the source of reproduction. Found on dry soils of rangeland, roadsides, waste places, and small grain fields.
- **Kochia** (*Kochia scoparia* L.) (**fireweed, Mexican firebush, tumbleweed**) is a native of Eurasia. Flowering season is from July to October. Seeds are the only source of reproduction. Found on rangeland, pastures, fields and disturbed sites.
- **Russian thistle** (*Salsola iberica*) (**tumbleweed, tumbling thistle**) is a native of Europe. Flowering season is from July to October. Seeds are the source of reproduction. Found on smallgrain fields, cultivated dryland fields, and waste places.
- **Common sunflower** (*Helianthus annuus* L.) (**annual sunflower**) is a native weed. Flowering season is from July to September. Seeds are the only source of reproduction. Found in cultivated fields, pastures, gardens, roadsides, waste ground, and disturbed sites.

3. Common perennial weeds:

- **Field bindweed** (*Convolvulus arvensis* L.) (**creeping Jenny**) is a native of Eurasia. Flowering season is from June to September. Seeds and spreading roots are the sources of reproduction. Found on both cultivated and uncultivated land. It is most common on smallgrain fields, waste places, gardens, and roadsides.
- **Woollyleaf bursage** (*Ambrosia grayi*) (**bur ragweed, woollyleaf povertyweed, woollyleaf franseria, lagoonweed**) is a native perennial weed. Flowering season is from August to October. Spreading roots and seeds are the sources of reproduction. Found in moist places in the fields, rangeland, and roadsides, and can grow in saline soils.

Chemical treatments:

In 1995, 61 percent of Kansas wheat acres received at least one treatment of a herbicide. The majority of the herbicides were applied postemergent with ground equipment (52 percent of wheat acres). Only 7 percent of Kansas wheat acres were treated by aerial application. Only 4 percent of Kansas wheat acres were treated with herbicides before planting, while 56% of wheat acres received a herbicide treatment after planting. In 1998 the most commonly used herbicide was 2,4-D, which was applied to 19 percent of the acres at an average rate of 0.47 lb a.i./A totaling 1.2 million lb.

The following are the primary herbicide active ingredients used on Kansas wheat acres in 1998. The herbicides are classified according to the primary mode of action.

Amino acid synthesis (ALS synthase enzyme) inhibitors:

Chlorsulfuron

- **Trade name and formulation:** Glean®
- **Average use rate:** 0.010 Ib a.i./A
- **Number of application:** 1.0
- **Percent acres treated:** 15%
- **Amount applied per year:** 19,000 Ib
- **Application time:** preplant and/or preemergence; primarily postemergence, after the 2-leaf but before the boot stage of wheat
- **Target plants:** many broadleaf weeds and annual cheatgrass suppression
- **Component of other products:** Finesse®.

Metsulfuron-Methyl

- **Trade name and formulation:** Ally®
- **Average use rate:** 0.003 Ib a.i./A
- **Number of application:** 1.0
- **Percent acres treated:** 9%
- **Amount applied per year:** 3,000 Ib
- **Application time:** preplant and/or preemergence; primarily postemergence after the 2-leaf but before the boot stage of wheat; occasionally in fallow, and preemergence in combination with chlorsulfuron; preharvest
- **Target plants:** many broadleaf weeds
- **Component of other products:** Finesse®.

Triasulfuron

- **Trade name and formulation:** Amber®
- **Average use rate:** 0.02 Ib a.i./A
- **Number of application:** 1.0
- **Percent acres treated:** 3%
- **Amount applied per year:** 5,000 Ib
- **Application time:** preplant and/or preemergence; primarily postemergence; after the 2-leaf but before the boot stage of wheat
- **Target plants:** many broadleaf weeds and cheatgrass suppression
- **Component of other products:** Rave™.

Growth regulators:

2,4-D

- **Trade name and formulation:** several formulations or trade names
- **Average use rate:** 0.47 Ib a.i./A
- **Number of application:** 1.3
- **Percent acres treated:** 19%
- **Amount applied per year:** 1.2 million Ib
- **Application time:** preplant and/or preemergence; postemergence to tillered wheat and prior to the boot stage of growth; fallow and preharvest
- **Target plants:** annual and perennial broadleaf weeds
- **Component of other products:** Landmaster®BW.

Dicamba

- **Trade name and formulation:** Banvel® , Clarity®
- **Average use rate:** 0.10 Ib a.i./A
- **Number of application:** 1.0
- **Percent acres treated:** 3%
- **Amount applied per year:** 30,000 Ib
- **Application time:** preplant; postemergence; preharvest
- **Target plants:** annual and perennial broadleaf weeds

- **Component of other products:** Fallow Master® , Rave™.

MCPA

- **Trade name and formulation:** MCPA amine 4 or LV ester,
- **Average use rate:** 0.21 lb a.i./A
- **Number of application:** 1.0
- **Percent acres treated:** 1%
- **Amount applied per year:** 25,000 lb
- **Application time:** postemergence after the 3-leaf stage but before the boot stage of wheat
- **Target plants:** broadleaf weeds
- **Component of other products:** Bronate® , Bison™.

Picloram

- **Trade name and formulation:** Tordon® * K
- **Average use rate:** 0.03 lb a.i./A
- **Number of application:** 1.0
- **Percent acres treated:** 2%
- **Amount applied per year:** 7,000 lb
- **Application time:** preplant, after wheat harvest and before planting winter wheat, barley, or oats in continuous small grains or small grain/fallow systems
- **Target plants:** field bindweed and many annual broadleaf weeds
- **Component of other products:** none.

®Registered name

™Trade name

*Restricted-use pesticide

Contacts

Kansas State University:

- Sorkel Kadir, Crop Profile Coordinator
Research Assistant Professor
KSU/Agronomy Department
2009B Throckmorton Hall
Manhattan, KS 66506
Telephone: 785-532-5420
Fax: 785-532-6094
Email: skadir@bear.agron.ksu.edu
- Donald C. Cress, Extension Pesticide Coordinator
Professor
KSU/Department of Entomology
239 Waters Hall
Manhattan, KS 66506
Telephone: 785-532-5891
Fax: 785-532-6232
Email: dcress@oz.oznet.ksu.edu

- Dallas E. Peterson, Extension Weed Science
- James P. Shroyer, Extension Agronomy
- Leroy Brooks, Extension Entomology
- Robert L. Bowden, Extension Plant Pathology

Kansas Department of Agriculture:

- Dale Lambley, Special Environmental Assistant to the Secretary
- Eldon J. Thiessen, State Statistician, Division of Statistics
- John K. Stamer, Special Assistant to the Secretary for Pesticide Issues

Brett W. Myers, Executive Vice President, Kansas Association of Wheat Growers

Doug Wareham, Kansas Fertilizer and Chemical Association

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Prepared August, 1999

Database and web development by the [NSF Center for Integrated Pest Management](#) located at North Carolina State University. All materials may be used freely with credit to the USDA.